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Dynamics of the Relationship Between Science and Ideology and the Origins of the Nuclear Program in the Context of the Socioeconomic Transformation of the FPRY

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Abstract:

During the Cold War, both blocs aimed to shape science, as well as conceptions about its role in society. Two perspectives on science prevailed: the perspective of free and apolitical science in the Western Bloc and the perspective of partisanship in science in the Eastern Bloc. The concept of big science became an important characteristic of scientific endeavors, especially in fields such as (nuclear) physics. Before the break with the USSR in 1948, the Yugoslav system was characterized by emulation of the Soviet model in all spheres of society, which also applied to the sphere of science. This dissertation looks into the consequences in the area of scientific organization and scientific discourse of the socioeconomic transition of the Yugoslav socialist system, which followed the turbulent break with the USSR. Using the Cold War scientific perspectives, I compare the organization of science and the scientific discourse in Yugoslavia before the break, to the period after the break, when the Yugoslavia, at least in the beginning, strongly turned towards the Western Bloc. Retaining the socialist ideology, but exposed to the dynamics of decentralization and, to a larger extent than before, to market forces, Yugoslav socialism acquired a specific form. This novel configuration has positioned Yugoslav science in the direction of the Western conception of the nature and the role of science in society (primarily with the emphasis on autonomy and decentralisation). Thus, while tracing those occurrences, I will analyse Yugoslavia's attempt to construct a big science project by presenting the development of the Yugoslav nuclear program within the context of the Cold War and geopolitical and socioeconomic dynamics in the (semi)peripheral Yugoslavia.

Keywords: Cold War; Science; Yugoslavia; Ideology; Big Science; Yugoslav Nuclear Program

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Динамика односа науке и идеологије и зачеци нуклеарног програма у контексту друштвено-економске трансформације ФНРЈ

Сажетак:

Током Хладног рата, циљ оба блока био је да обликују науку, као и схватања о њеној природи и улози у друштву. Преовладавале су две перспективе: перспектива слободне и аполитичне науке у Западном блоку и перспектива партијности у науци у Источном блоку. Концепт велике науке постао је важан елемент разних научних подухвата, нарочито изражен у областима попут (нуклеарне) физике. Пре раскида са СССР-ом 1948, југословенски систем тежио је ка успостављању совјетског модела у свим сферама друштва, самим тим и у сфери науке. Овај рад бави се последицама насталим услед друштвено-економске транзиције југословенског социјалистичког система, првенствено у области научне организације и научног дискурса, која је уследила након бурног раскида са СССР-ом. Користећи поменуте хладноратовске перспективе о науци, у раду се пореди организација науке и доминантног научног дискурса у Југославији пре раскида, са периодом када се југословенски систем након раскида, бар у почетку, снажно окренуо ка Западном блоку. Задржавајући социјалистичку идеологију, а изложен динамици децентрализације и, у већој мери него раније, тржишним силама, југословенски социјализам добија специфичан облик. Ова нова конфигурација усмерила је југословенску науку ка западном схватању природе и улоге науке у друштву (пре свега по питању аутономније и процеса децентрализације у науци). Стога, док пратимо овај развој, у раду се анализира покушај Југославије да направи пројекат у складу са концептом велике науке, кроз испитивање развоја југословенског нуклеарног програма у контексту Хладног рата и друштвено-економске динамике у (полу)периферном југословенском систему.

Кључне речи: Хладни рат; наука; Југославија; идеологија; велика наука; југословенски нуклеарни програм

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Introduction

This dissertation examines the relationship between political ideology and science, using the history of cooperation and the breakup of relations between the USSR and the Federal People's Republic of Yugoslavia (FPRY) as a case study. It looks into the effects of the termination of that cooperation in 1948 on Yugoslav scientific systems, as well as the origins of the Yugoslav nuclear program while taking into account the Cold War's effects on the country's political and economic transformation.

Looking at Yugoslavia's initial turn toward the West after breaking up with the USSR as an important aspect of certain socioeconomic and ideological processes that ensued in Yugoslav science, the dissertation emphasizes the significance of Yugoslavia in the international political system, despite being structurally (semi-)peripheral, in its quest for independence. This is one of the key reasons why socialist Yugoslav science makes a compelling case for investigating the various ideological influences associated with science during the Cold War era, both in terms of culture and other domains, which were an important aspect of the Cold War struggle for hegemony in the bloc-divided world. In line with this, by situating the relationship between Yugoslav science and the Yugoslav socialist system within the larger international context of the Cold War and global ideological struggle, the work presents the fundamental processes related to the relationship between science and ideology during this period through the lens of dependency theory. In other words, Yugoslav science is approached in a manner that opens up space for mapping and examining various global and local influences. By intertwining, these influences provide the structural and ideological basis for the development of a certain type of scientific organization and discourse in society.

Using a multidisciplinary approach, we will attempt to shed light on the connection between science and political ideology. This is significant because we believe that Yugoslav science should be evaluated from multiple angles in order to provide a complete picture of the scientific and ideological patterns that are interwoven during the turbulent Cold War period. Furthermore, this contributes to a more thorough understanding of nature and the role of Yugoslav science as an integral element of Yugoslav culture, politics and society. The work approaches science as a social activity that does not exist in a vacuum compared to socioeconomic and ideological processes but rather observes how they profoundly influence it, with science also being used in the given socio-political system as an instrument for shaping society in a certain direction. Thus, it creates space for addressing the nominally opposing conceptions of "free", Western science and "partisan", Soviet science, as well as the importance of these ideological perspectives in the Cold War setting.

Science carries undeniable importance in international relations, economic development, political and cultural prestige, and the state's global positioning, which was particularly visible during the Second World War, when nuclear energy was applied for the creation of atomic weapons (contributing to the further development of nuclear energy and its application). This, along with nuclear diplomacy, which was inseparable from ideological strategies and power struggles during the Cold War, brought the topic of the nuclear program to the forefront. This was indeed the reason to examine the origins of the nuclear program in Yugoslavia, viewing it as an attempt to create a big science project in a (semi-)peripheral country, whose developmental path was also marked by Soviet principles of scientific organization, as well as processes that, at least nominally, were associated with the Western model of science. Yugoslavia was a country undergoing accelerated modernization during this period, so the development of the nuclear program was also observed in that context. Additionally, the program was seen as a means to acquire military-political prestige and strength, the ability to deter enemies from attack, and strengthen the overall international reputation of the state. Furthermore, it is interesting to examine Yugoslav science, specifically in this case the Yugoslav nuclear program, in terms of the relationship between science and ideology because, as this work will demonstrate, certain

changes detected in its later stages mirrored the processes permeating the system of socialist self-management (decentralization, "deetatization," debureaucratization, etc.). On the other hand, even after Yugoslavia's break with the USSR, the Yugoslav nuclear program in its initial phase was structured in accordance with the model of Soviet science. In order to map organizational changes in Yugoslav science through the example of this program, this work examines the period of the Yugoslav nuclear program between 1948 and 1971, which is a specific focus compared to the rest of the paper, which predominantly covers the period between 1945 and 1960.

Examining the nuclear program in Yugoslavia in this way gives space to consider the big science phenomenon in the Cold War context from the perspective of Yugoslavia – a state that sought non-bloc positioning. This is important because, from a contemporary theoretical perspective, the Soviet model of science was seen as an early variant of the big science phenomenon. Therefore, it is not surprising that the guiding principles of big science, which will be further discussed in this paper, are in line with the important principles of organizing Soviet science (Kojevnikov 2004: 23). It seems that the reason for using different terminology and ignoring similarities needs to be sought, as the historian of science Alexei Kojevnikov (2004) points out, precisely in the atmosphere of the Cold War. Even though the real scientific practice in both blocs shared a larger degree of common practices and thus deviated from their proclaimed principles, the public highlighting and exaggeration of exclusively irreconcilable differences between the blocs dictated the dynamics of relations in science during the Cold War. Moreover, because Yugoslavia at the beginning of the 1960s actively participated in the creation of the Non-Aligned Movement, and was its member, this work contributes to mapping certain guidelines for the future analysis of the relationship between the Yugoslav quest for independence, the Non-Aligned Movement and the nuclear program in the context of Cold War relations of power, nuclear diplomacy and non-proliferation, as well as the US strategy of pushing the USSR out of Europe. Such an analysis could help identify certain patterns governing the relationship between political ideology and science more broadly. It will also help shed light on the organization of science in Yugoslavia and perhaps allow researchers in the future to investigate potential Yugoslav contributions to the formation of non-aligned science's underlying presuppositions.

The interpretation of interest in this paper is not confined to purely economic considerations, although this factor is considered very important for the analysis of this subject. In our analyses, it was also crucial to encompass the broader social position of scientific institutions, and political and ideological groups, particularly the Cold War Blocs and Yugoslavia, into this context. To comprehend the intricate influences of specific social conditions, and properly interpret social and political affairs in this period, using more expansive frameworks was necessary. The evolution of science in general and the nuclear program in Yugoslavia will thus be scrutinized through historical, sociological, and philosophical lenses.

The work will present the main characteristics, role, and position of science in the Cold War while highlighting both the similarities and the specificities of the organization of science in both blocs. It will strive to outline the basic assumptions of the "free" science perspective, as well as the Marxist-Leninist perspective of science, through the ideas and views of certain theorists, philosophers, sociologists, and ideologists. Accordingly, I will examine the ideology of Marxism-Leninism and the role of science in the USSR until 1953. This year marks the death of Joseph Stalin, which encouraged changes and so-called revisionism of the ideology of Marxism-Leninism. I will attempt to do the same with the science and ideology of science in the US, trying to grasp the basic notions of science that were underlined by this system.

Furthermore, the first part of this examination will focus on the FPRY from 1945 to 1948 and the initial period after the break with the USSR. This I consider significant because presenting and mapping basic economic, political, and social processes and changes in the Yugoslav society after

the war and the break with the USSR is an important aspect of this work, to better single out these processes and their effects on Yugoslav science. During the 1945-1948 period, Yugoslavia aligned itself with the Soviet Union, resulting in an emphasis on the implementation of Marxist-Leninist ideology across various social domains. This is evident in the realm of science as well. More specifically, this is also observable in the domain of scientific policy and organization, where a strong connection between the party, state, and science is present. This connection involves centralization, direct state funding, and an emphasis on the discourse of science for the benefit of society rather than science for its intrinsic value. Further in the analysis, I will address the post-1948 period, marked by the rupture in cooperation between Yugoslavia and the Soviet Union and its effects on science. During that time, Yugoslavia reoriented toward the West and started relying more on a limited and controlled market system. This shift, as I will show in this dissertation, is also reflected in the scientific domain, leading to a process of decentralization, change in the scientific organization, change in the funding of science and the dynamics of prominent scientific institutions, as well as ideological changes in scientific discourse.

To gain a comprehensive understanding of the significance and dynamics of the Yugoslav nuclear program in the context of the Cold War, the role of nuclear diplomacy, and the strategy in the power struggle, this work will present a brief history of the development of nuclear physics. Specifically, it will provide an overview of the period of significant scientific discoveries in nuclear physics leading up to the creation of the atomic bomb. Additionally, this section of the dissertation will also briefly present the basic characteristics and historical context of the phenomenon of big science in the US, and its connection to the idea of Soviet science, with a slightly greater focus on nuclear physics. As mentioned, this part of the work will focus on the initial steps of the nuclear program's establishment, its position, and its role in Yugoslavia. Slightly more attention is devoted to the organizational aspect of the nuclear program and the significance of state leadership in its development in the context of broader socioeconomic developments.

Subject, Goals, Hypotheses, and Contributions of the Research

The subject and goals presented in the Proposal were further elaborated and adapted throughout the process of writing this dissertation.

The subject of this dissertation is the relationship between science and political ideology, using the history of cooperation and confrontation between Yugoslavia and the USSR as a case study. It analyses the practical implications of the termination of this cooperation in 1948 on Yugoslavia's science system and the origins of its nuclear program. It considers the economic and political shifts during the Cold War era. Through novel insights and a multidisciplinary approach, I will try to contribute to shedding light on the dynamics of the relationship between science and political ideology in general during this period. The goal of the dissertation is to explore this relationship considering its historical-sociological and philosophical aspects. In this work, I also focus on analyzing the beginnings of the nuclear program in Yugoslavia. The aim is to compare the impact of Soviet ideology on Yugoslav science during Yugoslavia's collaboration with the USSR with Yugoslav science after the 1948 split, in the context of the Cold War and the introduction of a new political system – socialist self-management. I suggest that such an analysis enables us to identify certain patterns governing the relationship between political ideology and science overall. This, in turn, can enhance our understanding of how science was structured within Yugoslavia.

As its particular objectives, this dissertation highlights:

- A brief explanation of the relationship between political ideology and science.

- An examination of Cold War dynamics, with specific attention being lent to the nature and role of science throughout this period.

- Compiling, organizing, and presenting data concerning the nature and role of science within both the Western Bloc and the Eastern Bloc.

- A historical, sociological, and philosophical exploration of the collaboration between the FPRY and the USSR, emphasizing its influence on science in Yugoslavia pre-1948.

- An analysis of the termination of the cooperation between Yugoslavia and the USSR and Yugoslavia's (initial) strong shift toward the Western Bloc. The examination encompasses historical, sociological, philosophical and natural science viewpoints, emphasizing impact of the break on the relationship between political ideology and science within Yugoslavia.

- A short overview of the history of usage of nuclear energy and the path leading to the development of the nuclear bomb in the Second World War.

- A brief presentation of the big science phenomenon: basic features, the Cold War setting, (nuclear) physics in the US and presentation of Soviet science as a forerunner of the big science phenomenon.

- Presentation and analysis of the nuclear program in Yugoslavia: an attempt to create big science on the (semi-)periphery in the Cold War context.

- Examination and exposition of fundamental theoretical conclusions derived from analyses of the interplay between political ideology and science in the Cold War setting using Yugoslavia as a case study.

The dissertation presents the following hypotheses:

- By discontinuing cooperation with the USSR, Yugoslavia, which up until then had relied on the Soviet system based on Marxism-Leninism, began to reshape its structure along the lines of decentralization and the introduction of a limited market. In terms of the ruling socialist ideology, this resulted in a new ideological paradigm – socialist self-management. The specificity of the ideology of self-managed socialism was also reflected in science, where one can also detect the mentioned decentralization processes and effects of the introduction of a limited market, along with the effects of introducing the concept of autonomous science.

- An example of the nuclear program (nuclear physics) in Yugoslavia, India, the US, and the USSR shows us that the role of science, even in systems that were – in an ideological sense – mostly opposed, was in reality very similar due to the strategic importance of science for social development, and particularly of nuclear physics for ensuring the relative independence of the state. Thus, the state-level approaches to organizing scientific work were similar too. Despite this fact, or precisely because of it, science was essentially not independent from political ideology.

Compared to the subject proposal from 2020, specific goals for the dissertation have been clarified, which resulted in the adaptation of the draft from the proposal. It is also worth noting that the work on this paper was influenced by the pandemic, significantly hindering and slowing down the writing process. Access to certain libraries and archives (such as the National Library of Serbia and the Archive of Yugoslavia) was considerably hindered, even for some time after the pandemic, significantly affecting both the work on this topic, the time required for its completion, and its quality. Additionally, in-depth interviews for the period of the Yugoslav nuclear program, despite attempts to reach relevant interviewees, proved to be an unrealistic aspect of the proposal. This was due to the difficulty of accessing experts from that era, especially considering the pandemic and other unforeseen circumstances. The entire project underwent further specific challenges and delays, which were communicated to the committee members. Given the technical constraints of this paper, I decided to narrow the focus and orient it towards the Yugoslav nuclear program in the context of the Cold War, considering the attempt to form the big science phenomenon in a (semi-)peripheral country. The paper includes a brief comparison of differences and similarities in the development of nuclear energy and the big science phenomenon between the US and the USSR, with a focus on nuclear physics, its application, and its general significance for the superiority struggle during the Cold War; however, there was no opportunity for a comparative study of the Indian nuclear program.

Theoretical-Methodological Framework

One of the theoretical approaches to the subject of this dissertation will be based on the ideology-critique perspective combined with the ideology-theory approach. According to philosopher and social scientist Jan Rehmann (2015) the "ideology-theoretical turn" of the 1970s and 1980s aimed to reestablish Marxist investigations into ideology. The main idea behind this effort was to move beyond the traditional focus on criticizing "false" consciousness. However, this resulted in an understanding that suppressed the critical and radical aspects of Marx and Engels' notions of ideology. According to Rehmann (2015), the dichotomy between these approaches is counterproductive. Instead of this dichotomy, he advocates for a revival of ideology critique informed and supported by a materialist theory of ideology.

Marx's concept of ideology centers on the idea of false consciousness, primarily addressing distorted perceptions originating from economic structures. Gramsci's concept of "cultural hegemony" extends beyond false consciousness, positing that the ruling class not only enforces its ideas through force but also secures dominance by shaping norms, values, and institutions (see Marx and Engels [1848]1986). This approach delves into how ideas permeate various societal aspects beyond economic relations (Gramsci 1999). Hegemony allows for asserting control over the superstructure, assuming "that a social group can reproduce or fragment the concrete 'historical bloc' (the overall society from the superstructure to the economic base)" (Kadri 2023: 8). For this reason, Gramsci believed, it was important to pay attention to the dialectics "between the economic base and the super-structure" (Kadri 2023: 8-9).

Rehmann (2015) challenged an approach that places Marx/Engels' and Gramsci's concepts of ideologies at opposite extremes. He asserts that both perspectives gain strength from a distinctive combination of critical and structural ideology concepts. Rehmann concludes that these perspectives are not mutually exclusive but can complement each other effectively (Rehmann 2015: 11). He contends that within academia there was a period in which both ideology-critique and ideology-theory traditions were marginalized. Now, however, there is an attempt to resurrect the ideology-critique project. This involves employing a theory of the ideological as a "conceptual hinterland," underscoring the significance of a theoretical framework for comprehending and criticizing the ideological aspects of society. Understanding ideology in its specific historical and social context is likely a crucial aspect of this perspective (Rehmann 2015: 11-14).

Accordingly, certain segments of the dissertation (its attempts to map certain deviations in practice from declared scientific discourses) rely more on the ideology-critique approach. According to this perspective, ideology represents a "false consciousness" that always protects the particular social interests of the ideological hegemon. Universality, which, according to this perspective, ideology aspires to achieve, represents strategies of mystification of the "*true reality*" used by the ruling class to maintain its power in society (Marinković and Ristić 2013: 34-35). Ideology is the "defective/false model of thinking, knowing, and discourse […] opposed to the *true, adequate* thinking of the proletariat and its avant-garde about the possible social reality" (Marinkoivć and Ristić 2013: 36). According to this position, it is possible to radically change "social reality … in accordance with knowledge and thought that is not ideological, hence not *false* or *defective*…" (Marinković and Ristić 2013: 36).

In its original form, this perspective is founded on the critique of the capitalist order. The ruling class in capitalism – the bourgeoisie – controls the means of production and thus the key social mechanisms, enabling it to shape the dominant ideology according to its own interest. For Marx, the primary function of this understanding of ideology is to obscure the reality of existing production relations that underlie social inequality. In this way, ideology contributes to the reproduction of the

existing social structure and prevents the working, oppressed class from recognizing and opposing its exploitation. According to this view, ideology primarily serves the domination of the ruling class, shaping dominant social ideas and norms, thereby contributing to their general perception as "natural." In this way, society ensures the optimal cohesion necessary for the daily functioning and maintenance of the capitalist system (see Marx ([1867]1967; Marx and Engels [1846]1974).

> "Marx and Engels directed their assault on false consciousness and ideology against those intellectuals who, if they themselves thought they saw clearly, produced in their work a picture of reality that was distorted. Such distortion which in part could be traced to the class background of the authors, consciously or not served the interests of the dominant classes" [Eyerman 1981: 44].

On the other hand, because of the significance of the dynamics between ideology and science in this work, and in that context, insight into the status and role of science in society, certain segments rely more on Gramsci's ideology-theory approach. Although with a slightly different analytical focus, the philosopher Louis Althusser, whose approach will be discussed in the *Science and Ideology* section, also significantly relied on Gramsci's insights, as noted by Rehmann (2015).

"Gramsci pointed to the link, or 'vital connection', between ideology and society, culture and economy" (Omodeo and Badino 2021: 5). Accordingly, it is worth noting that according to Gramsci, (scientific) knowledge, which encompasses theory and practice, is connected to its historical and political context. According to this view, the nature of scientific knowledge requires reexamination within the broader context of cultural hegemony (Antonini 2014). Gramsci's concept of cultural hegemony originally refers to the dominance of cultural beliefs, social values, and norms imposed by the ruling class. According to this perspective, the ruling class maintains its social position not only through political and economic means but also by shaping and influencing the prevailing culture and science. In this way, the ruling class establishes its worldview as dominant in society and declares it as the socially desirable way of thinking. Such a situation makes it difficult for alternative ideological perspectives to gain power. For Gramsci, cultural hegemony is a key element in understanding the functioning of power beyond open political control (see Gramsci 1999). For Gramsci, in the process of struggle, political engagement, and common goals, culture and science move from transcendent logics that dominate consciousness, human relations, and action, into the sphere of political practice, which can be integrated into these collective endeavors (Omodeo 2019: 7). "[T]he Gramscian viewpoint of hegemony, specifically seeing science as a cultural praxis [...] recognizes that science inherently reflects the characteristics of the communities that generate and guide it" (Omodeo 2019: 7).

Accordingly, this perspective contributes to reexamining the role of science and scientists in society and strives to increase awareness about the political implications of scientific knowledge. This and similar observations contribute to an approach to history, sociology, and philosophy of science that recognizes links of science with social and political contexts, and points to its ideological character. Moreover, this approach points to a need to analyze science as part of the struggle for hegemony in the context of political and social transformations (Antonini 2014). Thus, in using this approach to analyze the role of science in society, science is primarily seen as a cultural phenomenon, that is, a part of culture where struggles for meaning take place. In this way, Gramsci's concept of hegemony, his view of culture and (scientific) knowledge contribute to the understanding of both science and, more generally, culture as social spaces where competition between different ideological perspectives takes place. Viewing "science as hegemony" entails an approach to science "as a politically articulated cultural phenomenon that is socially and historically grounded in struggles for meaning" (Omodeo and Badino 2021: 2). This approach has prompted the integration of political analysis into the study of scientific phenomena (Badino and Omodeo 2021: 2-3).

> "[T]he strength of this approach rests in the call for historical self-reflection as a means of comprehending the ideological component of any discourse on science and as a premise for political

> positioning in matters of culture, including science and the discourses thereupon. [...] For Gramsci [...] culture was not a mere epiphenomenon, but rather an integral part of historical reality. He saw it as an objectivizing force. Ideology transforms the world because it is part of the world, and science is the highest form of this transformative power of culture" [Omodeo 2020: 16-17, 47].

In this dissertation, we will also employ a theoretical approach based on world-system and dependency theories. This approach views the global economy as a complex system with a core (center countries) and semi-peripheral and peripheral countries. Center countries are economically developed and exploit (semi)peripheral countries, primarily viewing them through their resources and (cheap) labor force. These theories primarily emphasize structural inequalities established by the capitalist system on a global scale, focusing on economic relations, power dynamics, and historical development. This approach sees underdevelopment in poorer countries as a result of their dependency on richer countries. These theories identify economic, political, and social mechanisms through which wealth and power flow from the (semi-)periphery to the core countries (see Amin 1977; Wallerstein 2004).

Using this approach, sociologist Thomas Shott observes that the migration of scientists (and not just scientists) mostly took the direction from periphery to center, whereas the flow of dominant ideas (related to science and more broadly) went from center to periphery, despite science enjoying increased attention after the Second World War. He emphasizes that it was an unequal exchange, which further contributed to the existing imbalance between the center and the periphery. In such a distribution of power, the center accumulated recognition and influence that exceeded its own share in scientific research. Interestingly, Shott also observes that scientists from the center showed less flexibility and susceptibility to external (foreign) influences than initially expected of them, which also contributed to the "confidence" of center countries and their advantage over (semi-)peripheral countries. Additionally, Shott highlights that interactions between peripheral and center countries stimulated scientific research that was a significant part of modernization processes on the peripheries and strengthened the cohesion of the global scientific community. This community was based on a widely held belief in the universal validity of scientific knowledge, the idea that scientific knowledge should belong to humanity, the principle of granting autonomy and support to scientists, and collegial relationships among scientists worldwide. However, these scientific interactions between the center and the periphery also contributed to the strengthening of the dominance of center countries over (semi-)peripheral countries (Schott 1998).

The research in this work also involves employing document analysis, with a specific focus on pertinent literature, periodicals, published documents, and archival materials. This approach aims to either support or question the core hypotheses of the paper, primarily through the use of comparative-historical method.

According to sociologist Vojin Milić (1965), the comparative-historical method is defined as a research tendency toward studying specific social phenomena in their, preferably numerous and diverse forms arising from various natural and socio-historical conditions. According to him, the basic tasks of the comparative-historical method are systematic descriptions of specific social phenomena and different social orders and their explanation, which is also the focus of this research (Milić 1965: 657). The goal is to attempt to explain the observed connections among phenomena in order to uncover the general and specific conditions and causes due to which a certain phenomenon appears in its specific qualitative forms and different intensities (Milić 1965: 659). Thanks to the possibility provided by the comparative-historical method to analyze a certain social relations established through multiple historical situations, according to Milić (1965), researchers can now scientifically substantiate the assumption of general regularities observed in the relation to a greater extent. Moreover, considering that certain deeper social changes cannot be introduced into social life for scientific research, it could be useful to try to identify certain relations and phenomena that are our research interest, comparatively. This would allow us to observe how different social conditions and

circumstances affect the mentioned phenomena and thus reduce the risk of unjustified generalizations. According to Durkheim's division, comparative-historical research can be divided into three distinct groups based on breadth: (1) research conducted within in the same society; (2) research conducted in different societies but of the same socio-historical type; 3) general comparisons that basically refer to all historically known societies (Milić 1965: 659-661).

Employing the comparative-historical method in the study of various cultural, historical, social phenomena involves comparing and contrasting them to gain insights. This comparative approach enables researchers to uncover the fundamental beliefs or premises underlying their own conceptual frameworks. By exposing themselves to alternative perspectives and ways of thinking, individuals engaged in comparative research can critically reflect on their own assumptions. Since researchers are typically trained within a single cultural context, their primary task is to grasp another culture's perspective thoroughly. Subsequently, they face the additional challenge of effectively translating concepts, ideas, values, and worldviews into terms that align with their own familiar conceptual framework (Adams and Hoecke 2021: 244-245). In accordance with this, it may be essential to constantly shift between particularism and universalism (or between recognizing differences and similarities) (Adams and Hoecke 2021: 254). Some researchers concentrate primarily on highlighting differences in their research because differences are significant as they showcase the vast diversity and complexity of the social world. This emphasis on uniqueness acts as a counterbalance to comparative studies that excessively generalize (Lange 2012: 16).

Besides this, comparative-historical method encourages an interdisciplinary/multidisciplinary perspective (Adams and Hoecke 2021: 257: 261). This methodological approach frequently entails an exchange of ideas among disciplines and their theoretical frameworks, as well as among ideologies, cultures, their concepts, and the diverse ways they articulate and interpret reality (Adams and Hoecke 2021: 262). In essence, this method underscores the significance of maintaining an open mind, examining various viewpoints, and steering clear of oversimplification in comparative studies. It prompts academics to scrutinize evidence and theories rigorously, aiming to attain a more profound comprehension of intricate phenomena (Daloz 2021: 62-72). The comparative-historical method provides valuable insights into complex and relevant issues. This method has been useful in analyzing pivotal scientific issues, particularly focusing on change. Various central processes such as state building, nationalism, scientific and technological advancements, social movements, imperialism, warfare, capitalist development, etc., are essential for understanding the dynamics of the modern world. Many influential works on these topics have utilized comparative-historical methods (Lange 2012: 1).

In this study, a comparative-historical method will be utilized to analyze the development of science in the US, the USSR, and Yugoslavia during the Cold War era. The focus will be on comparing the organization, discourse, and ideological perspectives on science in these countries. Specifically, the research will explore the differences and similarities in scientific practices and ideologies between the US and the USSR, as well as changes in Yugoslav science before and after its alignment shift. The analysis will particularly delve into the nuclear program of Yugoslavia (but also of the US the USSR big science projects), examining the organization, financing, and political and ideological context. Through this comparative approach, the aim is to uncover how ideological perspectives influenced scientific endeavors and the impact of processes like centralization and decentralization on scientific development in Yugoslavia.

Science and Ideology

Upon examining the history of science, it becomes apparent that the notion of a rigid boundary between science and ideology is somewhat questionable. The historical development of science calls into question the notion that scientific endeavors are easily isolated from ideological influences. Although historian and philosopher of science Eric C. Martin acknowledges the problem of misrepresenting science to serve specific political interests, he shows that the politicization of science is not a new phenomenon. He contends that as long as science remains crucial to our most fundamental concerns, such contestations will likely persist. He sees the ideological debates surrounding science as indicative of its central role in the modern world (Martin 2018).

> "Science is normally portrayed as ideology-free, and ideology is usually accused of interfering with or distorting science. As the contributions to this book demonstrate, however, the interaction of science and ideology is subtler, complex, and interesting than this model of science and ideology as separate spheres would imply" [Walker 2003: 1].

In his book *Science in History* [*Nauka u istoriji*] ([1954] 1969ab; [1954] 1971ab), John Desmond Bernal, scientist and prominent science historian of a Marxist affiliation, argues that scientific progress should be observed in connection with dominant social processes and changes, particularly those in the sphere of the economy. Besides society and economy affecting the development of science, he highlights two key ways in which science can, in turn, affect the economy and society. One way implies the role of technology in production, while the other refers to scientific ideas and breakthroughs contributing to changes in the dominant ideology of societies. Bernal was not lonely in his observations.

> "If ideologies can be assimilated into science, science has also challenged traditional beliefs and ideologies. As one classicist argues, 'Ancient science is from the beginning strongly marked by the interplay between, on the one hand, the assimilation of popular assumptions, and, on the other, their critical analysis, exposure and rejection, and this continues to be a feature of science to the end of antiquity and beyond' (Lloyd 1983). Science and ideologies can adjust to one another, and this process is ongoing" [Martin 2018].

The interconnectedness of science, and its results, with the ideological struggle and national interests in the Cold War, was primarily achieved through state apparatuses (both ideological and repressive) and their mutual entanglement. Considering that this allowed for reproducing the certain social and economic relations, the essay by French philosopher Louis Althusser, *Ideology and State Ideological Apparatuses,* seems beneficial for this study. However, it is important to remember that the goal of these relationship dynamics during the Cold War was to attain hegemony in terms of the desired social and economic arrangements of a concrete bloc, rather than simply maintaining and reproducing them. The importance of economic mechanisms in the ideological shaping of science and technology points to Marx's (or Marxist) dialectical approach to analyzing the dynamics between the "base" and "superstructure," as well as more contemporary authors interested in the relationship between politics and culture. In both cases, the system of financing science and the repressive apparatuses represented the means of the system to exercise control over science. In the USSR this was somewhat more explicit than in the US, but in any way, the goal of directing science in accordance with the needs of a given socioeconomic system was to a large degree achieved in both blocs. The importance of this approach for this work also stems from Marxist insights into the significance of science and technology for an industrial society, and the Cold War period was marked by many examples demonstrating this importance.

"History has shown that a political group cannot have much influence over the material reproduction of society, without the control of the state" (Kadri 2023:6). When speaking about the dynamics

between the base and superstructure from the angle of a dialectic and materialistic approach to society, the role of the state should be highlighted. Given that the state has a monopoly over force in society, it represents an organization that can impose and enforce particular class interests. "Capital accumulation has been dependent on the power of state ever since its rapid development in the 15th and 16th century, during the era of the absolutist states in Europe" (Abdel-Malek 1981 and Anderson 2013 according to Kadri 2023: 6). Viewed this way, the role of the state is to ensure conditions for the extraction of the surplus of value for the further development of the capitalist system. Moreover, it is important to note that the state has a key role, although somewhat differently established, when it comes to production relations in socialist systems as well. "Grasping this central function of the state within the superstructure reminds analysts of the 'determination in the last instance' of the base, given that the state produces immense material consequences on people's lives" (Kadri 2023: 6).

Althusser explains that class society "transforms ideologies into tools of oppression and physical exploitation" (Kadri 2023: 19), and that it does this through a complex mechanism of structural domination, with the economy "in the last instance." He then explains this through the difference between "ideological state apparatuses" and "repressive state apparatuses." Both represent parts of the superstructure for Althusser, including the state (Altiser 2015).

> "The State, for Althusser, functions 'by violence' and enforces class interests all while being guided by ideologies. A material rupture of the economic base is possible, if the entirety of the concrete whole (the ensemble of the relations of production), through its 'relative autonomy' from the superstructure, is able to find the crack or primary weakness (the 'weakest link') in its own ensemble to break free from the social control of the elites" [Kadri 2023: 19].

In addition to Althusser's essay, insights from the American sociologist Wright Mills are useful for understanding the studied issues. The intertwining of science and politics during the Cold War points to complex and highly unequal power relations in both systems between scientists and government officials. Mills draws attention to numerous deviations from the ideal-typical role of science in society, or the role of knowledge, as Mills assumed it, which is the idea that it serves the common good rather than oligarchic, particularistic structures. Mills opposed the division into two Cold War camps, blaming "power elites" which included (highly positioned) intellectuals, politicians, state and military officials, etc., both in the US and the USSR. The division of the world into "ours" and "theirs," "in which devastating bombs and missiles are the sole guarantee of security" (Mills 1958 and Mills 1959 according to Novack 1960), was unacceptable to Mills. He believed that it was the duty of the intellectual to explain the irrationality of this approach to the world by emphasizing that the problem was war as such. The duty of scholars, writers, and scientists was to exert pressure on state and military officials to follow a different line that would promote peaceful international relations. But instead of this, according to Mills, a large number of intellectuals were obsessed "by a military metaphysics which induces them to keep piling up armaments in a race that serves no useful economic purpose and can end only in the destruction of mankind" (Mills according to Novack 1960). The Cold War context, particularly regarding the nature and role of science and technology in both blocs, opens up space for a somewhat different approach from Marx's to the concept of ideology. Viewing ideology solely as false consciousness within the analytical framework of this work proves, in certain segments, inadequate. Viewed only through that lens, some elements, concerning the highly complex dynamics of the relationship between science and ideology in the Cold War, cannot be fully understood. This is precisely why this work strives to complement this critical approach to ideology with a more contemporary, enhanced perspective, drawing from Rehmann's theoretical framework, which, like Althusser's, is based on Gramsci's insights. This perspective provides an analysis of the deeper processes, structures, and mechanisms through which dominant ideology operates in society and enables the hegemony of certain ideas, values, and norms (Gramši 1980; Rehmann 2015).

Despite Althusser's criticism of Gramsci, Rehmann suggested that Althusser's ideology-theory incorporates essential elements from Gramsci's examinations of civil society and hegemonic

apparatuses, as well as the distinction between repressive and ideological state apparatuses. While Gramsci explores how subaltern classes develop hegemonic capacities within superstructures, Althusser focuses on how ideological state apparatuses subject individuals to bourgeois state ideology (Rehmann 2015: 11).

In accordance with this, this work highlights the need to approach science, in order to perceive it as part of a specific socio-political framework, through a historical-sociological analysis of ideological and philosophical assumptions, structures, and processes related to it and its role in the system shaped by the Cold War period. I believe such an approach is highly beneficial for this work because it allows for the consideration of the perspective on "free" science, associated with the Western Bloc, as well as the perspective on Soviet, or Marxist-Leninist science. The analysis focuses not only on their actual role in society and deviations from proclaimed ideals in practice but also on how the two dominant representations of science are perceived in this context by examining the mechanisms, processes, and structures facilitating the dominance of particular class interests and ideas.

Examining the nature and role of science in Yugoslavia in the context of the established socialist order after the Second World War provides valuable insights into genuine interactions between science and ideology. Investigating this interconnected relationship offers a chance to understand the often overlooked (semi-)peripheral scientific position in the bipolar tensions of the Cold War. Yugoslavia's departure from the Eastern Bloc in 1948 marked the beginning of a distinctive form of socialism – socialist self-management. Yugoslavia in an ideological sense represented a heterodox form of socialism. This work shows that this ideological heterodoxy was also reflected in Yugoslav science; specifically, its organization, financing, dominant scientific discourse, etc. The dissertation also aims to provide a brief overview of the development of the Yugoslav nuclear program during the Cold War within the context of a socialist self-management society. The primary focus is on the relationship dynamics between the state and (big) science projects in Yugoslavia in the context of the Cold War. In short, this study delves into certain facets of Yugoslav science within the framework of socialist self-management, considering the economic, ideological, and international factors influencing the Yugoslav Cold War position. The aim is to investigate the processes that led to the establishment of a specific domain of scientific ideas, practices and projects (in this case the Yugoslav nuclear program).

The Cold War and the Role of Science in It

The relationship between science and the state shifted dramatically with the melding of science and technology in the late nineteenth century, also known as the period of the "scientisation" of industry (Gascoigne 2019: 218). Because of its economic progress as well as the advancement of society as a result of science, the state began to provide more support for scientific development. After demonstrating its potential during the wars, science became a valuable ally of the state. Particularly after the Second World War, "no state could afford to overlook the importance of science" (Gascoigne 2019: 218).

The Second World War immensely affected science and technology, and in turn science and technology profoundly affected the Second World War (Mindell 2009). Radar, naval science, operational research, DDT, penicillin, computers, advances in rocketry, the atomic bomb, etc. are just some of the scientific (and technological) breakthroughs of the period (see Feiveson 2018; Hartcup 2000). During this period, science was mobilized on a grand scale. The phenomenon of big science, i.e. "the combination of big organizations, big machines, and big politics" (Hallonsten 2016: 43) stems from the Second World War period, where science and technology served the political interest of the state.

> "The massive "research and development" (R&D) laboratory emerged in its modern form. The paradigm of these efforts was the "Manhattan Project" which put thousands of physicists together with Army-scaled logistics and designed, built, and manufactured the first atomic bombs" [Mindell 2009].

The ability to split the atom and create a nuclear bomb undoubtedly overshadowed the other applications of science discovered during the Second World War. The development (and use) of the atomic bomb profoundly impacted public perception of science's significance and changed how it was seen in relation to national security and warfare. Because of this social context, scientific endeavors have since been viewed globally from a new perspective, notably from a political one (see Krementsov 1997: 93; Gascoigne 2019: 141-150). Both scientists and politicians agreed that "science, which made the atomic bomb possible, had transformed the world" (Aronova and Turchetti, 2016: 3). In addition to being a scientific phenomenon that allowed science to achieve considerable relevance, demonstrating its immense potential and destructive power, the atomic bomb "marked the end of the greatest and most destructive war in history at the time" (Bondžić 2016: 25).

Gascoigne (2019) notes that after 1945 the United States "set the pace for linking science and the state" (Gascoigne, 2019: 204). Unlike the Soviet Union, where the government was the sole funder of research, the US approach to financing science, according to Gascoigne (2019), favored a "largely decentralized" model. Despite these differences, it is evident that both states recognized the significance of science within the framework of the state (Pascal 2020).

After the Second World War, the United States and the Soviet Union engaged in a power struggle. As a result of this, states worldwide were polarized and divided into two opposing blocs. During the second half of the twentieth century, this situation dominated the global political scene and represented the Cold War phenomena (for more see Hobsbawm 1994: 225-257). In accordance with this division, the Cold War was marked by a global competition between two ideologies: liberal-democratic, personified by the United States, and socialist, embodied in the Soviet Union. In addition to "implying the unforeseen possibilities of future destruction and suffering" (Bondžić 2016: 25), the atomic bomb became an integral part of the fight between the Soviet-dominated East and the US-dominated West. Consequently, as the historian of science and technology Helge Kragh (1999) notes,

no European country could compare with the United States and the Soviet Union in terms of the role and importance of the army for the development and application of physics (Kragh 1999: 300-301).

> "As time went on, more and more things were there which could go wrong, both politically and technologically, in a permanent nuclear confrontation based on the assumption that only the fear of 'mutually assured destruction' (correctly concentrated into the acronym MAD) would prevent one side or the other from giving the ever-ready signal for the planned suicide of civilization. It did not happen, but for some forty years it looked a daily possibility" [Hobsbawm 1994: 226].

This fear was based on the understanding of the extremely harmful effects of the atomic bomb, as demonstrated by the bombing of the Japanese cities of Hiroshima and Nagasaki. The destructive effects of the use of nuclear energy for military purposes on the entire human race were also highlighted by Yugoslav physicist Pavle Savić who, along with Irena Žolio Kiri during the 1930s, contributed to a discovery that ultimately aided in the development of the atomic bomb (Savić 1978: 113-119). This fact contributed to Savić's feeling of unease, as well as his sense of responsibility after learning of the effects of the bombing of Japan (Senćanski 1986: 65-68). Concerns about the reuse of nuclear weapons, which became more sophisticated in the years that followed, i.e. fear of the genuine prospect of widespread destruction during the Cold War, were expressed by many participants and witnesses at the time. This essentially ensured that no nuclear weapons were utilized for military purposes during the Cold War.

> "The US monopoly of information regarding nuclear weapons was one of the distinctive features of the early Cold War. It encouraged US officials to bolster their country's hegemonic role in post-war affairs, something that scholars have previously referred to in terms of "atomic diplomacy" [Turchetti 2020: 411].

However, when the Soviet Union developed the atomic bomb in 1949, the United States' monopoly in this field ended. The looming prospect of the Soviet Union using atomic weapons against the United States, while contributing to the general atmosphere of fear that prevented the bomb from being reused, did not result in both sides completely rejecting atomic weapons or accepting international control (again on both sides) (Bondžić 2016: 25). This led to a "frantic nuclear arms race, increased number of bombs, perfecting of their destructive power, and increased options for their transport and launch" (Bondžić 2016: 25).

Competition with the ideological enemy led to the emergence of many incentives for scientific progress, given that the advancement of science and technology in this conflict guaranteed both prestige and the possession of a diverse range of high-capacity tools. Financial, political, institutional, and moral support, even when not related to the creation of weapons of mass destruction, were mostly linked to the Cold War battle for hegemony (see Solovey 2001; Krige 2006). In other words, after the joint victory over Nazis in the Second World War, scientists and their work, both in the Soviet Union (Eastern Bloc) and the United States (Western Bloc) found themselves on opposing sides, serving their respective countries during the Cold War. The results of the situation in the West, which nominally encouraged autonomous science, were a great overlapping of civilian and military science sectors (Solovey 2001: 167). The "clear-cut boundary between politics, on the one hand, and scientific investigation on the other" (Solovey, 2001: 165) was not just constructed, but "it was often blurred in reality" (Solovey 2001: 165). This is demonstrated by the disquietude that American scientist Philip Morrison, who worked on the Manhattan Project, expressed in 1946 regarding the militarization of science, which became inextricably linked to state politics (Kragh 1999: 297).

> "[E]fforts to maintain a distinction between civilian and military science were often elaborate, as barriers based upon national security requirements determined who could and could not access data, results and instrumentation from classified studies. Not surprisingly, military research and development typically received top priority, which could further diminish the difference between the

> civilian and military arenas by encouraging scientists who were looking for funding to suggest that even so-called pure or basic research had potential practical applications. In other instances, so-called 'white' science, in contrast to classified 'black' science, served as a cover for secret work (van Keuren and Cloud)" [Solovey 2001: 167].

In reality, the role of science now reflected Marx's viewpoint, even in non-Marxist political regimes that saw it as active and revolutionary force within society (Bernal 1952). Even states that had previously lacked this ideological focus could not, regardless of the dominant, widespread, official Cold War stance they adhered to, fail to recognize the importance of scientific and technological advancement, as well as the potential of science for the future. In both the United States and the Soviet Union, science was viewed as an institution capable of bringing about fundamental changes to social and political systems. This was its appeal to specific regimes and military projects. Such a perspective of science compelled both blocs to steer the scientific community in the desired direction (see Oreskes and Krige 2014).

The big science phenomenon marked both US and USSR organizations of science. In the USSR, it was portrayed as a crucial feature of socialism, whereas in the US today's term "big science" was unofficially used (Kojevnikov 2004: 46). However, the similarity was striking. It was due to this that "[t]he existing Soviet tradition of big science undertakings proved itself in the process to be perfectly suitable for replicating the American Manhattan Project" (Kojevnikov 2004: xv). There are elements common to both blocs that can be used to describe this phenomenon, including: "gigantomania, state support, the cult of science in society, (con)fusion between science and engineering, multidisciplinary research, collective or team work, complex bureaucracy, and militarization" (Kojevnikov 2004: 46). Moreover, in both blocs "the aims, content, practices, technologies and locations of Cold War science reflected and contributed to the tense politics of that era" (Solovey 2001: 165). In large part, and despite ideological differences, these and other similarities were the result of the fact that a wide range of distinct scientific activities, scientists and scientific institutions in both blocs received significant support from their national security regimes (Solovey 2001).

The often-hidden mechanisms of political influence over science in the West involved "military patronage and/or cultural-political agenda" (Aronova and Turchetti 2016: 14). On the other side, in the East, this influence was primarily defined through "the central role played by the communist parties as (hegemonic) cultural agents" (Aronova and Turchetti 2016: 14). However, the power struggle between the two Cold-War forces "stimulated public patronage for research" (Solovey 2001: 166) both in the Eastern and the Western Bloc.

It is important to emphasize that these scientific and cultural stimulations in both blocs had the effect of giving "visibility to some scholars and groups while casting a shadow on others" (Aronova and Turchetti 2016: 14). To this end, various theoretical categories were employed. Some of them, given the significance of the Cold War for today's scientific and philosophical community, still influence how scientific and social issues are addressed today, as well as what topics are in focus. That is how, for example, "the question of the autonomy and uses of science (and indeed, of all forms of knowledge) remains sharp for us, as both an epistemic question and a social one" (Oreskes and Krige 2014: 6). One should not forget their use by "historical actors [...] as tools of both cognition and persuasion" (Oreskes and Krige 2014: 6) in "the role of scientific and technical knowledge in national goals" (Oreskes and Krige 2014: 6) – a social context still present today. One should also consider the fact that "[s]tate-sponsored science often took Cold War aims as its own" (Solovey 2001: 167), which surely affected the choice of theoretical terms. Given this, it is important to exercise caution when utilizing such theoretical assumptions in the selection and interpretation of specific scientific (and philosophical) problems.

In both blocs, the social system embodied in a concrete political regime exerted diverse sorts of influence over scientific workers and science as a whole. However, although different, regime

influences on science and researchers (very often) had the same goal in both blocs: to shape scientists and science as an institution in accordance with the needs and values of a specific Cold War society, i.e. the US or the USSR.

> "[T]he purpose of patronage, military or otherwise, is, in most cases, to adjust the focus of attention and influence the direction of work. Patient-driven patronage may shift biologists' attention toward cures for particular diseases on which their attention had not been focused previously. And military patronage is intended to garner scientific attention to questions of military pertinence and concern […] In the United States and the Soviet Union, weapons — including their testing, hiding, detection and delivery — were of paramount importance" [Oreskes and Krige 2014: 3].

In other words, through the establishment of the required infrastructure and political tools, both blocs aimed to shape science and technology, as well as conceptions about their role in society, to reflect their respective political stances and challenges. Despite philosophically clashing assumptions about the nature and role of science in society, the different methods of supporting science and technology served the same purpose, with each bloc seeking to build a theoretical and practical framework for scientific and philosophical thinking and doing within the system.

> "[P]olitical struggles on both sides of the Iron Curtain helped to shape what did and did not count as legitimate science. […] Cold War politics helped to determine what science was, what it did, and what it meant. But even leaving aside the critical issue of boundary-work, the contours of research in a wide range of scientific fields […] were influenced in various manners by defense funding and associated State objectives" [Solovey 2001: 168].

It is also important to note that, by increasingly associating science with the interests of the state via economic and political mechanisms, science increasingly exerted its influence on society, drastically changing it year after year during the Cold War race (particularly in the technological sense). This is not to take a vulgar-deterministic approach to the relationship between the social base and superstructure. However, without considering the importance of this relationship for the dynamics of scientific development, this analysis would be lacking theoretical foundation.

> "If science is what scientists do, then what did scientists decide to do in the Cold War, and how were those decisions shaped by the exigencies and opportunities of the period? Clearly, the availability of funds, instruments, research platforms, personnel, and moral and logistical support, along with personal commitments and cultural context, made some decisions more attractive than others. They also made some choices effectively impossible" [Oreskes and Krige 2014: 7].

For the purposes of this work, it is necessary to present in greater detail, in separate segments, and briefly, the nature, status, and role of science in the United States – which will be used here as the paradigm of Western science – as well as the main characteristics of science in the Soviet Union, which will represent science in the Eastern bloc during this period. It is critical to identify both their mutual parallels and distinctions in terms of their attitude toward science. The goal will be to present the basic features of Cold War science by emphasizing the importance of nuclear weapons in both blocs, as well as to better map the main differences in how science attained a prominent role within the system; in other words, the organizational, political, and economic mechanisms that helped shape science in both blocs during the Cold War.

Science in the US during the Cold War

During the Cold War, the United States established a liberal-democratic ideological framework, emphasizing a capitalist economy based on the free market while supporting democratic principles, individualism and anti-communism. The United States attempted to block USSR expansionism and combat communist ideology through containment policies (such as the Marshall Plan and the Truman Doctrine), alliance building (such as NATO), and assistance to other potential allies, among other means. Some countries formed alliances because they shared similar beliefs, while others joined for financial and military support, or because of the perceived increase in national security. During the Cold War, the United States imposed a variety of social and political restrictions on persons seen to be sympathetic to communism. The US experienced great economic growth and wealth during this period, but it was also marked by sharp political divisions, political conflicts, racism, and struggles for social justice and civil rights (for more see Leffler and Westad 2010).

After the Second World War, both industrialized and underdeveloped countries were ravaged. In this framework, the United States emerged from the Second World War as the world's biggest military and economic force, with no wars fought on its territories (Wang 1999: 1). More specifically, "[t]he balance of world power had shifted away from Europe, and for the first time, the United States stood as a global superpower" (Wang 1999: 4). This was undoubtedly helped by the fact that, until 1949, the United States was the only country in possession of an atomic weapon. The atomic bomb, as previously said, was viewed as a highly crucial element in defining international relations during the period. Consequently, the atomic bomb was a tool in the power struggle around which secrets were growing and which provided justification for research. The atomic bomb, as well as the questions that accompanied it, was the focus of both domestic and foreign US politics during the Cold War (see Sherwin 1973; Wolfe 2013: 9-22).

> "By the end of the war, the atomic bomb made it clear that science had, in the words of one scientist, "lost its innocence" – that is it was now a critical tool of military power, and was given government money for research at many thousands of times the pre-war levels. Scientists became advisors to presidents on the most pressing issues of national and foreign policy. Ever since World War II, the American government has mobilized science, mathematics, and engineering on a vast scale, whether in large government laboratories, by funding research in universities, or by purchasing high-tech products from companies in industry" [Mindell 2009].

Given the confidentiality of the period in question, the massive entanglement of the military complex's interests with political projects, as well as scientists' participation in actual state challenges during the Second World War, a surge in the militarization of American science occurred. In that sense, it is not surprising that "more than free-quarters of all federal investment in scientific research came from a single military research agency, the Office of Naval Research (ONR), in the early postwar years" (Wolfe 2013: 23). The atomic bomb probably increased the military's interest in funding, and hence guiding, science toward fields of study that are (or may be) related to national security. The continuation and strengthening of the relationship between the university, industry, and military during the 1950s resulted in what is known as the establishment of the military-industrial complex (Wolfe 2013: 23).

> "The atomic bomb was both a symbol of destruction and a symbol of the power of science. Yet even as some scientists began to feel constrained by the requirements of working within the national security state, the institutional power of science flourished" [Wolfe 2013: 21].

(Further) production and perfection of (various) nuclear and other weapons, as well as the (further) development of knowledge in fields such as nuclear physics, favored a system characteristic of the big science phenomena, which implied extensive support of the state. The American National Science Foundation (NSF) was founded with the idea of coordinating the national research plan as well as

funding primarily fundamental research projects (not military ones). However, what became a rule, particularly in the later Cold War period, was that "the battle for hearts and minds turned all kinds of science – military and civilian, basic and applied, big and little – into proxy areas in which to demonstrate the superiority of the American way of life" (Wolfe 2013: 53-54). Although later on the NSF played a very important role in the Cold War, this was not the case in the beginning (see for NSF England 1982; Wolfe 2013: 23 - 33). Before the NSF became the "powerhouse of scientific research funding" (Wolfe 2013: 25), this role was practically assumed by the ONR (Sapolsky 1990; Wolfe 2013: 23-33). It should also be noted that, with no federal research agencies in the United States, institutions like the Atomic Energy Committee (AEC) and the Department of Defense (DOD) were the most important funding agencies for scientific and technical research in this period (Wolfe 2013: 25).

> Later on, "[w]hen American scientific leaders pointed to the 'dangers' inherent in a scientific research policy skewed toward the programmatic goals of the DOD and the AEC, they were in part gesturing to the unintended similarities of this system to the Soviet planned economy" [Wolfe 2013: 53].

This does not mean that there were no organizational differences between US and Soviet scientific models. Unlike the Soviet centralized scientific model, the US model was more decentralized, as Gascoigne (2019) notes. However, the big science phenomena, which we will address in more detail in the second part of the work, strived toward a more centralized structure compared to the official decentralized organization - a model more aligned with the idea of free, autonomous science.

As previously stated, the US military and government discovered in 1949 that the Soviet Union had developed the atomic weapon. When it was disclosed that the US was looking for thermonuclear weapons, it became evident that the Soviet Union and the United States were engaging in an arms race (Siracusa 2020). Secrecy and security during the Cold War were a relevant mark of science in general, including American science. For this reason, federal employees had to undergo thorough security checks "that extended to citizens' attitudes and associations as well as their activities" (Wolfe 2013: 34). Security clearances were also necessary for university and industrial contractors working on classified projects, and occasionally for all employees of defense contractors (Wolfe 2013: 34).

> "Given that seemingly innocuous activities such as attending the labor rally or donating to civil rights group could endanger a person's security status, scientists increasingly curtailed their political activities to ensure their future livelihoods" [Wolfe 2013: 35].

The erosion of the image of science as apolitical in the United States was probably reinforced by domestic anticommunism, the fundamental feature of US interior politics throughout the time: "According to the dictates of anticommunist ideology, the price of insufficient vigilance against radicalism was no longer mere domestic instability but the spread of totalitarianism worldwide." (Wang 1999: 4). This situation led to some American scientists becoming victims of anticommunist hysteria (Oreskes and Krige 2014: 4-5). In her book *Scientists at War* (2015) historian Sarah Bridger states that at the start of the postwar period, when it became clear that the Manhattan Project had significantly increased American science's political weight and influence, scientists presented a moral argument for a ban on nuclear tests rather than limiting their analysis to technical evaluations.

An example of this is the father of the atomic bomb, the renowned physicist Robert Oppenheimer, America's foremost scientific advisor to the government. As the director of the Los Alamos Laboratory, he was essential in the Manhattan Project, which produced the atomic bomb. Oppenheimer's security clearance was revoked as a result of anticommunist fever, with anticommunist hysteria calling his loyalty to the US government into doubt. This was preceded by his remarks about the program to develop hydrogen (thermonuclear) weapons, which ran against the Pentagon's interests at the time. This stance earned him powerful enemies (see Thorpe 2002; Rubinson 2019: 19-29). As a result, Oppenheimer's involvement in politics and policy was

terminated, as was his career. Many consider his case an example of McCarthyism's anti-communist sentiment (see Bird and Sherwin, 2006). This was a significant event because it marked the first major step toward reframing the idea of scientists as public intellectuals in the early postwar period. This case is interpreted as an example of the state disciplining scientists. It made other scientists aware that the state only required them as authorities on specialized scientific topics, not as intellectuals (see Thorpe 2002; Bird and Sherwin 2005: 549; Rubinson 2019: 29-34).

For a better illustration of the importance of Cold War influences on the perception of science, it is worth considering the perspectives of historians and philosophers of science, such as George Reisch. In his paper, Reisch demonstrates an important link between geopolitics and the philosophy of science, focusing on the Cold War (Reisch 2005). Developing his argument, Reisch (2012) discussed the impact of the US Cold War political culture on the formulation of substantive statements about the nature of scientific knowledge and scientific change that were extensively influenced by the Cold War context. An example of this is the famous book *The Structure of Scientific Revolutions* (1962) by American philosopher of science Thomas Khun. Reisch (2019), in his analysis of Khun's personal, intellectual, and political relations, as well as his political and social engagements at the time, finds that Kuhn had placed himself within the framework of the Cold War in a certain way and that his political perspective from that period influenced his ideas on the nature of science.

This is highly relevant since, during the Cold War, philosophical ideals of free scientific inquiry were promoted alongside American democratic ideals. Scientists had (sometimes purposefully, sometimes unknowingly) joined in anti-communist[1] political efforts. This influenced Cold War diplomatic policies and cultural relations. When in the Soviet Union, as a result of the scientific turmoil caused by Soviet biologist Trofim Denisovich Lysenko (there will be more on this later in the text), scientists started facing repression, Western public opinion began to emphasize the contrast between the two opposing systems – liberal democracy and socialism. Lysenko's pseudoscientific notions, his rejection of genetics, and the Party's embrace of his ideas (at the time), which were viewed as more aligned with Soviet ideology, all contributed to the Western campaign against Lysenkoism, or pseudoscience. The American system utilized this atmosphere to create a certain image of Soviet science. An important lesson was drawn from what was happening to Soviet science, which suited American anticommunist propaganda (see Graham 1993: 121-137; Gordin 2012; Wolfe 2018: 1-34; Bogdanović 2013).

Yet, one must remember that American generalization was a caricatured product of Cold War propaganda. Hence, the situation with Lysenko was skillfully leveraged to promote official American Cold War principles, with American science presented as free, the total opposite of the repressive atmosphere where Soviet scientists lived and worked. At the same time, the US approach to science along with American science itself were presented as the only true contenders against continual state repression, a product of a socialist political system – as the Western bloc wanted people to believe – mercilessly carried out over scientists in the Eastern bloc. This propaganda aspect of the concept of free science and culture, and its relationship with democratic values in the US, which is especially evident when one analyzes CIA efforts in this field at the time, played a major part in spreading US hegemony in the world, primarily in Europe (see Saunders 2001; Wolfe 2010; Wolfe 2018; Krige 2006).

However, the Cold War and, accordingly, the anti-communist state sentiments in the US not only influenced prominent scientists and philosophers, but the habitus also "affected the entire scientific enterprise" (Wang 1999: 3). The irony of the situation was that the idea of free and apolitical scientific

[1] Communism as a classless society did not exist. The term communism, especially during the Cold War, often meant (and still does) socialism. In the background of this, there was the intention of equating the vision of a desirable society with socialism, as the existing authoritarian social order.

inquiry served as a political instrument in the fight to preserve and spread the political and economic interests of the United States.

> "Although physicists and scientists in related disciplines claimed and believed they were engaged in value-neutral basic research, the content and direction of their research agendas were swayed heavily by the technological needs of the Cold War, and their own political prominence and influence depended on their building close ties to the Cold War national security state" [Wang 1999: 3].

The importance of science in the fight against "communism", which the US viewed as embodied in the Soviet Union, could be seen in the shift in the funding for scientific research. When comparing the budget for science in the US during the Cold War to prior periods, it is clear that US science enjoyed a notable increase in funding. Prior to the Second World War, the US government invested around 50 million dollars in science each year. This funding was primarily intended for the health and agriculture sectors. This, together with the fact that until 1950, science financing totaled more than one million dollars (Wolfe 2013: 22), demonstrates an apparent and dramatic increase in state funding for scientific research. However, it is important to remember that these financial benefits did not come without a cost.

> "Cold War anticommunism narrowed scientist's immediate political strategies and ultimately their visions for expanding their own social role and capacity to challenge the status quo. Scientists abandoned a nascent public political style that attempted to rework the relationship between science and society and instead grew increasingly reliant on internal negotiations within government agencies to achieve more limited policy goals" [Wang 1999: 9].

Science in the Soviet Union during the Cold War

The USSR was a Communist Party-controlled state with Marxism-Leninism as the official ideology. In the early years after the Second World War, the Soviet Union rebuilt and developed its economy and society. It effectively seized power in the majority of Eastern European states. The Soviet Union bonded its satellite republics into a military alliance, the Warsaw Pact, and an economic organization, the Council for Mutual Economic Assistance. The creation of so-called people's democracies in liberated states, which acted within the USSR-created framework, was a result of the victory of Soviet-led antifascist forces in this part of Europe. These states tended to adopt five-year plans, fast industrialization, political centralization, highly centralized planned economy, and Marxist–Leninist ideology (see Leffler and Westad 2010).

The Second World War had a significant impact on the relationship between ideology and science in the Soviet Union. According to historian Pollock (2006), the events of the Second World War, and the role of Soviet science in it, contributed to the "relative freedom" of scientists from the Party at the time. This was linked to the "atmosphere of internationality" that was fostered during the Allies' cooperation, which "weakened the distinctions between 'bourgeois' and 'proletarian' science" (Pollock 2006: 4). As previously noted, the development of nuclear weapons, radars, and other technologies demonstrated the importance of science in national security. During the war, the emphasis on the practical significance of science contributed to greater party support and increased the Soviet Union's concentration on research and technology. Something along these lines was said by Joseph Vissarionovich Stalin in 1946 when he stressed that Soviet scholars must not only catch up with but also surpass other nations' scientific achievements (Stalin 1946). The Party's increased interest in science in the post-war years contributed to greater supervision over science during the Cold War (Kojevnikov 2004; Pollock 2006; Krementsov 1997).

Besides the significance of the Second World War for science in the Soviet Union, the Soviet ideology (Marxism-Leninism) placed a great focus on the importance of science for society. "No patrons were

more willing or more enthusiastic in their support of science than the Bolsheviks [...] The nationalization of all private enterprise made the Bolshevik state the sole patron of science" (Krementsov 2006: 1174, 1180). The Bolsheviks believed that scientific work in pre-revolutionary Russia was subservient to the ruling class's interests, detached from social praxis, and reduced to a mere state decoration (Vavilov 1947: 6-10). In contrast, the science and technology of the new socialist state were marked by collectivism, a developed relationship to social praxis, with the "main trait of advanced Soviet science" according to Stalin himself being that it "does not disconnect itself from the people, that it is not distanced from the people, but ready to serve them" (Vavilov 1947: 7). Following the Second World War, the practical value of science to the state became undeniable and it fit pretty easily into the ideological image of the relationship of science and the Soviet regime. A combination of pragmatic and ideological reasons contributed to the Soviet regime's strong faith in science (Kojevnikov 2008: 115).

> "Science palyed a unique role in Soviet ideology. When Soviet citizens publicly spoke or wrote about Soviet ideology, they were referring to a set of ideas identified and propagated by the regime and used to justify the superiority of the Soviet state" [Pollock 2006: 3].

Although the disparity between the Soviet ideology and the "bourgeois ideology" decreased during the Second World War (Pollock 2006: 4), it was far from erased. In the early post-war years, these differences were only stressed. Considering that starting in 1931 "[s]cientists and the regime reached a new [at the time] modus vivendi in which the Party supported scientific research while retaining control over scientific planning" (Pollock 2006: 4), it happened that many "young scientists who owed their education to progressive Soviet policies tended to be more sympathetic to Marxism-Leninism" (Pollock 2006: 4). The Party thus helped to widen the perceived ideological division between science in the Eastern and Western Blocs. In other words, there was a greater insistence on the party line in science.

> "Science became a sphere of Cold War competition in ways that went beyond national security. Stalin assigned Soviet scholars two key roles on the "ideological front" of the Cold War: they had to criticize Western ideas, and they had to export Soviet ideas to newly emerging socialist states in Eastern Europe and Asia" [Pollock 2006: 5].

The model of scientific organization was also a significant factor in enabling science to achieve such a status and role in the Soviet Union. The Academy of Sciences of the USSR was the most significant government entity in terms of highly centralized science organization. The Soviet Academy of Sciences served as the primary workplace for top fundamental researchers in the country (Graham 1992: 50). All scientific institutions in the USSR planned their activity following the Academy of Sciences' lead. Providing scientific work in conformity with the general line of the Communist Party and the USSR Council of Ministers program was one of the entity's key roles (Guins 1953). It was in accordance with this that, in his inaugural speech as President of the Academy, A. N. Nesmeianov stated:

> "[G]eneralization of the experience in socialist construction and gradual transition to Communism and, correspondingly, discussion and solution of problems of a paramount significance in the field of economics, philosophy, law, philology, ethics, esthetics, connected with the transition to Communism [. . .] assisting in the foundation of a proper basis for Communism, huge new constructions and new sources of energy, further development of agricultural economy, improvement of mechanical equipment, discovery of new kinds of material and everything that can relieve the worker and obliterate the contrast between mental and physical work" [Nesmeianov according to Guins 1953: 269-270].

The transition from a "little science" model to a "big science" model at a national level happened for the first time in the Soviet Union. The main feature of the Soviet phenomena of big science was its complete reliance on state funding "which led to the coevolution and convergence of the party-state

agencies and the scientific community, and to the development of a close and symbiotic relationship between them" (Krementsov 2006: 1199-1200). The application of this principle across the entire scientific system in the Soviet Union allowed not only the centralization of all institutions but also the politicization of scientific discourse (see Krementsov 2006: 1199-1200).

The main goal was to demonstrate the superiority of the communist organization of society, where the working class (proletariat) reigns over the capitalist, individualist West, as declared by official Soviet rhetoric. In such a cultural-political climate, "Soviet intellectual achievements could serve as symbolic measures of the superiority of the Soviet system" (Pollock 2006: 5). Aside from the symbolic value that the Soviet system and its leader Stalin put in science, they primarily placed tremendous hopes in science and technology, identifying them as instruments of recovery and advancement of the Soviet state, both before and (particularly) after the Second World War.

> "He believed that science provided the key to updating and industrializing the economy. Principles of scientific management would improve not only industrial production but all other aspects of societal development" [Pollock 2006: 3].

In terms of the ideological war, the Soviet Union behaved similarly to the United States, which incorporated all the negative intelligence it could obtain into its propaganda against the Soviet Union and the communist ideology, such as the Lysenko controversy. As a result, information regarding eugenics and racism in the United States was presented as the product of a "bourgeois" ideology. Eugenics was banned in the Soviet Union as early as the 1930s. In 1931, the Soviet Union was the first to proclaim eugenics completely untrue and halt associated research. Unlike the Soviet Union, eugenics spread throughout the world, thanks in part to Nazi Germany's 1933 laws, which were extensively imitated by many other countries in Europe and North America. It was not until 1945, with dramatic revelations of Nazi medical crimes, that it garnered widespread disapproval before quickly disappearing, at least nominally (Kojevnikov 2008: 127). Due to these revelations, "the Soviet Union overreacted to the new revelations" (Kojevnikov 2008: 127). The Soviet authorities' opinion of geneticists was affected by their strong opposition to the eugenics movement. The irony of the issue was mirrored in the fact that the ideological climate decrying the mistreatment of science in the case of eugenics resulted in the Lysenko controversy, i.e. a misuse of science.

> "In 1948, the agronomist Trofim Lysenko won political support for his claim that Mendelian genetics, too, was ideologically and scientifically untenable and racist and had to be abandoned in favor of his own, idiosyncratic, genetics based on the concept of "soft," or environmentally flexible, heredity. It would take the Soviet establishment sixteen years to officially recognize the latter decision as a serious mistake" [Kojevnikov 2008: 127].

This and other similar situations were partly due to the uncritical insistence of the state on polarizing scientific discourse and dividing the scientific community into those who align with the party line and those who do not (the "bourgeois" scientists). Such an approach to this and similar elements allowed opportunists like Lysenko to advance in the Soviet system (Krementsov 2006: 1198).

An illustration of the post-war sharpening of the conflict between the East and West, as well as the impact of that sharpening on scientists in the Soviet Union and their relationship with the Soviet state, is that of the prominent Soviet physicists and Nobel prize laureate Peter L. Kapitza. Despite his faith in science, Stalin questioned the loyalty of scientists. He saw them as easy prey to the influences of Western culture.

> "In 1947, Stalin told the popular writer Konstantin Simonov, "if you take our intelligentsia, scientific intelligentsia, professors, physicians - they are not sufficiently inculcated with the feeling of Soviet patriotism. They have an unjustified admiration for foreign cultures" [Pollock 2006: 6].

Kapitza was not spared from these concerns; the Politburo questioned his loyalty.[2] However, the official Soviet press portrayed Kapitza as an example of a Soviet scientist whose work benefited socialist society (Kojevnikov 2004: 99). "During the war Kapitza had even been appointed to a public office, head of the Oxygen Trust, where he was organizing a branch of industry for the production of liquid oxygen" (Kojevnikov 2004: 291). However, the relationship between Kapitza and the Soviet state could not be described as entirely harmonious, neither before nor after the war.[3] Although his Western colleagues held him responsible for the development of the Soviet atomic weapon, the truth was somewhat different. Kapitza was included in the bomb project's Special Committee and Technical Council, where he was supposed to work with NKVD[4] chief Lavrentiy Beria[5] (see Kozhevnikov 1991; Kojevnikov 2004). Beria controlled the Soviet Union's atomic weapon project, and Kapitza quickly started quarreling with him. In 1943, the Soviet Union started working on the atomic bomb on a very small scale. Following the US demonstration of the use of the atomic bomb in 1945, a Special Committee under the State Defense Committee (GKO) was established with the goal of reorganizing the entire project (Kozhevnikov 1991: 153). In this capacity, Beria was able to oversee both Soviet industry and intelligence, allowing him to assign project detainees from the camps for forced labor. Throughout this battle, Kapitza went above and beyond, even complaining to Stalin in a letter about Beria's arrogant attitude, lack of respect for scientists, etc. (Kojevnikov 2004: 141-143, 291-292). He concluded "that politicians were not ready for mutually respectful relationships with scientists" (Kozhevnikov 1991: 156). Despite being a respected scientist with numerous socialist accolades, in 1946 Kapitza lost his official functions and vanished from the public eye for several years (see Kozhevnikov 1991).

The state's intense pressure to "Sovietize" science and other segments of society increased drastically during the Cold War. At the official level, the Party always stressed working-class interests as its primary goal, which served to justify the pressure. The irony of this situation was the frequent deviations from this important socialist idea in the Soviet Union's actual deeds. Some left-wing critics contended that certain decisions made by the Bolshevik party were not always in line with the objective interests of the working class (see Cliff 1963; Goldman 1996). Some scholars also showed that the conditions of workers and peasants often differed from official Soviet claims, stressing systemic repression and other challenges that these people faced (see Bettelheim 1976, 1978, 1996). This was also shown by some researchers that demonstrated how, despite Soviet declarations, the conditions of workers and peasants were frequently very different, with systemic repression and other challenges (Bettelheim 1976, 1978, 1996).

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[2] For example, he defended and helped save the lives of some of the persecuted scientists during the purges, including Soviet physicist L.D. Landau (see Kojevnikov 2004: 98-99, 117-120, 259; Kozhevnikov 1991: 131).

[3] Before the war, during the 1920s, Kapitza worked as a physicist in UK with the approval of the Soviet government. He first worked at the Cavendish Laboratory with British physicist Ernest Rutherfordom. After that, he was appointed as Assistant Director of Magnetic Research at the Cavendish. He also became a fellow of Trinity College. Rutherford managed to acquire special funding for the construction of a new laboratory where Kapitza would serve as Director – the new Mond Laboratory in Cambridge, which opened in 1933. In August 1934, he returned for a visit to the Soviet Union, but Soviet officials did not allow him to make the voyage back to England. He was in despair and felt surrounded by hostility and suspicion (for more on this see Kozhevnikov 1991: 132-139).

[4] The NKVD, or People's Commissariat for Internal Affairs, was founded in 1917 as the NKVD of the Russian Soviet Federative Socialist Republic. Initially, the organization was in charge of managing the nation's jail system and performing police duties. After being dissolved in 1930 and having its duties distributed among other organizations, it was reestablished as an all-union commissariat in 1934 (for more see Pringle n.d.).

[5] Lavrentiy Pavlovich Beria was a Soviet politician, Marshal of the Soviet Union, Bolshevik, and government official who held key positions in state security and served as the head of the NKVD during World War II. He rose to the position of deputy premier under Stalin in 1941 and became a full member of the Politburo in 1946. Among Stalin's inner circle, Beria wielded significant power, particularly during and after the Second World War (for more see Britannica, T. Editors of Encyclopedia, n.d.).

The promotion of the Soviet way of life and science was intricately linked to ideas of societal growth, particularly during the Cold War, i.e. the struggle against the capitalist system, the victory of the working class around the world, and so on. These ideas were articulated and implemented through a state apparatus in such a way that they became subservient to and served the Communist Party. In addition to emphasizing the necessity of specific political and economic conditions for scientific advancement, planning principles, and so on, the Soviet Union insisted on the class-conscious character of science, notably its partisanship (or party-line) (Lenin [1909] 1977; Graham 1967). In the USSR, partisanship in science (aligning with the party line), on a practical level, implied the influence of party politics on scientific activity (see Krementsov 1997; Gerovitch 2002). Historian of science Loren Graham (1996) has demonstrated some effects of these politics on science and technology in the USSR, particularly with regard to the often flawed process of Soviet industrialization ("gigantomania"), which resulted in the deaths of many Soviet workers. When scientists and engineers criticized or warned about the negative impacts of the implemented processes, they frequently encountered serious repression (Graham 1996).

Two Ideological Perspectives on Science

As already noted, during the Cold War period of intense geopolitical and ideological conflict between the US and the USSR, science had an immensely important place in both blocs (Graham 1993; Leslie 1993; Pollock 2006; Wolfe 2013). In accordance with the Manichean approach that dominated international relations, science was characterized by two dominant ideological views. One, prevalent in the US and among its allies, was based on the notions of autonomous, value-neutral, and apolitical scientific endeavors (e.g., Polanyi 1962; Merton 1938; Popper [1945]2011). The other, that of the Soviet Bloc, emphasized "partisanship" in science, or class-conscious science (e.g., Lenin [1909] 1977; Bernal 1939; Bukharin [1931]1971). In reality, however, both blocs significantly deviated from their declared viewpoints on the nature and role of science. Science in the USSR, as previously shown, was profoundly influenced by the Bolshevik state apparatus (Krementsov 1997; Pollock 2006; Kojevnikov 2004; Gerowitch 1996), which failed to adequately articulate working-class interests in the USSR (Bettelheim 1976, 1978, 1996). Moreover, owing to contemporary research on the nature and role of science in the West, attention is now increasingly being called to the ideological function of the discourse on free and apolitical scientific research, as well as the use of science by the Western Bloc during the Cold War. Awareness of the role of science in the struggle for US hegemony during this period, as well as insights into the political aspects of the Western perspective of science as free and value-neutral (Greenberg 1999; Reisch 2005; Krige 2006; Wolfe 2018), are some of the key factors in the ongoing critical assessment of this subject (Korolija 2023).

It seems that the opposing ideological stances during the Cold War, when both science and technology gained prominence, served a similar political role in both blocs. Considering the tasks and aims of this work, in the following section we will attempt to present the principal points of both perspectives on the nature and role of science in society through their most prominent theoretical representatives.

The Free Science Perspective

Immediately following the end of the Second World War, an intense production of works written to propagate and defend scientific autonomy (a concept with a history prior to the Cold War) , as well as the (almost constant) criticism of the Soviet idea of the nature and role of science in society and its philosophical foundations, began in the West. The message to the academic community was clear. According to this viewpoint, the Soviet Union's political and economic systems tend to undermine fundamental scientific principles while also blurring the epistemological boundaries between science and pseudoscience. It was so determined that, in order to achieve scientific advancement, neither the Soviet Union nor (implied) fraudulent science could be tolerated. It followed that the only option to protect the integrity of science was to exclude"communist science", and deny it the right to be classified as scientific. "Proper" science, according to this perspective, was free and (relatively) independent of society; it had to be "pure" and value-neutral in order to be valid, i.e. objective. It is worth noting that this new stance on the nature and purpose of science in the West swiftly supplanted the support to Soviet research, which, despite views about autonomous science, originated from some US military personnel. In this context, it is useful to turn to the article *Soviet Genetics and the "Autonomy of Science"* (1945), which was written by Second Lieutenant, Sanitary Corps, Army of the United States – Leo Kartman. In addition to criticizing Polanyi's advocacy of independent science, Kartman is critical of equating the USSR with fascist regimes, provides the right context to understand the errors of Lysenkoism, and insists on collective planning in science:

> "This has not been the place for a discussion of the more basic aspect of Dr. Polanyi's thesis that science must remain autonomous to survive. Such men as J. D. Bernal, H. Levy, J. B. S. Haldane, J. G. Crowther, Henry Sigerist and others have written books and articles upon the subject which seem

> to indicate that Dr. Polanyi 's argument is basically unsound. That is to say, his thesis is unsound in application to all forms of state control while it is undoubtedly valid in reference to specific types of which fascism is the best example in the contemporary world. In attempting to show the evils of state planning on the basis of the analysis of a mere historic incident he has not only weakened his case but has shown a degree of uncertainty regarding the question of what constitutes state planning, not in a vacuum, but in any given type of existing economic system" [Kartman 1945: 70].

The following pages present the positions of three key thinkers who advocated for autonomous science (not always using the same arguments), a concept of science that was particularly important during the Cold War.

Michael Polanyi

Michael Polanyi offered significant theoretical insights in the fields of physical chemistry, philosophy and economics. He was a critic of the Soviet Union and opposed "planned" science. Polanyi was a leader in the Society for Freedom in Science[6]. During the Cold War, he was also involved with the Congress for Cultural Freedom (CCF)[7] (see Mitchell 2006; Wolfe 2018: 74-91).

According to this well-known scholar, who also studied philosophy of science and theory of knowledge, the pursuit of knowledge is both a value in and of itself and the primary aim and task of science ("pure" science). This, Polanyi maintained, was supported by the entire history of science. Formulating and developing scientific laws without regard for their practical application is how "pure" science functions. Polanyi cited Copernicus, Kepler, Galileo, Newton, Ritz, Max Plank, Niels Bohr, and Einstein as examples of scientists whose work demonstrated this and who approached science to better understand the laws of nature. According to Polanyi, theology, rather than science ("pure" science), worked to solve social issues, that is, to serve economic, social, and political interests and needs (e.g., see Polanyi 1945; Polanyi 1956).

> „It is equally easy to dispose of the claim to academic freedom of applied scientists in industry or government offices. There is a good deal of confusion, intellectual, emotional and political, on this subject. The obvious fact of the matter is that any research which is conducted explicitly for a purpose other than that of the advancement of knowledge, must be guided ultimately by the authorities responsible for that outside purpose" [Polany [1951]1998: 44].

Polanyi was critical of the USSR (and Nazi Germany), which he viewed as a totalitarian system. He believed that the primary task of a free society was to enable autonomous individuals to actively pursue authentic moral and intellectual principles. Accordingly, he believed that scientific work should be based on academic freedom, which cannot exist without a free society. "Academic freedom is of course never an isolated phenomenon. It can exist only in a free society; for the principles underlying it are the same on which the most essential liberties of society as a whole are founded" (Polanyi 1951: 45) He drew an analogy between Adam Smith's classic economic theory and how science works, stating that science is governed by the same principles as the economy.

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[6] The Society for Freedom of Science was founded with the following goals in mind: (1) to increase knowledge by scientific research (2) science can only thrive in a free environment; (3) science should be autonomous/free; (4) research workers should have freedom to choose their own research problems; and (5) scientists in non-dictatorial nations should collaborate to uphold scientific freedom (Society for Freedom in Science 1944).

[7] The CCF was a cultural anti-communist organization, established in 1950 with financial and infrastructural backing of the US Central Intelligence Agency (CIA). CCF sponsored programs that gathered and mobilized intellectuals, who were critical of Stalinism and Marxist ideas and practices, in the service of the US foreign policy (see Saunders 2000).

> „My argument for freedom in science bears a close resemblance to the classical doctrine of economic individualism. The scientists of the world are viewed as a team setting out to explore the existing openings for discovery and it is claimed that their efforts will be efficiently co-ordinated if - and only if - each is left to follow his own inclinations" [Polanyi [1951]1998: 154].

Polanyi held that science can only be advanced if scientists can freely and independently make decisions about scientific matters they have chosen to work on themselves (see eg., Polanyi 1945; Polanyi 1947; Polanyi 1962). He writes:

> "You can kill or mutilate the advance of science, you cannot shape it. For it can advance only by essentially unpredictable steps, pursuing problems of its own, and the practical benefits of these advances will be incidental and hence doubly unpredictable" [Polanyi 1962: 62].

Polanyi cites self-coordination as a key principle for the functioning of a scientific community. It is a principle governing the mutual adaptation of independent entities. Within the same system, each entity spontaneously adjusts and aligns with the operations of the others. According to him, self-coordination is guided by an invisible hand. Scientists refer to other scientists as their reference frame. As a result, they should not direct their work based on current societal situations. The concept is that scientists, in order to arrive at the "truth", spontaneously adapt to each other instead of depending on processes and regulations imposed by the state (see e.g., Polanyi 1947; Polanyi 1951; Polanyi 1962).

> "The individual scientists take the initiative in choosing their problems and conducting their investigations; the body of scientists controls each of its members by imposing the standards of science; and finally the people decide in public discussion whether or not to accept science as the true explanation of nature. At each stage a human will operates. But the exercise of will is fully determined on each occasion by the responsibility inherent in the action; and hence any attempt to direct these actions from outside must inevitably distort or destroy their proper meaning" [Polanyi [1951]1998: 58].

Polanyi contrasts this principle to the principle of centrally directed coordination, which he criticizes and thinks is characteristic of a "totalitarian" society. Planned science, according to Polanyi, subjects this key aspect of science to state and treats it instrumentally. For him, the planning of science undermines scientific autonomy, placing science directly under state control. Polanyi believes that any attempt at central planning stifles scientific advancement. In other words, he believes that science in this way stops being science, or more precisely, "pure science" (see e.g., Polanyi 1945; Polanyi 1948).

> „The Planning of Science is supposed - as we have seen - to conduct the pursuit of pure science towards discoveries which will be useful when applied to practical problems. That is in general impossible. Pure science has its own inherent aim and could embrace different aims only by ceasing to be what it is. It would have to discontinue the pursuit known to-day by the word "science" and substitute for it some other activity-which presumably would then be called science instead." [Polanyi 1945: 323-324].

Another reason Polanyi is critical of the concept of (central) planning of science is that he believes it is impossible to exactly articulate objective norms for how science should function. He believes that subjective factors affecting scientists (such as intuition) have a significant impact on scientific discoveries. These factors are impossible to prove, i.e. confirm. Polanyi refers to this understanding as tacit knowledge (see e.g., Polanyi [1958] 1998; Polanyi [1966] 2009).

Robert K. Merton

Robert King Merton is regarded as one of the founders of modern sociology. His diverse and long career was marked by a longstanding interest in the sociology of science, primarily the interplay and significance of social and cultural frameworks with regard to science. His theory and research essentially established and maintained the foundation of contemporary scientific sociology (see e.g,. Holton 2004), whilst his ideas on the nature of science (e.g., Merton 1938; Merton 1942) were often used to defend scientific autonomy during the Cold War.

Even before the Second World War, Merton emphasized in his work *Science and the Social Order* (1938) the need to preserve scientific autonomy. However, Merton argued that the application of science in the form of, say, technology, has positive effects on science that should not be overlooked. He believed that the practical application of science represents a significant factor contributing to the wider social support for scientific research. In addition, he noted that the role of technology in science facilitates acquiring as well as preserving the integrity of scientists themselves. According to Merton (1938), laymen are better able to recognize the value of science, as well as the value of scientists in society, through the technological application of science in everyday life rather than through abstract scientific theories. Merton was thus aware that demonstrating the value of science in concrete, practical situations was an important part of developing a public environment conducive to continued scientific advancement.

> "They also testify to the integrity of the scientist, since abstract and difficult theories which cannot be understood or evaluated by the laity are presumably 'proved' in a fashion which can be understood by all, i.e., through their technological applications. Readiness to accept the authority of science rests, to a considerable extent, upon its daily demonstration of power. Were it not for such indirect demonstrations, the continued social support of that science which is intellectually incomprehensible to the public would hardly be nourished on faith alone" [Merton 1938: 9].

However, further in the text, Merton (1938) points out the potential dangers of the scientific community's excessive focus on practical scientific application. This insight was one of the reasons he insisted that science had evolved into an autonomous institution with its own rules, or ethos, which should be nurtured in the future as well. According to Merton (1938), scientific ethos includes intellectual honesty, integrity, organized skepticism, disinterestedness, and impersonality. Later, in his text *The Normative Structure of Science* (1942), he codifies these rules into scientific norms. The point is that scientific norms enable science to be independent of the state, market, church, etc., and to preserve scientific integrity. Additionally, Merton emphasizes that preserving pure science is the key component enabling science to be autonomous (see also Mendelsohn 1989: 281-286).

> „One sentiment which is assimilated by the scientist from the very outset of his training pertains to the purity of science. Science must not suffer itself to become the handmaiden of theology or economy or state. The function of this sentiment is likewise to preserve the autonomy of science. For if such extra scientific criteria of the value of science as presumable consonance with religious doctrines or economic utility or political appropriateness are adopted, science becomes acceptable only insofar as it meets these criteria. In other words, as the 'pure science sentiment' is eliminated, science becomes subject to the direct control of other institutional agencies and its place in society becomes increasingly uncertain. The persistent repudiation by scientists of the application of utilitarian norms to their work has as its chief function the avoidance of this danger, which is particularly marked at the present time" [Merton 1938: 8 - 9].

Merton (1938) argues that in societies where science and technology have advanced to a high level, there is a risk that the general public (laymen) could question science as such (and thus pure science). According to him, this is related to some of the negatively perceived effects of technological growth that the public associates with the concept of pure, fundamental research. He feels that the long-term consequences of these scenarios may undermine scientific autonomy.

> "Since the scientist does not or cannot control the direction in which his discoveries are applied, he becomes the subject of reproach and of more violent reactions insofar as these applications are disapproved by the agents of authority or by pressure groups. The antipathy toward the technological products is projected toward science itself. Thus, when newly discovered gases or explosives are applied as military instruments, chemistry as a whole is censured by those whose humanitarian sentiments are outraged. Science is held largely responsible for endowing those engines of human destruction which, it is said, may plunge our civilization into everlasting night and confusion" [Merton 1938: 10].

According to Merton (1938), in the background of this unfavorable image of science as an institution, is the fact that some scientists believe that research exists in a social vacuum. He believes that because science does not actually operate in a social vacuum, this behavior, i.e., disinterest in the social repercussions of the application of research, can be damaging to science itself (see also Mendelsohn 1989: 281-286).

> "Precisely because scientific research is not conducted in a social vacuum, its effects ramify into other spheres of value and interest. Insofar as these effects are deemed socially undesirable, science is charged with responsibility. The goods of science are no longer considered an unqualified blessing. Examined from this perspective, the tenet of pure science and disinterestedness has helped to prepare its own epitaph" [Merton 1938: 12].

For Merton (1938), these situations are the consequence of institutional boundaries in practice, as well as the cause of the conflict between the ethos of science and of other social institutions. He sees antiscientific sentiments as a result of insufficient scientific autonomy, i.e. "as long as the locus of social power resides in any one institution other than science and as long as scientists themselves are uncertain of their primary loyalty, their position becomes tenuous and uncertain" (Merton 1938: 17). In line with this, he concludes that relative scientific autonomy (and institutional autonomy in general) is most attainable in social orders with a liberal structure (see e.g., Merton 1968: 591-615; Mendelsohn 1989: 281-286; Hollinger 1996: 80-96) because there is no large centralization, which in turn "permits the necessary degree of insulation by guaranteeing to each sphere restricted rights of autonomy and thus enables the gradual integration of temporarily inconsistent elements" (Merton 1938: 16).

According to Panofsky (2010), for Merton, scientific ethos, autonomy and validity of scientific knowledge are interconnected in the following way: "…freer scientific communities who have institutionalized ideals of pure science are more likely to produce true knowledge" (Panofsky 2010: 142). For Merton, a society based on democratic principles best suits the scientific community (see Merton 1968: 591-615; Kalleberg 2010; Wang 1999: 281; Hollinger 1996: 80-96; Mendelsohn, 1989: 281-286), because there is the least chance that politicians will jeopardize the autonomy of science (as with "totalitarian" systems) as the ethos of science does not collide with the values of such a social order (see Merton 1938; Merton 1942; Hollinger 1996: 80-96).

Karl Popper

One cannot discuss scientific autonomy without mentioning Karl Popper, one of the 20th century's most influential philosophers of science. Besides being a philosopher, Popper was also an academic and social commentator. When it comes to the subject of political ideology, he is also famous for his defense of liberal democracy and principles of social criticism (Weinert 2022). It is worth mentioning that at one point, as a young man, Popper considered himself a communist, and even joined a socialist association in 1919, but ended up being disenchanted with the Marxist ideology (Popper 1974: 24-25; Artigas 1997). The most significant event that drove Popper away from

Marxism was an incident during a demonstration in which young socialist and communist workers were killed. He realized that Marxist doctrine dictates that the class conflict be escalated, and that the socialist revolution will claim some victims, which was unacceptable to him (Popper 1974: 25).

> "The encounter with Marxism was one of the main events in my intellectual development. It taught me a number of lessons which I have never forgotten. It taught me the wisdom of the Socratic saying, "I know that I do not know". It made me a fallibilist, and impressed on me the value of intellectual modesty. And it made me most conscious of the differences between dogmatic and critical thinking" [Popper 1974: 27-28].

Popper's notable and renowned works in the field of the humanities and social sciences are *The Poverty of Historicism* (1944) and *The Open Society and Its Enemies* ([1945] 2011). These texts were a critical reaction to "totalitarian" ideologies, focusing on the philosophical foundations that support them and advocating for a political philosophy of democratic liberalism.

In the realm of philosophy of science, Popper (1974) focused on scientific autonomy, something he believed was undermined by systems based on Marxist philosophical assumptions, which he held as dogmatism and metaphysics. This was one of the reasons he was concerned about science's autonomy from ideology. Under ideology, Popper mostly and explicitly referred to Marxism. Aside from his intellectual biography providing a strong foundation for this claim, the very way in which he developed his arguments on the nature and role of science supports this reading (Popper 1974; Krige 1978).

To protect scientific autonomy, Popper seeks to limit the possibility of criticizing science. He restricts the field of science to scientific theory, just as he restricts "reason to 'objective' logical relationships between propositions" (Krige 1978: 8). In this way, Popper reduced the prospect of science being questioned outside of the realm of science. He does this by connecting the valuing of science as a discipline exclusively with questions that only scientists can answer. Moreover, to protect scientific autonomy, he "restricts rational response to anomaly to the single option of theory-rejection" (Krige 1978: 8). Insisting on this, Popper "reinforces this tendency by rejecting Marxism and the associated ideas of large-scale planning as 'irrational' and 'utopian'" (Krige 1978: 8).

According to Popper, the principle of critical examination of reality—which he deems intrinsic to the scientific community for scientific autonomy and an important feature of an open society—is challenged by the dogmatic phenomena it encounters (see e.g., Popper [1945] 2011). He believed that a claim can be considered scientific only if it is falsifiable, that is if it can be "logically countered" (Škorić 2020: 124), and as such serve as a criterion for demarcating between science and non-science, as well as pseudoscience (e.g., astrology, creationism) (Škorić 2020). However, according to Krige (1978), one gets the impression that the demarcation criterion had theoretical and practical functions in addition to those commonly seen. The function of the demarcation principle extends to the phenomenon that Kuhn named "normal" science, i.e. the distinction entails the difference between a "pure" scientific community and "impure" communities (such as communities of applied scientists like engineers, etc.) (Krige 1978: 289 - 290).

> "The 'normal' scientist, as described by Kuhn, has been badly taught. He has been taught in a dogmatic spirit: he is a victim of indoctrination. He has learned a technique which can be applied without asking for the reason why (especially in quantum mechanics). As a consequence, he has become what may be called an *applied scientist*, in contradistinction to what I should call a *pure scientist*. He is, as Kuhn puts it, content to solve 'puzzles'. The choice of this term seems to indicate that Kuhn wishes to stress that it is not a really fundamental problem which the 'normal' scientist is prepared to tackle: it is, rather, a routine problem, a problem of applying what one has learned: Kuhn describes it as a problem in which a dominant theory (which he calls a 'paradigm') is applied [...] Kuhn's description of the 'normal' scientist vividly reminds me of a conversation I had with my late friend, Philip Frank, in 1933 or thereabouts. Frank at that time bitterly complained about the uncritical approach to science of

> the majority of his Engineering students. They merely wanted to 'know the facts'. Theories or hypotheses which were not 'generally accepted' but problematic, were unwanted: they made the students uneasy. These students wanted to know only those things, those facts, which they might apply with a good conscience, and without heart-searching. I admit that this kind of attitude exists; and it exists not only among engineers, but among people trained as scientists. I can only say that I see a very great danger in it and in the possibility of its becoming normal (just as I see a great danger in the increase of specialization, which also is an undeniable historical fact): a danger to science and, indeed, to our civilization" [Popper 1965: 53].

In agreement with previous observations, Popper saw the scientific method as a crucial component of (pure) science on which science's autonomy depended. "[S]cience, he says, is to be distinguished from other systems of thought not only by the logical structure of its theories, but also by its distinctive method" (Krige 1978: 288). Popper's method can be described as an "anti-inductivist version of the hypothetico-deductive method" (Sankey 2008: 253). This approach implies that the posited assumption is not justified by the empirical data backing it, but that the goal is to find empirical data that would show the falsity of the hypothesis. This can be called the *falsificationist theory of method* (Sankey 2008: 252-254).

> "Scientists propose bold, speculative theories in an attempt to explain phenomena which appear problematic in light of background knowledge and expectation. But rather than support such theories by means of experience, scientists seek to disprove theories by means of rigorous tests of the predictions that the theories entail. Those theories which fail such tests are rejected. Those theories which survive all attempts to refute them are then tentatively accepted as the best currently available" [Sankey 2008: 253].

One of the main ideas of *Logic of Scientific Discovery* ([1935]1959), according to Popper, is that scientific knowledge is tentative and scientific theory has to be falsifiable. This contributes to the growth of scientific knowledge and represents an important trait of science, one which allows for scientific progress, which he sees as moving away from wrong, less comprehensive theories toward more comprehensive theories when it comes to explaining empirical data. Getting closer to scientific truth, according to Popper, represents an important task of science. Popper's theory of approximation to the truth is still discussed in the academic community (Veronesi 2014).

What can be concluded about Popper's philosophy of science is that his view of the purpose of science, which is getting closer to truth and the growth of scientific knowledge, is inseparable from his view of the scientific method and scientific theory. These are the elements that Popper believes ensure the independence of science in society and contribute to its demarcation not just from pseudoscience but also applied science.

The Soviet Marxist-Leninist Perspective

Exhausted from the consequences of the Second World War, as well as major industrialization processes in which science played an essential role, scientists (and other citizens) in the USSR, might have hoped for the abandonment of the military economy after the victory over fascism. But this did not happen, due to the start of the Cold War (see Pollock 2006: 4-5). Moreover, one should remember that "Marxist-Leninist 'scientific philosophy' provided the foundation for the ideology that underpinned the state and society" (Pollock 2006: 2-3). As a result, throughout this time in the USSR, substantial state activities across all disciplines, including science, continued. Given that Marxism-Leninism was the official ideology of the USSR, state operations largely implied organization and ideological control in relation to the new and specific state needs produced by Cold War circumstances (see Pollock 2006).

Marxist-Leninist philosophy, as well as Marxism in general, had a positive role in terms of the various influences on the views of scientists on certain subjects (such as the work of Vygotsky [psychologist], the ideas about the origin of life of Oparin [biochemist], the interpretation of quantum mechanics of Fock [physicist]) as well as a repressive and harmful effect on science and scientists in general (the noted Lysenko affair) (see Graham 1993: 121-134; Graham [1966]1972: 368-377, 93-101, 257-296).

In the following pages, I shall try to explain the Marxist-Leninist concept of the nature and role of science in society. I will accomplish this by presenting the main theoretical ideas of key exponents of this approach, who founded their views on the development and further expansion of the scientific ideas of Karl Marx and Friedrich Engels. I will thus present both the basic ideas dominating the Soviet Union and the international communist movement of the time, and the criticism of the concept of autonomous, value-neutral, or "pure" science—criticism that was an integral part of the communist understanding of the function and role of science.

Vladimir Ilyich Ulyanov Lenin

Lenin was a revolutionary and one of the main political theorists of revolutionary Marxism. He served as the first and founding leader of the government of Soviet Russia from 1917 to 1924 and of the Soviet Union from 1922 to 1924. He became an ideological leader and a powerful figure in the international communist movement (see Shub 1966; Service 2000). Lenin was a staunch advocate of Marxism who greatly contributed to its development. He believed that his understanding of Marxism was genuine and orthodox (Sandle 1999; Service, 2000). After Lenin's death, the Soviet government canonized his thought and labeled it Marxism-Leninism (Shub 1966; Service 2000). Marxism-Leninism was adopted by many revolutionary movements and developed into variants such as Maoism, Hoxhaism, etc. (Read 2005).

Lenin's thoughts on science and technology were heavily influenced by realpolitik circumstances and the establishment of Bolshevik hegemony in Soviet society. He believed that Bolsheviks were generally "deeply interested in science and valued it enormously" (Lenin according to Krementsov 2006: 1199). A significant reason for Lenin's considerable interest in science was that he was aware of the relevance of science in the socialist creation of society (Keldysh 1970).

> "In the past, the genius of man's mind was used to provide the benefits of technology and culture to a part of the population, depriving others of the basic essentials, education and progress. Now, all the wonders of technology, all the conquests of culture are to be the heritage of all people..." [Lenin according to Keldysh 1970: 9].

Because of the importance that Lenin placed on science in society, he dealt with philosophical issues related to scientific achievements, mainly in physics, such as the development of electrodynamics, the theory of relativity, and so on. Given that these shifts had a significant impact on views on science as well as the materialistic approach to the world, Marxists such as Lenin regarded this subject as very important, due to the works of Marx and Engels, their critique of idealism, and their dialectic approach to issues of nature, among other things.[8]

> "Serious difficulties arose. In particular, the conclusion of the classic electron theory, according to which electrons had mass and electromagnetic characteristics, was interpreted by many mechanistic

[8] See e.g., Marx, K. ([1846]1974). *The German Ideology*. London, Lawrence & Wishart; Marx, K.([1846]1969). Theses On Feuerbach. In: F. Engels, ed., *Marx/Engels Selected Works*, Volume One. Moscow: Progress Publishers, Engels, Friedrich. [1877]1947. *Anti-Dühring. Herr Eugen Dühring's Revolution in Scienc*e, Moscow: Progress Publishers. Available at: https://www.marxists.org/archive/marx/works/1877/anti-duhring/ [Accessed June 22, 2022].

> and positivist physicists of the time as a veritable *disappearance of matter*. Research scientists spoke heatedly of the *big crises in physics*" [Lenin according to Keldysh 1970: 6].

To affirm the philosophy of materialism, i.e. dialectical materialism[9] Lenin writes in his work *Materialism and Empirio-Criticism* ([1909]1977) that the crisis in physics signaled the beginning of a revolution in this field of research. New insights pointed out the inadequacies of the mechanical, or empirical paradigm, in physics. According to Lenin ([1909]1977), these novelties were not to be viewed in terms of matter loss, but rather as matter appearing in new forms previously unknown to scientists, for which the mechanistic paradigm was limited. According to Lenin "[n]atural science is progressing with such speed and undergoing such revolutionary upheavals in every field that the sciences cannot do without philosophical conclusions" (Lenin according to Laumulin 2019: 52). He argued that such a circumstance did not diminish, but rather reinforced, dialectical materialism. In other words, Lenin (1909) believed that modern physics supported dialectical materialism.

For Lenin ([1909]1977), being a dialectic materialist meant consistently advocating for a materialistic approach to reality. In agreement with his philosophical, or ideological, views, he highlighted the significance of political and economic conditions for scientific development as well as the possibility of the class character of science; in other words, he argued for partisanship in science.

> "Thus, on the one hand, the materialist is more consistent than the objectivist, and gives profounder and fuller effect to his objectivism. He does not limit himself to speaking of the necessity of a process, but ascertains exactly what socioeconomic formation gives the process its content, exactly what class determines this necessity. In the present case, for example, the materialist would not content himself with stating the "insurmountable historical tendencies," but would point to the existence of certain classes, which determine the content of the given system and preclude the possibility of any solution except by the action of the producers themselves. On the other hand, materialism includes partisanship, so to speak, and enjoins the direct and open adoption of the standpoint of a definite social group in any assessment of events" [Lenin 1972: 401].

For Lenin, the state played an indispensable role in realizing the function of science in society, i.e., its partisanship, as well as in its development, particularly in terms of supporting, promoting, and applying scientific research. In line with this, Lenin called for state support and oversight of the expansion of scientific institutions, even during times of economic hardship in society. Lenin paid special attention to the USSR Academy of Sciences because he believed it was essential to the economic development of society. This is why researching natural resources was one of the Academy's most important responsibilities. According to Lenin, the social framework that enabled this necessitated the development of a centralized national (and economic) plan (Keldysh 1970: 9).

Because of Lenin's vision of the party as the one in charge of expressing the interests of the working class, partisanship in science necessitated strong Bolshevik party control over scientific pursuits. It is interesting to note that Stalin's Bolshevik rival Leon Trotsky, still menshevik in that moment, criticized the possible problems that could arise from this situation already in 1904, warning of substitutionism, that is the danger of the party's interest replacing the working class interest and thus the interest of society itself with the particular interest of the party, as has often been the case throughout history (see Trotsky 1904: 54; Cliff 1960).

> "The party's administrative control was embodied in a new system of agencies supervising science policy. In January 1930, the Central Committee of the Communist Party established a Sector of Science and Culture, a year later transformed into a separate Sector of Science. In 1935, this sector grew into a Department of Science and Scientific and Technical Inventions and Discoveries. This department

[9] Lenin, like Marx and Engels, argued that non-dialectical materialism leads to idealism (see Lenin [1909] 1977).

> prepared decisions for the highest party agencies – the Secretariat and the Politburo, and oversaw every facet of science policy: it granted permission to organize new institutions, hold conferences, publish periodicals and books, appoint personnel, and bestow prizes and rewards for scientific research. Sometimes the party apparatus openly intervened in disciplinary development" [Krementsov 2006: 1197].

Nikolai Ivanovich Bukharin

Nikolai Ivanovich Bukharin was a Bolshevik revolutionary, Soviet politician, Marxist philosopher and economist, who inspired the Five-Year Plans and made the scientific method a part of the Soviet approach to the technological development of Russia (for more see e.g., Kemp-Welch 1992; Cohen 1980). During the Great Purge (that began in 1936), he was arrested and accused of conspiracy against the Soviet state. He was executed in 1938. (see Graham 1993: 142; Medvedev 1983). Regardless of his end, he is still considered a highly important figure for the Soviet scientific perspective. He was a Member of the Academy of Sciences, Director of the Industrial Research Department of the Supreme Economic Council, President of the Commission of the Academy of Sciences for the History of Knowledge (see Graham 1964: 135-136; Gerowitch 1996: 104; Bukharin et al. [1931]1971).

One of the most important assumptions in Marxism in general, and thus in the Marxist-Leninist perspective, is that the decisive separation of theory and practice, rather than focusing on the dynamics of their mutual relationship, contradicted the materialistic view of the world to which science belongs. Hence, rather than emphasizing the distinction between "pure" and "applied" science, this viewpoint attempts to underline their interdependence and highlight the fragility of their boundaries. Accordingly, at the *II International Congress of History of Science and Technology* held in London in 1931, delegates of the USSR presented the Marxist-Leninist view of the relationship between science and society. On this occasion, Bukharin delivered a speech on the relationship between theory and practice, where he noted that this relationship is not a purely logical problem, and should not be viewed as such. His speech focused on the historical and sociological dimensions of the theoretic divide, i.e. the historic process of the (relative) break of the relationship between "pure" and applied science, as well as its relevance to relations of production in society.

> "The problem of the 'pure' and 'applied' sciences, reflecting and expressing the problem of theory and practice, is not however a purely logical problem. It is itself a problem of history, and a problem of transforming historical practice. The acuteness of the problem in the innermost recesses of the capitalist order, and even the posing of the problem itself, is the theoretical expression of the real separation, fixed in terms of profession and class, and rupture between theory and practice—a rupture, naturally, relative and not absolute. This rupture, consequently, is a historical phenomenon: it is bound up with a historically transitory 'mode of production', with the bifurcation of labour into intellectual and physical labour, with the polarisation of classes. It may therefore be said with every justification that socio-economic formations ('modes of production', 'economic structures') differ from one another also *in the particular character of the relationship between theory and practice*. And in fact, in the theocratic state of Ancient Egypt, there were elements of a natural centralised planned economy; knowledge (theory) was most closely connected with practice, since it was expediently directed towards practice. But this connection was of a special type of Knowledge that was inaccessible to the mass of workers: their practice for then was blind, and knowledge was surrounded with an aureole of dread mystery. In this sense, there was a vast rupture between theory and practice. If we take for comparison the epoch of industrial capitalism, the epoch of the flourishing of "economic man," of boundless individualism, of 'laissez faire', we see a different picture. On a social scale, no one puts forward in an organised fashion either problems of cognition or problems of application of acquired knowledge. The division of labour creates a group of scientists and ideologues, bound up with the ruling class, which in its turn is broken to pieces by competition. The connection between theory and practice is to a considerable extent built up 'privately'. But the bifurcation of intellectual and physical labour does not disappear: it receives a different expression—a certain degree of 'democratisation of

> knowledge', necessary from the standpoint of technique: the formation of a large stratum of technical and other intelligentsia: the specialisation of science: the creation of high theoreticised generalisations, completely remote from the consciousness of the mass of practical workers (wage-workers). This is another type of connection. Its inevitable consequence is the abstract and impersonal fetishism of science (science for science's sake), the disappearance of the social self-consciousness of science, etc. Modern capitalism reproduces this anarchy on the new and more powerful basis of trustified industrial complexes and the corresponding scientific organisations. But it cannot either discover a scientific synthesis, or attain the self-knowledge of science, or achieve its organisation, or its *fusion with practice*. These problems, which are poignantly felt, lead already *beyond the boundaries of capitalism*" [Bukharin, [1931]1971: 26, 27, 28].

Based on the above, one can see that Bukharin points out the development of a structural relationship of scientists and ideologists with the ruling class in the social division of labor. This results in a relative fragmentation of the relationship between theory and practice, which ultimately leads to the domination of the idea of science for science's sake. Furthermore, Bukharin's insights can be linked to Marx's idea of the relationship between the particular and the general, i.e. the thesis that science becomes "general" only when it serves the working class (proletariat), because for Marxists, the interest of the proletariat corresponds with generality, or the general interest of society, to which science cannot fully contribute while serving capital disguised as "autonomy" (see Marx [1856]1969; Marx and Engels [1848]1986).

> "On the one hand, there have industrial and scientific forces started which no epoch of the former human history had ever suspected. On the other hand, there exist symptoms of decay, far surpassing the horrors recorded of the latter times of the Roman Empire. [...] At the same pace that mankind master's nature, man seems to become enslaved to other men or to his own infamy. Even the pure light of science seems unable to shine but on the dark background of ignorance. All our inventions and progress seem to result in endowing material forces with intellectual life, and in stultifying human life into a material force. This antagonism between modern industry and science, on the one hand, modern misery and dissolution, on the other hand, this antagonism between productive powers and the social relations of our epoch is a fact, palpable, overwhelming, and not to be controverted. [...] On our part, we do not mistake the shape of the shrewd spirit that continues to mark all these contradictions. We know that to work well with the newfangled forces of society, they only want to be mastered by newfangled men – and such are the working men. They are as much the invention of modern times as machinery itself" [Marx [1856]1969].

In addition to Bukharin's relevance to the philosophy of science and his contribution to the application of the Marxist approach to the relationship between theory and practice, his interest in science planning should be noted as well. In his view, "the planning of science is necessary not only to hasten socialist construction but also to increase the productivity of science" (Graham 1964: 138). Hence he strongly disagreed with the notion that scientific research cannot be planned. He saw the prevalence of this view among scientists in the USSR as a vestige of imperial rule, which had no place in the socialist system of government. He advocated for Soviet science to be planned based on state needs. He pointed this out in his speech in 1931 when the *First All-Union Conference for the Planning of Scientific Research Work* was convened. While presenting a paper on the subject, he listed the areas of science that can be planned: 1. The country's share of budgetary resources to be allocated to science (determined by the highest level of the party and economic hierarchies); 2. Subject planning (although very hard, according to Bukharin, is conceivable in science); 3. Support for scientific research institutions; 4. Geographical placements of scientific research institutes (institutes must be decentralized even though central management is retained); 5. The supply of the personnel (Graham 1964). We can see that Bukharin advocated for a centralized model of scientific planning, in line with the Marxist-Leninist ideology which he promoted in other areas as well.

John Desmond Bernal

John Desmond Bernal was a natural scientist who spearheaded the utilization of X-ray crystallography in molecular biology. Besides his primary profession as a natural scientist, Bernal was interested in the history of science and wrote extensively on the subject. He was a Marxist-Leninist and member of the Communist Party of Great Britain (CPGB). Although Bernal lived in Great Britain, he was part of the international communist movement and promoted Soviet politics (Aprahamian and Swann 1999; Brown 2005; Sheehan 2007). Even throughout the Lysenko affair, he adhered to the official party line and did not publicly criticize the Soviet Union, as was expected of Communist Party members. For Bernal, this caused a lot of controversy regarding his (professional) image. Many perceived his scientific image as tarnished by his politics (see Brown 2005; Sheehan 2007). Bernal believed that most stories about Lysenko were "magnified out of all proportion" in the West (Bernal according to Walker 2003: 3).

In his work, where he focused on the dynamic of the relationship between science and society, notably many examples from history (see for example, Bernal [1954] 1969ab; Bernal [1954] 1971ab), Bernal often underlined that science cannot realize its full potential in systems like capitalism (Bernal 1939). For him, the notion of an autonomous, "pure" science dominating philosophy of science is a false consciousness that stifles scientific progress. As a result, Bernal proposed that scientists and theorists of science look to Marxist-Leninist paradigms to better comprehend the relationship between science and society.

> "The relevance of Marxism in the development of science is both theoretical and practical. It removes science from its imagined position of complete detachment and shows it as part, a critically important part, of economic and social development. The organization of science in capitalist countries has gradually molded itself in the service of big business, but because the process is not understood or appreciated its service is poor and incredibly wasteful. In any case production for profit can never develop the full potentialities of science except for destructive purposes [...] The Marxist understanding of science puts it in practice at the service of the community and at the same time makes science itself part of the cultural heritage of the whole people and not of an artificially selected minority" [Bernal 1937: 63].

According to this view, it is impossible not to plan science. This is because, according to Bernal, there is no way for science to be independent from a social system. This idea, in addition to admitting the importance of the planning principle in science, implies an instrumentalist perspective, i.e. an approach to science considering its position in society. For Bernal (1952), behind the insistence on autonomous, "pure" science, there is an interest of the ruling class to preserve the existing socioeconomic system through (indirect) control over science.

> "It becomes more and more difficult to think of science abstracted from society. The indirect control through benefactions and government grants, well-concealed by the doctrine of pure science, can no longer operate on the scale demanded. In capitalist countries, the scientists are now directly controlled by governments or by monopolies, and often in a peculiarly unpleasant way" [Bernal 1952: 37].

Connected to this subject, it is also noticeable that, unlike the previously mentioned theorist of science Polanyi, who argued that the entire history of science supports the perspective of autonomous "pure" science, Bernal emphasized precisely the opposite; he believed that the entire history of science testifies to the mutual influence of scientific activity and relations of production throughout history. Historical insights into scientific development specifically lead us to arguments emphasizing the importance of the social function of science. For Bernal (1939), the fulfillment of the role of science (as well as its development) as defined by Polanyi, among others—that is, the pursuit of knowledge—is impossible (and its understanding is incomplete) unless addressed from the perspective of its social function.

> "In spite of the fact that this is a view held by many scientists themselves, it is essentially self-contradictory. If the contemplation of the universe for its own sake were the function of science, then science as we know it now would never have existed, for the most elementary reading of the history of science shows that both the drive which led to scientific discoveries and the means by which those discoveries were made material needs and material instruments. The fact that this view could have been held so successfully for such a long time can only be explained by the neglect, by scientists and historians of science, of the whole range of man's technical activities, though these have at least as much in common with science as the abstractions with which the great philosophers and mathematicians occupied themselves" [Bernal 1939: 5-6].

Bernal ([1954]1971a) did not hold that the application of science is inherently problematic; rather, as seen above, he emphasized the critical interplay between "pure" science and applied science. However, in his work, he highlighted an issue that 20th-century scientists encountered, namely anticipations of the destructive applications of science in wars and other troubling events during the period. The First World War led to the advent of jet fighter planes, tanks, and poison gas. The Second World War brought us the atomic bomb, while the Cold War continued to use science for destructive purposes. According to Bernal ([1954]1971a), governments and industries in capitalist countries adopted the planning approach of the Soviet Union, despite their declared opposition to this notion.

Bernal ([1954]1971a) also observed that, even after the war, many capitalist societies performed research primarily in accordance with military directives. The situation was exacerbated by the fact that in capitalist countries, after rejecting a simplified mechanical vision of natural science, scientists turned to positivism. Bernal considered positivism a "diluted form of agnosticism" (Bernal [1954]1971a: 861). In this way, because of the concept of value-free science, according to which science was independent of society, and which Bernal recognized in the philosophy of positivism, scientists not only lost their share in deciding about the role of science, but they also saw their fundamental research being shaped by positivism, an ideology serving the status quo, as value-free science in a given social context serves the interests of the ruling class.

> "The relativism of Einstein, the indeterminacy of Heisenberg, the complementarity of Bohr, take a positivist form, not for any intrinsically physical reason but because they were conceived by men brought up to have a positivist outlook" [Bernal [1954]1971a: 861].

Geopolitical Context and Characteristics of the Yugoslav System after the Second World War: Break with the USSR and Forming of the Non-Alignment Movement

At the end of the Second World War in Southeast Europe, the anti-fascist partisan movement led by the communists, with Josip Broz Tito at the helm, and alongside allied forces, defeated the Nazis and abolished the monarchy. Exposure to long-term fear of death, poverty, occupation, and other unfavorable conditions during the war, as well as the resulting new world division, paved the way for new, young communists to affirm and assume power. Under such circumstances, Yugoslavia began the construction of a new, socialist system. This system was created on the Popular Front's foundations, with the general support and assistance of the USSR, whose sociopolitical model Yugoslavia emulated (Jakovina 2003: 80-81; Petranović 1980: 376-398; Životić 2015: 11-17).

The process of establishing a new state began even before the end of the Second World War, thanks to the Communist Party of Yugoslavia (CPY), which organized the people's liberation struggle in 1941. In every territory recovered from enemy domination, the Partisan movement, led by CPY, would construct People's Liberation Councils and People's Front Councils (established at the state level in Yugoslavia in 1945). Interestingly, "the structure and the character of people's councils corresponded to that of the Soviets" (Obradović 1995: 30). This political system of "people's democracy" in Yugoslavia represented a democratic model in the sense that it involved the social strata in decision-making processes. This situation was unique to Yugoslavia as a "people's democracy" compared to almost all other similar political systems or "people's democracies" in Southeast Europe. In other countries, the new political system was mostly formed at the end of the war, with the party structure infiltrating the pre-existing parliamentary system only to later assimilate it (Obradović 1995: 29-30). On the other hand, in Yugoslavia "[s]tructure of the party-state was already established during the war, and after liberation, it successfully governed relations in all state subsystems. The country's renewal began as early as the summer of 1945" (Obradović 1995: 31). Thanks to this, as well as the fact that the Partisan grassroots resistance movement in Yugoslavia was one of the most notable during the Second World War, Yugoslavia was seen as more independent compared to other countries in the Eastern Bloc (see Čalić 2013).

In this initial post-war stage of the establishment of a new system on broader social foundations, the Politbiro of the Central Committee (CC) of CPY, the party's key political organ, represented the "only autonomous political institution in the system of 'people's democracies' that could base political action on freedom of the will in accordance with its own interests" (Obradović 1995: 43). Members of the Politbiro of the CPY's CC with the most decision-making power were Josip Broz Tito, Edvard Kardelj, Aleksandar Ranković, Milovan Đilas, Andrija Hebrang, and Boris Kidrič.[10]

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[10] **Josip Broz Tito** (1892-1980): A Yugoslav revolutionary and statesman who from August 1937 served as Secretary-General of the Communist Party of Yugoslavia, and later President of the Presidency of the Central Committee of the League of Communists of Yugoslavia. He served as the country's Marshal (1943–80), Prime Minister (1945–53), and President (1953–80). He was also the Supreme Commander of the Yugoslav Partisans (1941–45) and the Yugoslav People's Army (1945–80). Socialist Yugoslavia, a federation that existed from the Second World War until 1991, is associated with the figure of Tito. In short, Tito supported alternative routes to socialism, the nonalignment with the two opposing blocs during the Cold War, and was the first communist leader to challenge Soviet leadership (for more, see: Dedijer, 1953; Gužvica, 2020; Bakić, 2011a : 43-57).

Edvard Kardelj (1910-1979): Edvard Kardelj (1910-1979): Following Yugoslavia's breakup with the USSR, Edvard Kardelj, a communist from Slovenia who was active in the years before the war, became a leading proponent of the Titoist system of socialist self-management and its main ideologist. Kardelj significantly influenced the new sociopolitical structure of Yugoslavia through his political and ideological engagements (Jović 2003).

Aleksandar Ranković (1909-1983): Vice President of Yugoslavia, known as the second-in-command in Yugoslavia after Tito. He was the chief of the Department for People's Protection (OZNA) and the Directorate for State Security (UDBA), formed at the end of the Second World War in Yugoslavia, according to the Soviet model of

> "The leadership group in the political system of the 'people's democracy' is an institution of a party-political center constituting an informal but effective government, and this political position is the primary source of its political power. In the process of political decision-making, the leadership group and its leader have a dominant and monopolistic position. In conflicts inside the leadership group of the party state, the leading individual serves as the adjudicator" [Obradović 1995: 44].

It can be argued that theoretical and practical considerations of revolutionary tactics pervaded the workers' movement from its inception, even before the Second World War. The main ideological divide between the antiauthoritarian and authoritarian political strategies of the workers' movement, that is, those who thought that the struggle should be led only bottom-up (anarchists, anarcho-syndicalists) and those who thought the working class should be liberated through the state apparatus (social democrats, Bolsheviks, or Marxist-Leninists), was further widened following the conflict in the leadership of the USSR with the emergence of another, Trotskyist tendency (see Perović 1978; Istorija međunarodnog radničkog i socijalističkog pokreta 1952). Unlike the idea of the dictatorship of the proletariat, stemming directly from Marxist theory, the idea of a "people's democracy" had a tactical character.

> "The historical reason for its formulation should be sought in the need, primarily of the Russian Bolshevik party, and then other communist parties, to ensure political associates and then broaden their political base in the fight to seize power, i.e. to become not only representatives of the interests of the working class, but also the 'general people's' and 'general nation's' party" [Obradović 1995: 25].

In that sense, after the Second World War, the very notion of a "people's democracy" was used as a political instrument by the USSR "for establishing communist governments and systems in different parts of the world" (Obradović 1995: 25). At the beginning, prior to the Marshall Plan[11], the USSR took a flexible approach to the idea of a "people's democracy", which essentially represented a "transition phase" from a bourgeois social-political system, or parliamentary democracy, to a Soviet system, but without the rigid demands in terms of the method and pace of attaining that goal.

> "The systemic revision of the concept of a 'people's democracy' as a 'specific path to socialism' was done through the speech by Georgi Dimitrov at the Fifth Congress of the Bulgarian Communist Party

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intelligence services. He was the dominant figure in the field of state security before being removed from his official duties (Đorđević 1989; Dimitrijević 2020).

Milovan Đilas (1911-1995): Đilas is arguably best known for his book *The New Class* (1957) and his dissident activities during the Cold War. Nevertheless, Đilas held significant positions in the party until 1954, including leading AGITPROP (party organ in charge of agitation and propaganda), an extremely important ideological position (Dimić 1988; Bogdanović 2013).

Andrija Hebrang (1899-1949): Croatian and Yugoslav communist, active in the workers' movement since before the Second World War. Among other things, he performed the duties of the Secretary of the Communist Party of Croatia, the Ministry of Industry of SFRY, President of the Economic Council of SFRY, and President of the Planning Commission of SFRY. He was the key figure in the industrialization and economy of SFRY, and probably one of the most important member of the then-leadership of CPY alongside Ranković and Kardelj. After the Yugoslav breakup with the USSR, as someone seen as Stalin's choice to succeed Tito as Secretary-General of CRY, he was arrested and killed in the Glavnjača prison in Belgrade 1949 (Banac 1990).

Boris Kidrič (1912-1953): Notable Yugoslav politician and revolutionary. Besides being the Prime Minister of Slovenia (1945-46), he was the President of the Yugoslav Economic Council, a member of the Secretariate of the Executive Council of the CKY's CC, and a scientist (see Enciklopedija Leksikografskog zavoda 4, 1959: 188).

[11] The Marshall Plan of economic help to West Europe was launched in 1948 at the initiative of the United States in order to combat the threat of communism. The basic idea behind this strategy was that the US should aid in the economic recovery of postwar Europe, laying the groundwork for US economic, political, military and cultural dominance in Western Europe and thereby strengthening the system against Soviet threats. One of the methods of helping was providing scientific and technical support with the nominal goal of improving the development of underdeveloped regions (see Chomsky 1999; Krige 2006).

> on December 19, 1948. The political form of the 'people's democracy' was identified with the dictatorship of the proletariat" [Obradović 1995: 24].

At the very start of the post-war period, the concept of the "people's democracy," which was ideologically associated with the changes in the sociopolitical structure of Yugoslavia, as well as the conflict between progressive and reactionary social elements, in this context developed an increasingly economic-political character (Obradović 1995: 63). A 1946 statement by one of the major players in Yugoslavian economic politics, Boris Kidrič, attests to the economy's role in forming the new social system, determining its political (and ideological) character.

> "*The nature of the economy as it develops is inextricably linked to the character of the government. The character of the economic and social system in every country and in every time is inextricably linked to the character of governance*. […] The nature of the economy should thus be observed in all major and significant social developments as connected to the nature of the government" [Kidrič 1985: 326].

In alignment with this, Kidrič (1985), who believed that there could be no contradiction between the ideological character of the government and the ideological character of the economy, argued that it was important to address the issue of commanding positions in the Yugoslav economy. If commanding positions in the economy would fall into the hands of carriers of the old (capitalist) system, the Yugoslav economy would not change its character and development. As a result, the conflicts between the nature of the economy and the nature of the government would become more prevalent, jeopardizing the new government in "its material basis" (Kidrič 1985: 525). Considering all this, Kidrič (1985) assessed that the Yugoslav economy could not lag behind the development of the Yugoslav political system, whose basis consisted of the "people's government," which is, basically, "in its social essence, the government of the working people" (Kidrič 1985: 523). For this reason, Kidrič (1985) saw the strengthening of the state sector of the Yugoslav economy, which placed the commanding positions in the hands of the state, as a necessary segment of the struggle for socialism. He believed that this was a way to eradicate the contradiction between the social character of production (characteristic of socialism) and the "private capitalist property over the means of production," which characterized the capitalist economy (Kidrič 1985: 527).

It is interesting that Kidrič, a highly important figure of Yugoslav communist command during that period, aligning with the Marxist-Leninist doctrine of "people's democracy", confirmed that it would be "completely wrong and *non-Marxist* if we were to identify our new government with the dictatorship of the proletariat. It is not that. Rather, it is the people's government, which is fundamentally democratic and, in general, the government of the working people, that gives workers, particularly the working class, every opportunity to fulfill their historical role of abolishing exploitation and building socialism. It is perfectly natural that along with new changes in the nature of our economy, more changes in the nature of our government would be adopted" (Kidrič 1985: 527-528). Following the breakup with the USSR, which occurred already in 1948, Yugoslav leadership quickly modified its understanding of the character of the Soviet Union and the role of the Yugoslav system.

It may be inferred that in the early stages of the postwar period, it was believed that the Yugoslav regime's transition to socialism was dependent on the economy's progress in the same direction. According to this idea, the disagreement between the political, i.e. ideological order toward which the Yugoslav system strived and the economic principles it was based on at the time had to be abolished, for "if such a contradiction were to continue existing for a longer time, the new government would fail" (Kidrič 1985: 327). In the words of Andrija Hebrang, Yugoslav and Croatian communist and minister in the government of FPRY: "It is a well-known thing that he who holds the economy holds power" (Hebrang according to Petković 1988: 341). Given the CPY's state socialist ideological

orientation and its reliance on the USSR, the resulting economic model was expected to be etatist-socialist. According to this model, etatism i.e. state property, practically under party control, was key to the structure of social relations in Yugoslavia at the time (Obradović 1995: 270).

> "Creating a state-property monopoly through confiscation, agrarian reform, and nationalization, was an important and necessary political condition for the party-state to become the direct and exclusive organizer of social reproduction and its main subject. The change of relations of production, from capitalist to socialist, created a socioeconomic basis for institutions, instruments, mechanisms, and measures of the economic system to function in accordance with the political and economic goals of the party-state. In other words, the main 'task' of the given economic system was to reproduce and develop socialist relations of production" [Obradović 1995: 64].

Etatist-socialist economic model was a necessary condition for the planned economic development of society, i.e. "socialist industrialization," based on "state-concentrated social accumulation" (Obradović 1995: 64), "centralization of the budget, i.e. allocation of national income according to set priorities" (Obradović 1995: 271). The process of building this model lasted from 1947 to 1952, which corresponded to the implementation of the First Five-Year Plan, regardless of the major geopolitical events that took place in 1948 (Obradović 1995: 65).

The first Five-Year Plan in Yugoslavia was inspired by similar socialist plans in the Soviet Union. It was intended to modernize the backward Yugoslav society by advancing the country's postwar reconstruction, industry, and urbanization. The general tasks of the reconstruction of the war-ravaged country, which was already one of Europe's underdeveloped countries prior to the war, concerned overcoming economic backwardness, strengthening the country's economic independence and defense forces, developing the state economic sector, and increasing the "general welfare of the workers…" (Čepo 1986: 80; see also Čepo 1983). The creator of the plan was Andrija Hebrang (Ožanić 2019: 49). Following Hebrang's removal from all functions, Boris Kidrič took over the plan's implementation (Bilić 2020).

In societies with a capitalist and liberal-democratic socio-economic system, which was primarily associated with the West, "the change of social structure toward industrialization occurs spontaneously, organically 'from below' by way of undirected modernization" (Obradović, Frendo, Cook 1996: 859). However, it is clear that "capitalism in Yugoslav countries did not realize its historic mission of industrialization" (Bilandžić 1985: 113). After the Second World War, Yugoslavia was economically backward, war-ravaged with a poor foundation for industrialization, and with millions of hungry people. In this sense, the electrification and industrialization of the country become an "all-people's task" (Antonić 1999). Unlike modernization of a liberal-democratic type, socialist modernization implied "the process of guided (directed or managed) modernization. Command, management, and administration of social developmental changes are the main characteristics of Communist modernization. The Party appears as the political programmer and ideological creator of changes" (Frendo, Cook, Obradović 1996: 859).

Socialist modernization, like liberal-democratic social systems, embraced rationalization, which is "the process of introducing rational content and acts into an economic activity" (Kuljić 1998: 159). However, although Yugoslavia underwent socialist modernization, particularly during the First Five-Year Plan period, which focused on removing socioeconomic inequities, it was also obvious that an "uneven intervention into certain segments of social organization" was taking place (Kuljić 1998: 159).

> "The imperative of class equality, which the communist ideology derived from a strongly European natural law school of thinking, appeared to have clashed more with economic and legal rationality than with that in other social activities [...] Its effect was surely most prominent and lasting in enlightening and spreading education as the most important channel of social mobility" [Kuljić 1998: 159, 160].

According to Kuljić, socialist modernization involves processes like centralist industrialization, urbanization, and overcoming the semi-colonial status in the international division of labor. During this period, Yugoslav modernization entailed emulating the Soviet model, which implied implementing modernization processes "top down." Driving its adherence to this principle (particularly after the break with the USSR) was the necessity to increase industrial potential, which would serve as a foundation for autonomous foreign policy and state independence. This was because "industrial modernization everywhere on the European continent demanded in addition to the extensive unification of the market, state centralism embodied in the inviolable authority of the ruler" (Kuljić 1998: 161).

Yugoslavia received an invitation to take part in the Marshall Plan for the reconstruction of post-Second World War Europe in 1947. With the explanation that the Plan had been developed without Yugoslav involvement and that this aid might enable foreign powers to meddle in its domestic affairs, the Yugoslav leadership turned down the offer. Instead of this, Yugoslavia embarked on a process of economic integration with the Eastern Bloc. Numerous trade agreements were reached with the "people's democracies," culminating with Yugoslavia signing an agreement with the Soviet Union on July 25, 1947, on the timely purchase of industrial facilities and equipment. This agreement meant to provide US$135 billion in funding to the First Five-Year Plan. In exchange, the Soviets requested lower prices on raw materials and other commodities. The 1948 conflict with the Soviet Union inflicted serious economic damage on Yugoslavia. The Treaty on Friendship and Mutual Assistance was unilaterally revoked by the Soviet authorities in late September 1949, and other "people's democracies" followed. These nations were supposed to provide 85% of the equipment and supplies required to carry out the Yugoslav plan (Frendo, Cook, Obradović 1996: 862).

During this period, "the state was the main economic subject, i.e. creator of the economic system and politics, including the goals of Yugoslavia's planned socio-economic development" (Obradović 1995: 65). The fact that the CPY autonomously organized and led the struggle against the fascist occupation during the Second World War contributed to the Party's legitimacy, earning it a major political role in society at the time (Obradović, 1995: 270). In that sense, it was clear that "strong political mobilization (the 'national front' policy) precedes the stage of economic mobilization (industrialization) and cultural mobilization ('socialist realism')" (Frendo, Cook, Obradović 1996: 859).

Even with the deadline extended and investment resources focused on the "vital capital construction facilities," the First Five-Year Plan was not implemented in its entirety until the late 1950s. The First Five-Year Plan's implementation, which sought to implement "socialist industrialization" in Yugoslavia, caused a dramatic shift in the country's economic structure. Specifically, the rise in industrial production and fall in agricultural production altered the proportion of various economic sectors in the GNP structure. In 1952, the industry made up around 40% of the GNP and agriculture around 30% (Frendo, Cook, Obradović 1996: 863). The period from 1953 to 1964 was marked by industrialization and economic modernization in Yugoslavia. During that time, the country's gross domestic product increased by 133%. Yugoslavia was able to bridge the boundary separating industrial and rural life. As a result, for the first time in 1960, agriculture accounted for a smaller share of the national GDP than industry. In 1961, the agricultural population accounted for slightly less than half of the entire population (Antonić 1999; see also Kostić 1955).

In the postwar period, the insistence on close ties with the USSR, as well as the attempts to implement the hegemony of Marxist-Leninist ideology in every pore of the new social system, contributed to Western countries being regularly described in Yugoslavia "as reactionary and imperialist" (Jakovina 2003: 82). The Soviet influence was also noticeable in the realm of Yugoslav culture. Notably, Yugoslavia established groups for cultural cooperation with the USSR and a wide range of other

people's democracies. Almost every mass meeting, conference, rally, reading group, commemoration of the October Revolution anniversary, and other events – such as those promoting the aesthetics of socialist realism – attempted to popularize the USSR in Yugoslavia (Jakovina 2003: 83-94).

As already noted, unlike other satellite states in the Eastern Bloc, Yugoslavia was positioned as an independent center of communist power, much to the displeasure of Stalin, the leader of the Soviet Union at that time. In 1948, an international crisis erupted and caused Yugoslavia to leave the Eastern Bloc after the USSR accused it, among other things, of reintroducing capitalism and nationalist tendencies (Bakić 2011: 25; Čalić 2013; IB Resolution[12]). This situation resulted in Yugoslavia facing pressure from the Cominform in the form of blockades, provocations, conspiracies to assassinate Tito, and so on (Jakovina 2003: 319). An example of this was the exclusion of Yugoslavia from the Council for Mutual Economic Assistance and imposing a full trade blockade. This was accompanied by a media campaign in East European countries calling to "overthrow the Yugoslav state and party leader Tito" (Čalić 2013: 236). In other words, the break with the USSR was followed by an acute economic and ideological crisis. „The break with the USSR sent Yugoslav communists into a deep state of shock, which quickly led to an extended war psychosis. With one blow, their ideological hero, symbolized by the mighty leader Stalin, disappeared, and was now probably preparing a military incursion" (Čalić 2013: 236).

The West viewed "Tito as the greatest dissident of the new era," finding that he "made a dent in the monolith of the communist unity by standing up to Stalin" (Bogdanović 2013: 147-148). Realizing the geopolitical significance of Tito's detachment from Moscow, despite the ruling socialist ideology in Yugoslavia, the US decided to aid the war-ravaged and devastated country under threat of attack by the USSR (Jakovina 2002: 32; Čalić 2013: 228, 236). The political context of Yugoslavia's relationship with the West at the time was defined by American-Soviet rivalry, the USSR's hegemony in Eastern Europe, and the dread of the USSR's military intervention in Western Europe. Western backing for Yugoslavia, primarily economic but also military, was "motivated by strategic interests for limiting the area under Soviet influence and encouraging governments under Soviet domination to redefine their foreign policy orientations" (Bogetić 2000: 14). In accordance with this policy, it is worth noting that in the early 1950s, the US provided Yugoslavia with non-reimbursed food aid (valued at as much as 95.2 million dollars in 1950) and military assistance, including support in military equipment (Bilandžić 1985:163). In this situation, Tito prioritized the "issue of political power rather than ideology" (Čalić 2013: 237). Though he made it obvious to the West that he was unwilling to renounce communism at all costs, he made a number of compromises, the most significant of which was ending his support for communists fighting in the Greek civil war. After this compromise, made in 1949, Yugoslavia was granted a million-dollar loan by Great Britain and launched a hunt for Cominform supporters who represented the interests of Moscow.

> "Around 5,000 of Stalin's supporters emigrated for political reasons. […] Around 16,000 sympathizers, agents, and suspicious individuals were sentences and sent to the notorious Goli Otok and Sveti Grgur camp for 're-education' labor under the scorching sun. Kardelj simply believed if Soviet supporters had not been isolated, Stalin would have had 'turned the whole Yugoslavia into a horrible camp'" [Čalić 2013: 237].

These were the circumstances that led Yugoslavia to open up to the Western Bloc (Bogetić, 2000; Jakovina, 2003). Despite obvious ideological disagreements and frequent misunderstandings[13], observing the cooperation between socialist Yugoslavia and the Western Bloc following the break with the USSR in 1948, it can be said that cooperation was progressing well in the first few years,

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[12] The Resolution of the Information Bureau of the Communist and Workers' Parties concerning the state of affairs in the Communist Party of Yugoslavia, passed on June 28, 1948.

[13] An example of this was the Trieste crisis. For more on the Trieste crisis in the first half of the 1950s, (see: Novak & Zwitter 2007).

culminating in Yugoslavia's entry into the Balkan Pact in 1953. Yugoslavia's new foreign policy drastically differed from the one it adopted prior to 1948. The new Yugoslav foreign policy was "focused on achieving tactical closeness to the West in order to break the economic blockade imposed by the Soviet Union and East European states after the conflict in 1948" (Bogetić 2000: 14). Yugoslavia received substantial aid from the United States, France, and Great Britain (Petranović 1980: 497). It is significant to note that during this period of intense and tight cooperation between the Yugoslav leadership and the West, collectivization of agriculture was abandoned in the country, among other things, and peasants were allowed to leave the cooperatives that served as a model for collectivization. As a result, a great number of cooperatives were liquidated shortly after being established (see Mirković 1958: 229-234).

The West seemed to have been pleased with how things had turned out. The "frequent interactions between politicians from Greece, Turkey, and Yugoslavia to establish the Balkan alliance" (Bogetić, 2000: 13) only contributed to this. Both Turkey and Greece were NATO members at the time. As a result, the West had high expectations of this regional alliance, which was viewed as the first step toward Yugoslavia joining NATO. "This would happen indirectly, with the Balkan first submitting to the command of the Western military alliance and then developing a mechanism of coordinated action with it" (Bogetić 2000: 14) Interestingly, the Yugoslav leadership not only did not "energetically oppose" this idea but also positively assessed the significance of the West and its defense mechanism in preserving world peace, expressing a desire for Yugoslavia to contribute to world peace. There are notable examples of this. In 1951, American statesman and military officer Eisenhower, who held the post of 34th President of the United States (1953-1961), asked Koča Popović, the Chief of the General Staff of Yugoslavia at the time, about the possibility of Yugoslav soldiers fighting alongside the West against the Soviet Union despite their disparate ideologies. Popović replied that Yugoslavia had no problem fighting against the "imperial nature of Soviet 'communism'" (Popović according to Jakovina 2003: 331), adding that there were "fewer Cominform supporters in Yugoslavia than in Western countries" (Jakovina 2003: 331). It was Yugoslavia's resolute decision to enter a military alliance with two NATO member states that led to the West approving military aid of over US$200 million dollars to Yugoslavia (Bogetić 2000: 14).

These circumstances, combined with the Yugoslav leadership's desire to cooperate with the West owing to a lack of choice and fear of the USSR, presented the US with a rare opportunity to construct the image of a peacemaker in these difficult geopolitical circumstances. Therefore, although Yugoslavia continued to adhere to the socialist ideology even after breaking with the USSR in 1948, which from a liberal-democratic perspective was synonymous with a lack of democracy and freedom, pragmatism once more proved to be one of the most important features of American foreign policy.

> "An opportunity arose to show how American military force served to preserve peace and protect from aggression. […] The military and strategic importance of the FPRY would not be diminished even if the country would turn to the East again, provided that the East did not have the last say in its area. That's how things really were" [Jakovina 2003: 330].

The significance of Tito's dissidence for the West is also demonstrated by the fact that Yugoslavia, despite not being formally a member of NATO and having a socialist ideology, "was recommended that weapons be purchased and that equipment be delivered according to the same standards that apply to NATO countries" (Jakovina 2003: 328). The Treaty of Friendship and Cooperation between Greece, Turkey, and Yugoslavia was signed in Ankara in February 1953. "This not only provided the FPRY with leverage for smoother discussions with the West, but it also accomplished something unprecedented in the Cold War up to that point. The country formed an alliance with two NATO members..." (Jakovina 2003: 350).

To maintain its socialist ideology oriented toward workers' control while exposed to the dynamics of decentralization and, to a greater extent than before, market forces, the Yugoslav socialist system

evolved into a distinctive form – that of socialist self-management (Čalić 2013: 238). The new Yugoslav system of socialist self-management combined elements of workers' self-government, controlled market relations, state decentralization, and Party control. Most of these elements revised or even directly opposed the ideology of Marxism-Leninism. The Yugoslav system thus represented a heterodox form of socialism. Along these lines, it can be concluded that the Yugoslav system, after breaking with the USSR, sought to develop distinctive, if not opposite, characteristics from the Soviet Union.

> "Its entire legitimacy and inner cohesion it derived from the fact that it was more democratic than the USSR and that it resisted its political pressure […] The reformed system was connected to the idea of renewed national identity in the form of Yugoslav socialist patriotism. […] Such Yugoslavism did not disrupt the free development of national languages and culture, but rather encouraged them" [Čalić 2013: 240].

In the 1950 draft of the Basic Law on the Management of State Enterprises, several basic system elements were emphasized: "debureaucratization" through the establishment of workers' councils, decentralization of administration, politics, and culture, and democratization in all aspects of life. To send a message about adhering to the democratic line, the CPY changed its name to the League of Communists of Yugoslavia in 1952 as well as some key elements of its party program (Čalić 2013: 238-239).

> "In the following years, self-management was still being built, which allowed for the gradual development of a freer market supply and demand […] Yugoslavs believed that the state should only coordinate instead of plan everything" [Čalić 2013: 238].

At the nominal level, the Yugoslav economy with an inadequate and limited market system, sought to distinguish itself from both the USSR and the Western bloc governments by establishing a free association of producers, sometimes known as new socialist free producers. These were "*associations of producers producing commodities and exchanging their products on a socialized market for products of another association freely and independently*" (Popović [1953]1964: 27). At the nominal level, this entailed a certain degree of economic individuality, as well as the freedom of producers to "possess the products of their work and to exchange them in the market" (Popović [1953]1964: 27-28). Some theorists have argued plausibly that such an established economic order stemmed from the political-economic concepts of mutualist anarchist Pierre-Joseph Proudhon (Commisso 1979: 3). And while some view this as positive, from a Marxist-Leninist standpoint, it constitutes further proof of the "petit bourgeois" character of the Yugoslav system and its leaders (Yudin 1948).

Yugoslavia's modernization was heavily influenced by its leadership's international connections, i.e. its foreign policy and investment decisions (Kuljić 1998: 165). In this setting, the relationship between the economy and politics cannot be overlooked; what is more, the economic and political "components" of socialist Yugoslavia's development cannot be separated. Yugoslavia's geopolitical position during the Cold War further contributed to this, particularly after the break with the USSR, as Yugoslavia "adeptly used the raptures between the blocs to obtain protection and support without doing something in return" (Kuljić 1998: 165). Therefore, in the Titoist approach to modernization, there was a continual entanglement between "the revolutionary Marxist vision of a just society and the aspirations for independent state development free of Soviet patronage and bloc-informed proletarian internationalism" (Kuljić 1998: 161).

However, there were contradictions at the inner political level, particularly in the period after the break with the USSR, which also cannot be separated from Yugoslav foreign policy. According to Kuljić (1998), while state centralism and the centralism of political authority in the form of the party represented the necessary factors regulating the development of Yugoslav society, as well as a significant guarantee of its unity, "over time, the unchanged role of the party became an obstacle to

the new vision of a decentralized state, causing but also resolving new forms of non-progressive systemic conflicts" (Kuljić 1998: 166). Despite some deregulation in administration in the socioeconomic sphere, in the political sense, "[the] party was [still] the main lever of power of Tito's government, without whose monopoly […] socialism was unimaginable" (Kuljić 1998: 107). Opposing the multiparty system was based, on the one hand, on experience during the war, in which the bourgeoise political parties often collaborated with the occupation forces, whilst the CPY organized the anti-fascist resistance movement. However, in addition to this and similar practical reasons, related to the "liberating effect" of the party and the "legitimate basis of a permanent possession of power," equally important was the rational, ideological explanation based on the "faith in the necessary dying out of the party and state" which was the inevitable consequence of democratization (Kuljić 1998: 108). "Here we follow the path of democratization that entails the disappearance of the state" (Štaubringer 1976 according to Kuljić, 1998: 108). At the official level, in the context of socialist Yugoslavia, the idea was that the working class, or the immediate producers organized in free associations, should prepare the basics of society's democratization, because "socialism cannot be built without active, revolutionary, democratic awareness of organized people and their activities" (Popović [1953]1964: 33). In this ideological process, the CPY represented an ideological means, to which the very leadership (meaning, Tito) should be subjected, and it served to achieve the ideological goal of a "just, classless, and harmonious society" (Kuljić 1008: 151). In other words:

> "It would be wrong to understand Tito's insistence on the unchanged role of the party as pragmatism aiming to maintain power […] Belief in the progressiveness of socialism and the morally superior revolutionary idea of liberating the productive class from exploitation […] [f]aith in the moral and enlightenment superiority of the communist organization was one of the components of the modern-era charisma of reason […] communist ideology belongs to the modern-era line of thought based on natural law and enlightenment […] Unlike bourgeois conservativism and various versions of national-fascists irrational ideologies, the enlightenment tendencies shared a belief in reason. […] Marxism and communist parties supplied a strong moral component to the new wave of the charisma of reason. In a vision of a just society, destroying the religious cult was no longer enough; social disparities had to be addressed as well. The rationalistic vision of society was founded on a strong belief in the power of science and technology, and the communist party became the emissary of the emancipatory process. […] The communist leader is not supernaturally gifted with heroism, generosity, and political ingenuity but rather raised through party work […] Unlike fascism in socialism, the leader never superseded ideology nor the party as the main source of sovereignty" [Kuljić 1998: 152-153].

Despite the regime's clear efforts to ensure that the ideology implemented in Yugoslavia remained socialist, the West's treatment of Yugoslavia in foreign policy relations after the break with the USSR (particularly at the beginning, but also later) was very different from that of other socialist countries, particularly the Eastern Bloc.

> "Everything that applied to 'Iron Curtain' countries in terms of psychological war after 1948, did not apply to Yugoslavia, at least not to a large degree. Voice of America broadcast tailored programs for Yugoslavia that did not call for the overthrowing of the system but emphasized the benefits enjoyed by the country because of its new foreign policy orientation. The other radio programs, Radio Free Europe and Radio Liberty for the USSR broadcast their programs in only one South Slavic language – Bulgarian. Surely, what was required to overturn, say, the regime in Czechoslovakia, had not been done in Yugoslavia. State administration should not have become less, but more efficient, defections to the West from satellite countries, which were proof of the regime's weakness, in the Yugoslav example, showed the instability of a friendly regime that should have been a model for similar orders in satellite countries" [Jakovina 2003: 526].

Although dissident Yugoslavia's primary function was perceived by Americans as geopolitical, the West made clear demands for the adjustment of certain structural elements of the Yugoslav socialist system in a direction that would allow for greater compatibility with the Western liberal-democratic,

capitalist systems. Given the importance of the economic component in this paper, we shall briefly discuss the demands connected to the Yugoslav economy. The West intended for the Yugoslav economy to be "restructured" from "heavy and military industry to light industry, focusing on consumer goods and food production" (Bogetić 2000: 15). However, for socialist Yugoslavia, which at that time attempted to continue the implementation of the Five-Year Plan and the modernization process, this "idea of development" meant abandoning the idea of a "self-sufficient economy" that would focus on heavy and military industry and be independent of global market trends.

The Yugoslav leadership wanted to build an economy "that can manufacture everything by itself and export only accidental surplus goods in accordance with party leadership orders. This conception, however, required accelerated industrialization, which in turn required importing equipment from the West – as well as Western loans (but also aid in the form of food and weapons)" (Bogetić 2000: 15). In other words, the only way for Yugoslavia to continue with the modernization of society after the break with the USSR was to turn to exporting to the West, which it did in the end. In this situation, it was the only way to obtain the money to repay debts and acquire raw materials (Bogetić 2000: 15). "In that way, Yugoslav economic politics kept falling into certain contradictions manifested in the gap between revolutionary ideals and pragmatic developmental imperatives" (Bogetić 2000: 15).

In January 1952, Yugoslavia and the United States signed an agreement on economic cooperation. This was the first bilateral trade agreement signed by the United States, the representative of the capitalist, liberal-democratic social order, and a socialist state. It should be noted that this type of agreement is comparable to those "that the US concluded with most Western European countries, based on the American Mutual Security Act (MSA)" (Bogetić 2000: 16).

> "With this agreement, the Yugoslav side obliged itself to develop its industry and agriculture on a 'healthy foundation' and to inform the US government of projects it intended to realize using the funds it received. The agreement also accounted for Yugoslavia's obligation to export needed strategic raw materials to the United States, at reasonable prices and in accordance with its own interest, to 'beneficially' use US aid, to stabilize its currency, and to cooperate with other countries receiving American aid, which meant removing trade barriers and opening itself economically to the world. Yugoslavia also agreed to 'develop basic human rights, freedoms, and democratic institutions'" [Bogetić 2000: 16].

In the quest for the state independence of Yugoslavia (to the extent possible in an ideologically polarized system with profound inequality in political power between states), Tito sought suitable "international support" immediately following the split with the USSR. "In the hierarchical world order, there were various efforts by subordinate countries to resist the vassal position by creating coalitions between countries of a similar position or by utilizing the opposition of great powers" (Kuljić 1998: 270). Until the mid-1950s, Yugoslav foreign policy after the break with the USSR was marked by a focus on Western countries. However, newly liberated colonies, particularly India, shifted the focus of Yugoslav leadership, still seeking independence, to third-world countries.

The Non-Aligned Movement was founded under the critical influence of the President of Egypt, Gamal Abdel Nasser, the Prime Minister of India, Jawaharlal Nehru, and the President of Yugoslavia, Josip Broz Tito. Leading up to the formation of the movement, leaders had a series of contacts and meetings, culminating in the first conference of the Non-Aligned Movement held in 1961 in Belgrade, Yugoslavia. During the Cold War, non-alignment officially stood for a position independent of both Cold War blocs. However, after the mid-1960s, its influence started to wane, mostly because of doubts about the movement's nonaligned ideals in practice. In the case of Tito, he embraced non-alignment in order to strengthen Yugoslavia's position as an independent state in international affairs following Stalin's 1948 expulsion of Yugoslavia from the socialist camp (see Lüthi 2020: 287-306).

Because political independence was high on the Yugoslav leadership's priority list, it is unsurprising that it sought the most advantageous and autonomous position in every field. The non-aligned movement greatly aided it in this aim.

> "In the mid-1950s, the League of Communists of Yugoslavia concluded that Yugoslavia would be economically inferior in the West, a mere supplies tag of Western Europe. In contrast, cooperation with impoverished African and Asian countries could be the leading political strength, while also assuring a market for the new Yugoslav economy" [Kuljić 1998: 271].

Imperialism was the common enemy of third-world countries and socialist Yugoslavia. Even with the number of members in the Non-Alignment Movement growing, leading to an increase in ideological and political differences between state members, the cohesive element was the perception of imperial forces as a common enemy. In this way, the very non-alignment concept represented a cohesive and flexible political idea, allowing for "tactical shifts in relationships with great forces" (Kuljić 1998: 273). It is worth noting that during this period, Milentije Popović, a prominent Yugoslav official, once Minister of Foreign Trade and Finance and President of the Federal Council for Scientific Research, stated in an interview that "blocs should be overcome and new sociopolitical relationships in the world established" (Popović ([1960] 1964: 269). In this Cold War context of a bloc-divided world, the non-alignment movement was seen as having the political potential to overcome a deeply polarized world. According to Popović, the "central issue" when it comes to these countries' development, and thus their independence, was the issue of accumulation (Popović [1960] 1964: 238). In his view, the issue of accumulation was basically the impossibility of a "simple" transfer of socioeconomic systems formed in the West and East to other countries with different historical circumstances, such as Southeast Asian countries and similar underdeveloped states. Thus, a new political solution had to be sought for the development and independence of these countries. Popović suggested that the Yugoslav model for addressing accumulation problems was a solution in which third-world countries had shown interest.

> "It is characteristic, and surely not accidental, that Southeastern Asian countries show a great interest in Yugoslavia, specifically for its ways and social forms to solve rapid accumulation problems. Because practice has shown that neither capitalism nor etatism, whatever form they take, provide satisfying solutions to their problems, people in these countries naturally show interest in the experience of a country, which – through its specific socioeconomic and political organization, as well as systems of workers' and social self-government – achieved the most in terms of immediate activation of the people's masses as a factor of accelerated economic and social development, profoundly deviating from classical capitalism and etatism" [Popović [1960] 1964: 243].

Between 1953 and 1956, Yugoslavia's relations with the Soviet Union were somewhat normalized, which facilitated the emergence and institutionalization of the Non-Alignment Movement. The idea was for the Movement to evolve into the Third World's challenge to the bipolarity of the Cold War international system. Tito played a crucial role in the institutionalization of the new gathering and in uniting Third World leaders behind it thanks to the strategic maneuverability created by the elimination of the Soviet threat following Stalin's death and improving relations with Moscow (Rajak 2011: 216). The influence of Yugoslavia on developments in Eastern Europe in 1956 stemmed from the Yugoslav model's attractiveness and its capacity to move the satellite states from Moscow. For example, a significant contribution to Hungary's liberalization effort came from Yugoslavia. Simultaneously, one of the main things that hindered and ultimately led to new decline of Yugoslav-Soviet normalization was exactlly Belgrade's influence in Eastern Europe. The Soviet Union persisted in pressuring Yugoslavia to re-join the "socialist camp" despite the clear failure of their efforts, because they feared its divisive influence. The denial of the Stalinist model served as the foundation for the ideological identity of Tito's administration and the reasoning behind the "Yugoslav road to socialism." Yugoslav-Soviet reconciliation appeared to be on track as long as Khrushchev and the post-Stalin leadership appeared to be removing themselves from the Stalin's shadow. The conflict

with the Yugoslav proposal, however, was unavoidable as soon as the Soviet leadership gave up on drastic, sharp and fast dismantling of its previous forms, particularly by imposing ideological homogeneity on the "socialist camp" in Hungary. The destructive impact of Yugoslavia's model and its independence from Soviet tutelage on the cohesiveness of the Soviet Bloc served as the border for the Soviets (Rajak 2011: 214). The USSR's relationship with Yugoslavia saw some improvements after Stalin's death, but in the years that followed, there were many changes to this relationship. The USSR did not succeed in moving Yugoslavia back in the "socialist camp" (see Rajak 2011; Dimić 2014: 10-19).

Yugoslav Science Prior to the Tito-Stalin Split

I begin with an analysis of the aspiring organizational and financial model, as well as the official stand on the nature and role of science, in Yugoslavia before its break with the USSR. The period in question is one in which the ideology of Soviet science held hegemony. Nominally, the Soviet perspective insisted on the importance of political and economic conditions for scientific development, planning principles, the unity of theory and practice, as well as the class-conscious character of science, specifically its partisanship (e.g., Lenin [1909] 1977; Bukharin [1931]1971; Graham 1967). The belief was that only after science was openly placed in the service of the working class (proletariat) could its social function be associated with "universality." For Marxists in general, the interests of the proletariat correspond to "universality," or the general interest of society, to which science cannot fully contribute as long as it serves the capital under the guise of "autonomy" (Marx [1856]1969; Marx [1848]1986). In the USSR, partisanship in science, on a practical level, implied the influence of party politics on scientific activity (Krementsov 1997; Gerovitch, 2002; Pollock 2006). Thus, critics on the left argued that, in reality, certain Bolshevik party decisions were not always aligned with the objective interests of the working class (e.g., Cliff 1963; Goldman 1996), which was also shown by academic researchers (e.g., Bettelheim 1976, 1978, 1996; Graham 1996).

After the Second World War, Yugoslavia was an economically and culturally underdeveloped, war-ravaged, and poverty-stricken country with a weak foundation for industrialization. Thus, industrialization, along with educating the population, became "the people's task" (Bilandžić 1985: 112-114; Čalić 2013: 227-233). "The inherited backwardness was best illustrated by the number of illiterate inhabitants, which was 44.6 % before the war, and 56.4 % among the female population, according to the 1931 census" (Bondžić 2018: 201). The insistence on modernization in society also had an ideological dimension; it was a crucial requirement for building and further developing socialist relationships in Yugoslav society, which the country was striving for at the time. The first five-year plan reflected the Communist Party of Yugoslavia's (CPY) attempt to reinforce the concept of communist modernization (Obradović 1994: 41), with science playing an important role in general social development (Ristić 2013: 342, 349, 350). The task of scientific institutions was to "produce Marxist scientific youth who would master the knowledge and technological and technical procedures for the achievement of the plan for early industrialization and electrification of the country, in addition to other plans" (Bondžić 2018: 203). This was in line with the Bolshevik view of the role of science in society in general. For this reason, the communist regime in the USSR saw science as "a powerful lever of the planned development of socialist economy" (Deržavin 1945: 5). This view of science is particularly evident in Lenin's words, that the key task of the Academy of Science in the USSR following the October Revolution is to establish a plan for industrial reorganization and economic advancement of Russia, with a focus on the industry's electrification (Lenjin 1976a: 342-343, 378-379, 410-411, 415-416, 421-413). The importance that Lenin placed on electrification became widely known through his famous statement at the All-Russia Conference of the R.C.P.(B.) in Moscow, 1920, when he said: "Communism is equal to Soviet power plus the electrification of the entire country" (Lenjin 1976b: 44). The ruling system's political ideology dictated a dominant perspective in society in terms of the nature, role, and desired model for organizing and financing science in Yugoslavia, just as in the USSR. In accordance with this situation, Yugoslav natural scientist and communist Vojin Gligić (1945) highlights the significance of the USSR as a model for agricultural (and broader) development, which was significant in post-war Yugoslavia for the country's recovery and development, particularly its rural parts.

> "The achievements made in expanding the borders of Soviet agriculture, even into polar regions and the most barren deserts, were founded on the successes of Soviet science. […] Indeed, it is unclear what is more remarkable in Soviet science: its organization or its results, especially considering the legacy from which it emerged. Dealing with deserts, swamps, tundra, taiga, and all the hostile forces of nature is not an easy task. But conquering living space with water and hoe instead of fire and sword,

> with a tractor instead of a tank, with an airplane sowing seeds instead of dropping bombs, is a dignified way for man. Conquering living space from scientific institutes rather than an occupying military staff, through the honorable efforts of armies of physical and intellectual workers rather than the wild onslaught of aggravated, plundering hordes and enslavers, is what prevents us from losing faith in humanity, in the rational use of its powers in the service of progress. The wonderful possibilities opened up by such conquests of new living spaces best refute the claims of conquerors about the necessity of war due to overpopulation. The resources expended in past and present world wars could have made all the world's deserts fertile. Just as the heroic efforts of the Soviet peoples in this war served as a magnificent example of how to fight against arrogant conquerors, so now, when we stand in peace to assess our heavy wounds, the Soviet methods of conquering living space will serve as a shining example that there is a remedy even for our 'passive' regions" [Gligić 1945: 39-40].

Up until the break with the USSR, authorities and scientists in Yugoslavia propagated the Soviet approach to scientific and sociopolitical issues, opposing "various deficiencies" inherent in what they deemed to be "bourgeois science." This view was reflected in Tito's speech delivered in 1947, on the occasion of him being named an honorary member of JAZU[14]. Among other things, Tito noted that scientists in the past were oftentimes exploited, just like other workers. As an example, he mentioned Yugoslav-American inventor Nikola Tesla "whose scientific findings enriched many American and other capitalists enormously, [but who] died as a poor man without any means" (Broz (Tito) 1959: 209). He stated that in a socialist society, scientists enjoy "limitless possibilities" for their work, as well as respect and care from the people, who hold power and thus the means of production in such a system (Broz (Tito) 1959: 209). Tito concluded that in Yugoslavia, "as it has already been accomplished in the USSR, science […] is becoming the people's property because the people benefit from its results" (Broz (Tito) 1959: 210). The Bolsheviks generally emphasized this feature of Soviet science as an important specificity. In the USSR, and more broadly, it was believed that the October Revolution marked a "fundamental turn" when it came to the relationship between science and society, placing science "in the service of the people," which entailed abandoning the "narrow confines of work cabinets and small laboratories" (Deržavin 1945: 5).

> "Democratization of science was primarily evident in making scientific knowledge accessible to the broader population and in the establishment of numerous new schools […] Science became closer […] to common people […] Science extended beyond the 'temples' of academies and universities and entered factories and rural communities, no longer being the exclusive domain of the nobleman and the bourgeoisie. Most young Soviet scholars came from working-class and peasant backgrounds" [Vavilov 1947: 8].

It is views such as this that further explain why spreading literacy throughout the Yugoslav state became another of the key "people's tasks" (Bondžić 2018: 201; Bilandžić 1985: 112-114; Čalić 2013: 227-233).

Before Yugoslavia ceased political and scientific cooperation with the USSR, its preferred model of scientific organization was that of the USSR. Accordingly, the field of scientific research was dominated by processes of the fundamental transformation of old scientific institutions and organizational models toward the establishment of new structures, which were aligned with the Soviet model. Considering that, traditionally, universities represented the centers of scientific research work, it was believed that – in accordance with the Soviet ideal of a socialist society – the focus should be shifted to scientific institutes while also controlling old institutions. The idea was that these institutes should be associated with academies of science, or "subjected to state or party authorities" (Najbar-Agičić 2013: 101).

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[14] Yugoslav Academy of Sciences and Arts in Zagreb, Croatia

A good example of this practice can be seen in the Serbian Academy of Sciences - SAN[15], as outlined in the Law on SAN published in the SAN Yearbook (Godišnjak SAN) of 1947. According to this law, the Serbian Academy of Sciences represents the highest scientific institution in the People's Republic of Serbia and operates under the oversight of its government. Moreover, SAN provides scientific insights and expert opinions on various matters to the highest state organs and institutions upon their request. Among other things, SAN has the authority to award doctorates and maintains a budget account within the framework of the republic's budget. In addition to laboratories, cabinets, libraries, museums, and commissions, it may also include research institutes within its departments (Godišnjak SAN 1947: 1-4). Through its institutions, SAN is able to carry out scientific research activities, the work and internal organization of which are determined by the Academy's Presidency upon the proposal of the respective department and confirmed by the President of the Committee for Scientific Institutions, the University, and higher education institutions (Godišnjak SAN 1947: 13-14). Interestingly, to illustrate the atmosphere of that time on this issue, it is worth mentioning the words of SAN President – Aleksandar Belić[16], describing the effect of these changes towards socialism at the Main Annual Assembly of SAN on March 18, 1948.

> "The Academy has acquired a completely new character: it has become an almost entirely new working institution. It employs more than twenty institutes. Major enterprises are launched within it. Hundreds of scientific workers are engaged in its activities. Hundreds of younger people have begun or will begin to be trained for scientific work. Its budget has reached the enormous sum of 82 million dinars. What it could never have imagined before – today is easily achievable. This applies not only to its institutes but also to its central institution […] The Academy is integrated into the new life of our country, with respect and love, and it is up to us to justify and maintain that high rank. We may ask who deserves credit for this. First and foremost, the one who so wisely and skillfully organizes our modern state. He has made a place for the Academy in it, with great honor but also great responsibility. It is the same people's leader who, at the helm of our Communist Party, called the people to the difficult liberation struggle, which, despite all the immense sacrifices, led our people to victory and freedom. He leads our people today in the struggle for their culture and well-being, facing perhaps insurmountable difficulties at every step, for everyone else. Besides love and heroism, enormous knowledge and the ability to solve numerous problems that arose at every step were also required. I believe you will agree with me when I say that, at the beginning of its new life and work, the Academy should pay tribute to the Marshal of Yugoslavia Josip Broz Tito, who made this possible through his statesmanship and skillful work. We will pay him that tribute by offering him the position of the first honorary member of our Academy" [Belić according to Godišnjak 1947: 382-383].

The Regulation on the Institutes of the Serbian Academy of Sciences (SAN) from 1948 states that all institutes, as well as other institutions, are managed and supervised by the Academy through its own Presidency, i.e., its Departments (Godišnjak SAN 1948: 5). According to this Regulation, "[the] institutes have separate estimates as part of the budget estimates of the Serbian Academy of Sciences" (Godišnjak 1948: 8). By 1952, SAN, which came under the control of the party thanks to the law on the Serbian Academy of Sciences, managed 28 scientific institutes (Najbar-Agičić 2013: 101-102).

Although institutes were not unique to the USSR, having already existed in the US, Germany, United Kingdom, France, and so on, in the Soviet Union, this relatively new form of scientific organization was established as "the basic organizational kernel of Soviet research" (Graham 1993:175). The idea for institutes was developed by Russian academicians in the post-revolution period, and it leaned toward the notion that "specialized research institutes [should be] separated from higher education" (Kojevnikov 2004: 31), which was ultimately realized in the socialist system.

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[15] In 1947, the Serbian Royal Academy of Sciences was renamed the Serbian Academy of Sciences (Najbar-Agičić 2013: 102).

[16] Aleksandar Belić (1876-1960) was a prominent Serbian linguist and academic that served as a president of the Serbian Royal of Sciences, and later Serbian Academy of Sciences, since 1937 till his death. Politically, he was noted for being able to adapt to different regime changes.

> "The new scientific institutes were organized and funded by the government, they tended to exist independently of, or at least separately from, universities and other institutions of higher education, and their workers received salaries for doing research rather than teaching" [Kojevnikov 2004: 23].

Although the Bolsheviks were aware that Soviet science was a part of global science, they emphasized its "qualitative specificities," such as "its new organization and general way of seeing the world" (Vavilov 1947: 5). In this context, it is worth noting the words of Sergey Oldenburg, permanent secretary of the Academy of Sciences: "If the eighteenth century was the century of the academies, while the nineteenth century was the century of universities, then the twentieth century is becoming the century of the research institutes" (Graham 1993: 175). In other words, both "scientists and Soviet officials quickly agreed that a research institute was the best and most progressive way of organizing science" (Kojevnikov 2004: 24). The Bolsheviks recognized a possibility in this situation "to win over scientists as collaborators" (Kojevnikov 2004: 26). It can also be concluded that the large institutes, which were established in the USSR, represented not only an alternative but also served to demonstrate ideological opposition and superiority over the pre-revolutionary science in whose "tiny laboratories [...] individual scholars worked" (Vavilov 1947: 13). In other words, the scientific organization in the USSR, which focused on large institutes (and academies), represented for the Bolsheviks one of the aspects of a "fundamentally different structure and character" of science in the USSR (Vavilov 1947: 5).

Considering the need to reorganize scientific work according to the Soviet model, one of the important segments of that process was the initiation and encouragement of activities that would contribute to cooperation among academies. Primarily, this referred to collaboration among the republic academies, such as JAZU (Yugoslav Academy of Science and Art in Zagreb) and SAN, as well as with the Slovenian Academy of Sciences and Arts, but academies beyond Yugoslav borders were not excluded, such as the Soviet Academy of Sciences. Additionally, it was emphasized that a more even reorganization of scientific work at the republic level was necessary. After discussions and meetings among representatives of the three academies, it was confirmed that there was a real need for coordinating research work.

> "It was argued that the absence of such a Council was a deficiency and a problem in the development of science under the new conditions. Striving for greater influence of their institutions, the academicians correctly concluded that in order to achieve greater influence on the Federal government, it was necessary to establish a body at the federal level that would serve the government as the supreme advisory body in the field of science" [Najbar-Agičić 2013: 113].

This was evident in 1948 at the founding meeting of the Yugoslav Council of Academies. The Council was tasked with directing and overseeing scientific and artistic institutions and served as the advisory organ of the federal government on matters pertaining to significant scientific and artistic endeavors. The Council represented a coordinating and unifying body for the scientific and artistic pursuits of the Serbian, Slovenian, and Croatian academies, and a representative body for Yugoslavia in international scientific and artistic associations. The Council was in direct communication with the Government's Presidency, and its funding was integrated into the Government's budget (Korolija 2017: 1162-1163; Meeting of the delegates of Yugoslav republics' academies 1948; CIA report 1954c: 17-18).

> "The recording of scientific research and artwork in the FPRY should be handled by the Academies of Sciences. They should be leading and supervising bodies of scientific and artistic work in the entire country. To coordinate this work, a Council of Academies should be formed as part of the federal government, composed of the delegates of all (republic's) Academies. The Council of Academies would serve as the advisory organ of the federal government regarding scientific and artistic work of federal importance, a coordinating structure of scientific and artistic work of all three academies (Serbian, Slovenian, and Croatian), a body that represents our country in international scientific and

> artistic organizations. […] The council would communicate directly with the Presidency of the Government and its budget would be part of the Government's budget. [...] The Yugoslav Academic Council would provide the federal government with the required advice regarding all scientific and professional elements. However, the Council would also be obliged to engage in topics of the Federal government regarding the solution of problems important to the everyday life of the population, the improvement of methods of the work, or the correction of shortcomings of the work, if required. Institutes, boards, and similar institutions would be managed by the Council, the scientific council or its constituting bodies. Although these structures are partly autonomous in their work, they are now primarily under the guidance of the general leadership of the Council. Within the boundaries that are determined by the budget, they have organizational and operational independence, however, with regard to their work, they are answering to the Council" [Meeting of the delegates of Yugoslav republics' academies in 1948].

It was decided that each academy would be represented by three delegates and two deputies. After several preparatory meetings, the Academic Council, or the highest body in the field of science, through which relationships with the international community were achieved and scientific scholarships were granted, was formed. This body had "great power over the scientific community in the country" (Najbar-Agičić 2013: 114).

The institution to assume such a role in the USSR was the Academy of Sciences of the Soviet Union. From a hierarchical point of view, the Academy was a key scientific institution under the direct jurisdiction of the Council of People's Commissars (effectively the Soviet government). Universities and other institutions served as mediators between the Academy of Sciences and social life, while scientific work was mostly planned and supervised by the Academy (Korolija 2023). According to Vavilon, in 1934, "the Academy basically came to the helm of scientific work and had in its hand the entire network of scientific activities. *Its activities realized concrete tasks of the Soviet state*" (Vavilov, 1947: 996, *italic added*). Here we see that the partisanship of science through its very structure, or its organization, correlated with *centralization*, as a key element of Soviet scientific organization. According to Vavilov, from the new constitution of the Academy in 1935, it follows that the Academy of Sciences in the USSR ascends as the highest scientific establishment, uniting the prominent scientists, with the main task outlined in the constitution being "[u]niversal cooperation for the advancement of theoretical and applied sciences in the USSR and to achieve the highest scientific achievements in the world" (new constitution of the Academy of Science from November 1935, according to Vavilov 1947: 996).

Such a centralized and planned organization aimed to coordinate scientific institutions and enhance the compatibility and cooperation of 'pure' science and praxis (Guins 1953; Graham 1967; Korolija 2017: 1163). For Bolsheviks, the USSR Academy of Science was meant to represent "a place of great effort, where tasks determined by the Soviet government and its rapidly growing industry are performed" (Deržavin 1945: 6). Therefore, it is not surprising that publications such as *The Academy of Sciences of the Soviet Union* (1945), which promoted the Soviet model of scientific organization and partisanship in science, were translated, published, and distributed in Yugoslavia at the time. In support of these ideas, noted Yugoslav biologist, communist and the first president of the People's Republic of Serbia, Siniša Stanković, in the preface to the book[17] by natural scientist Vojin Gligić (1945), while praising the science in the USSR, wrote the following lines in 1945:

> "Planning in the socialist construction of the Soviet Union did not stop at the material-economic sector; it inevitably spilt into the intellectual realm, the realm of science and theory. The old relation between theory and practice, between so-called 'pure' science and practical life, has changed drastically. Primarily, theoretical scientific work cannot remain private property in the hands of individuals: that work also has to be placed onto a planned and organized basis, and integrated into a general plan of

[17] *Fighters for a Better Harvest (Borci za bolju berbu i žetvu)*

> the socialist development of the country. The entire network of scientific institutes and institutions across the country, with teams of professional intellectual workers, functions as a connected, organized whole, with common goals of increasing the productive forces of the country" [Stanković 1945: 6-7].

During this period, scientific activity in Yugoslavia was "funded directly from the federal and budgets of federal republics" (Blagojević 1982: 316). The situation was orientated towards striving for a radical change in the role of science in the newly established system. Just as in the case of Soviet science after the October Revolution, there was a move towards creating an inseparable bond between theory and practice. Therefore, it was necessary to fundamentally redefine both the organization and the financing of science because as the ultimate goal of Soviet-style science was to meet the needs of society, it was believed that this aspiration must be reflected in the system of organization of scientific research institutions, in their work plans, and the results achieved (Vavilov 1947: 10).

The Serbian Royal Academy of Sciences was renamed the Serbian Academy of Sciences in 1947. The processes of transformation within the Serbian Academy of Sciences, connected to the broader socialist changes in the socio-political system, contributed to significant changes in its "traditionally conservative scientific profile" (Najbar-Agičić 2013: 102). Thanks to the aforementioned law, "the Government of the People's Republic of Serbia gained the right to determine the number of regular members, and the National Assembly confirmed or commented on the decisions of the Academy Assembly regarding the election of new members" (Najbar-Agičić 2013: 102). Although the old composition of the Academy was retained, its status was changed in the sense that the Serbian Academy of Sciences "became a state institution financed from the budget of the People's Republic of Serbia, and organizational changes were introduced, including the planned establishment of institutes following the model of the USSR" (Najbar-Agičić 2013: 102).

However, even though the funding model for scientific institutions was clearly moving toward "state budgeting," there were certain compromises. An example of this is the change in the financial status of the JAZU. Before the war, this Academy was funded by money from private foundations, real estate income, and the like. Besides acknowledging that its tasks and role "in the country's social life should be completely different from those before the war" (Najbar-Agičić 2013: 110), after the war, its revenues were drastically reduced, and the former financial independence of the academy was lost. "The only way out was the assistance of the people's government through the state budget" (Najbar-Agičić 2013: 110). Efforts were made to finance scientific institutions in the same way as all other state institutions. However, the academicians sought to "secure a privileged status for JAZU" (Najbar-Agičić 2013: 111). In line with this, the Academy emphasized in letters to the Government's Presidency, the republic, as well as federal ministries of finance, that it was "an autonomous and independent body" (Najbar-Agičić 2013: 111). Their request was granted. It was decided that JAZU should "be considered an independent institution and therefore can have its own budget, which is not part of the state budget framework. The assistance provided by the state is considered to be in the form of a subsidy" (Najbar-Agičić 2013: 111).

"The traditional method of funding research in the Soviet Union was through block funding of large institutes" (Graham 1993: 188). However, such a system of financing scientific institutions "had never been absolute" even in the USSR (Graham 1993: 188). Usually, "[i]t was supplemented by contracts between institutes and various other government organizations, civilian and military for task-directed research" (Graham 1993: 188). However, "[t]hese contracts also went through the central administrations and were under the control of the institutes' directors" (Graham 1993: 188). Even if this is taken into account, the communist Yugoslav regime, despite the indisputable general tendency to follow the traditional Soviet ideological line in the field of science, among others, made a compromise on the example of JAZU's financial status by recognizing it as an independent institution. Still, the Soviet approach to scientific issues in Yugoslavia during this period was evident in the discourse that dominated public discussions on the topic, especially in journals of scientific and propagandist nature (see Miloradović 2012; Duančić 2019; Bondžić 2010).

After the war and before the break with the USSR, the *Journal of the Society for Cultural Cooperation of Yugoslavia and the USSR*[18] *(Yugoslavia-USSR)* was published in Yugoslavia, as an important tool for the establishment of Soviet ideological hegemony (Miloradović 2012: 201–217). The task of this Society, according to the rules of its republican branch in the People's Republic of Serbia, implied that through all "appropriate" means, efforts should be made to "familiarize with the USSR and to create and maintain cultural cooperation between the Serbian people and the people of the Union of Soviet Socialist Republics" (Pravila Društva za kulturnu saradnju Srbije sa SSSR 1945: 4). Regarding science, the practical tasks of the Society mostly involved "lectures by our scientists […] as well as lectures by scientists […] from the USSR in Serbia, and likewise lectures by Serbian scientists […] in the USSR" (Pravila Društva za kulturnu saradnju Srbije sa SSSR 1945: 4 – 5), as well as activities in the form of sections for natural and social sciences.

The journal represented a highly effective product of the work of the *Society for Cultural Cooperation of Yugoslavia and the USSR*. It was issued from November 1945 to June 1949 (Miloradović 2012: 208). It featured propaganda articles glorifying the achievements and ideas of the Soviet way of life, including its military, economy, science, and culture. As this study also examines scientific changes in the context of dominant economic tendencies, I will present the prevailing economic perspective at the time, which was also propagated through this journal (Korolija 2023).

In line with its ideological role, the journal presented the Soviet economic model, specifically the *principle of planning*, as one of the "most important economic laws in the development of the socialist mode of production" (Nikolin 1948: 8). This model, "as Stalin teaches," must ensure the independence of the Soviet economy from the capitalist surrounding, solidify in the country the undivided rule of the socialist economic system, completely close all roads and channels that allow for the entry of capitalist elements, prevent disproportion in the people's economy and create stable state reserves (Nikolin 1948: 8). A clear example of the glorification of planned economy is an article[19] criticizing, one might even say mocking, the discovery of "free planning" by the then-ruling Labor Party in Great Britain (Strumilin 1947: 4). It is noted that, with the Labor Party nationalizing "only" stone coal mines and the Bank of England,

> "[t]heir agents study the 'development trends' of the economic structure and compile 'forecasts', then based on these forecasts, they draft corresponding economic plans. The government, having chosen the best of these variants, informs the 'broad public' about it and calls upon them to fulfill that plan. Labor leaders will not succeed in persuading employers with their eloquence that their interests align with the interests of the workers, nor will the employers themselves, out of goodwill, fulfill all the Labor Party's economic plans as they should. It's hard to imagine even the naivest among employers falling for that bait. They, no less than the workers, know that their class interests are directly opposed to the interests of the working class and for this reason, they value the eloquence of Mr. Churchill and his friends more than the eloquence of Mr. Stanley and Mr. Morrison" [Strumilin 1947: 4].

From the standpoint of the Marxist-Leninist view on the economy, this was evaluated as a naive political idea, because it is based on the presumption that capitalists shall act against their own objective private interest for the sake of the general interest of the society and the workers. According to Marxism-Leninism the interests of workers and capitalists are economically opposed. That is why those who advocate the interests of the working class, according to this perspective, require nationalization and state planning within the economy (see Lenin 1918). In accordance with this position Vlajko Begović, a prominent Yugoslav political figure and president of the Federal Planning Commission of Yugoslavia, presented the view that a "[s]tate economic plan is the basic element for

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18 *Društvo za kulturnu saradnju Jugoslavije sa SSSR (Jugoslavija-SSSR)*

19 *On the Conditions of Socialist Planning*

managing the economy" (Begović 1946: 14). Further, he notes other important factors, such as creating a public sector in the economy (as the "basic element of planning and planned leading"), and the interest of the working people and their participation in the plan's realization as well as in industry control. He claims that, besides the USSR, Yugoslavia is the only country with the potential to completely transfer to planning, or the planned economy. According to Begović (1946), the conditions for such processes were acquired through fundamental changes in government and the socio-economic sphere, primarily through the people's liberation struggle, and later solidified in the FPRY.

> "Economic planning in Yugoslavia has the task not only of rebuilding the economy, satisfying the basic needs of the people, and raising their standard of living, but also of introducing organization and rationalization into production, combating waste and speculation, developing and strengthening the state and cooperative sectors, and creating economic independence for the country. Planning also involves increasing the mobilization of the entire nation in the economic sector, strengthening the country economically and politically" [Begović 1946: 15].

When it comes to the concept of a planned economy, it is important to note that at this time, it was given substantial consideration in the context of scientific activity in Yugoslavia and its connection with the economy. Accordingly, the documents of the Committee for Schools and Science within the Government of Yugoslavia from 1947 state the following:

> "The ever-increasing demand and necessity of planned management raises the issue of planning in the field of scientific work, planning scientific institutions, coordinating their work, closer connection with the tasks of the economy and building the country, as well as planning of cadres" [Establishment of the Committee for Scientific Institutions 1947].

Moreover, based on the Decree of the Committee for Scientific Institutions, Universities, and Higher Education Institutions passed in 1947, the Committee was established "for the purpose of planning scientific work, as well as establishing a unified management of scientific institutions, universities, and higher education institutions and planned education of senior professional cadres..." (Decree of the Committee for Scientific Institutions, Universities, and Higher Education Institutions 1947). Returning to the journal *Yugoslavia-USSR*, it is worth examining the views of Yugoslav professor Radovan Lalić expressed in the text *Significance of Soviet Science* [*Veličina Sovjetske nauke*]. Besides including Lenin and Stalin among Soviet scientists, he writes the following praise to science in the Soviet Union, which he regards as the most perfect democracy in the world.

> "In contrast to the bourgeoisie, socialist society is interested in the advancement and progress of science and in making scientific knowledge the property of the broad masses of the working people. Soviet society and science are not in contradiction with each other, but in the deepest harmony […] For the first time in history, a society is being built on the basis of science, according to scientific principles. The Soviet economy, culture, and politics are developing based on the achievements of science [...] Never before have Russian scientists had such a broad range of possibilities for scientific work and research. The Soviet government was most generous to those scientific workers who did not fully understand revolutionary changes in Russia and thus didn't understand certain measures of the Soviet government. The Bolsheviks were not afraid of science even when its representatives were not in favor of the workers' and peasant's rule. The Bolsheviks knew that all true scientists, all scientific workers who loved their science and wished good for their homeland, would inevitably come to the positions of the Soviet government. And this understanding turned out to be the rule" [Lalić 1948: 26-27].

In this quote, one can observe the element of the *charisma of reason*, a concept previously mentioned in this text when introducing the foundational elements of establishing a socialist system, using Yugoslavia as an example (see Kuljić 1998: 151-166). Here, one can also observe the emphasis on the ideological compatibility between scientific principles, critical thinking, and a society structured according to socialist principles, which forms the foundation of the socialist system. This leads to the

belief that "true" scientists eventually align themselves, as was the case in Yugoslavia, with the Communist Party of Yugoslavia (CPY), and consequently, also with positions supportive of the Soviet government. Over time, "within the contradictory conditions of the party's threat, the charisma of reason in Bolshevism persisted as a blend of rationalist modernization and unrestrained glorification and exaltation of its resources, namely the party and its leaders" (Kuljić 1998: 154).

On a similar line, Yugoslav professor Đurđe Bošković[20] wrote about Soviet scientists, who had spent some time in Yugoslavia, and whose work "demonstrated how far science had progressed in the USSR" compared to autonomous science or science that was "independent of society".

> "From 'pure science', one that is an end in and of itself, we arrive at true advanced science, science as the most reliable instrument in the service of life, society, man – science in which theory and practice merge into a condensed and indivisible whole [...] It is up to us to equip ourselves with a similar science" [Bošković 1946: 40].

It follows that the FPRY should follow the "Leninist-Stalinist" scientific model in the USSR, which aims to overcome the boundary between theory and practice, or "pure" and "applied" science, in order to achieve its synthesis. This meant that, at least nominally, the essence of the Soviet type of science and the insistence on its connection with practice was not (or was not supposed to be) applied to a concrete scientific activity in a way that

> "does not elaborate problems with no immediate practical significance [...] Speaking of the inseparable connection between theory and practice, which exists in Soviet science, we are primarily saying that a scholar who deals with problems, however abstract they may seem, must always remember that the goal of science – is to satisfy societal needs, and thus, he must strive, with all possible means, to establish a connection between his scientific legacy and practice" [Vavilov 1947: 9-10].

Marxists (see e.g., Bernal [1954] 1971ab), who linked this division within science to the Western view on its nature and role in society, most often have seen it as artificial, especially from the standpoint of the history of science; which is not an attitude reserved only for the theory of Marxist orientation (see e.g., Gooday 2012). From the way how dynamics of the relation between science and society in a socialist society were understood, within the scope of applied sciences, there emerges an idea about the need to plan the research of scientific topics relevant to the concrete needs of the existing society, and not "only" focusing on the application of already existing "pure" science in practice (Graham 1964).

The text by the influential Yugoslav communist, writer, and art historian Oto Bihalji-Merin *Great Achievement of the New Socialist Intelligence* [*Veliko delo nove socijalističke inteligencije*] (1948), published in the same journal, argues for the advantages of Soviet science, which is said to ultimately serve man, society, or the wider masses through *the leadership of Stalin, or the party*, and is available to all, contrary to the elitist autonomous, or "pure" bourgeois science.

> "Vladimir Komarov, the late President of the Soviet Academy of Sciences, wrote that the 'October Revolution brought down the walls of solitary scientists' isolated laboratories. Only after the revolution could we fully merge with life, production, young students, and scientists, to whom we brought our experiences and knowledge. […] Never and nowhere have scientific workers been treated with such care as in the Soviet Union. [...] We are joyful to work under the leadership of fearless, resourceful communists-Bolsheviks, the bold reformers of our country, under the leadership of the genius Stalin – the continuator of Lenin's work" [Bihalji-Merin 1948: 53].

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[20] Đurđe Bošković (1904-1990) was Yugoslav art historian and one of the most prominent scholars of medieval Serbian architecture. He was prominent academic, and held position of professor and other different posts at the University in Belgrade.

In the context of this journal, it is worth noting the text[21] translated from the Russian about women scientists in the USSR. Written by Soviet author Antonina Babič (1947), it speaks of the improved position of women in Russia after the October Revolution in all spheres, including science. Similarly, Marija Vujanović from Yugoslavia describes the situation in the predominantly rural, war-ravaged Yugoslavia after the Second World War in terms of illiteracy and the position of women, who she thought "undoubtedly" walked the same path as women in the USSR after the October Revolution.

> "The woman who was doubly enslaved and neglected in former Yugoslavia was particularly backward in terms of education. There were entire regions, especially in Bosnia, Macedonia, and Kosovo and Metohija, where one could hardly find literate women. [...] With the liberation of our country and the efforts to combat illiteracy, as well as the general education of women, tremendous attention was given [to this issue] [...] Massive campaigns to combat illiteracy were organized with the assistance of organizations such as the AFŽ [Antifascist Front of Women], youth organizations, trade unions, and educational authorities. [...] In short, women became active participants in our national life. They now face great tasks in the decisive transformation of our country, in the realization of our five-year plan, in [the processes of] electrification and industrialization" [Vujanović 1947: 23-24].

The same journal features a text[22] commemorating the 30th anniversary of Soviet science by the president of the Serbian Academy of Sciences, Aleksandar Belić. Just as Lalić's text, it notes the democratic character of the USSR, considering it a major factor in the advancement of Soviet science.

> "The support that the great Stalin, as the continuator and fulfiller of ideas by the ingenious Lenin, has provided to science and scientists, increasing the already very high esteem of the Soviet Central Academy and helping to create eight republic academies and many associated scientific institutes – besides everything else undertaken toward a similar purpose – have undoubtedly democratized scientific work and demonstrated its great importance, which was generously and sincerely admitted by the highest actors in the country" [Belić 1948: 1].

Further in the text, Belić points to the reasons why "the rest of us Slavs" find Soviet science "so close," underscoring partisanship, as a crucial feature of USSR science, as the reason for this enthusiasm.

> "Given all the conditions that have contributed to its strong development, need we emphasize that this science is humane and constructive, given that its *ultimate goal is a happy individual in a satisfied community*? If science has ever had this noble task anywhere in the world, it continuously does so in the Soviet Union. That is its main characteristic and its highest glory. That is why it is so close to us, to the rest of us Slavs, because we feel that the same blood flows in it as in the body of our nations. [...] Long live Soviet science, the hope of all Slavic nations and all of humanity-loving world, leading both its own people and all Slavic nations toward complete mutual cultural understanding and spreading mutual respect and love throughout the world" [Belić 1948: 2, *italic added*].

The text[23] by the Russian academician Cicin emphasizes the significance of the path of modernization for Yugoslavia, similar to that which the USSR embarked on after the October Revolution, as well as highlights the major role of the state in advancing science. "The state takes care, honors its scientists, and awards them [...] The state is concerned not only with improving the material well-being of scientists but also with creating suitable working conditions" (Cicin 1946: 26).

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21 *Žene naučnici u SSSR-u (Women Scientists in the USSR)*

22 *Tridesetogodišnjica sovjetske nauke (Thirtieth Anniversary of Soviet Science)*

23 *Značaj nauke u SSSR-u (The Significance of Science in the USSR)*

The text *Science and Work* [*Nauka i rad*] (1945) by Soviet botanist Komarov points to the need to integrate science and societal and revolutionary needs, which is something that scientists-revolutionaries themselves felt. It points to the need for a class-based, socially engaged science, which is possible to be achieved by taking the Soviet approach to science.

The text[24] by the then-president of the Soviet Academy of Sciences, Sergey Vavilov (1948), in the context of the need for science to serve the greater good rather than be an isolated, or "pure" science, independent of society, states the following:

> "In old Russia, alongside truly progressive people's scientists – Lomonosov, Mendeleev, Timiryazev, and others – there were many scientific 'snobs' who considered themselves 'nobility' and thought that science was for the selected few, that it existed for its own sake, for its internal development. These aristocrats in science looked disdainfully and mockingly at the application of science for the benefit of the people, at the spread of scientific knowledge among the broad layers of the population. For our country, that time has long gone. *Our science is now Leninist-Stalinist*, *'which does not allow its old and recognized leaders to arbitrarily enclose themselves in the shell of science priests, in the shell of science monopolists'*…" [Vavilov 1948: 23, *italic added*].

The stance was clear: Yugoslavia must emulate the USSR's "Leninist-Stalinist" model of science. The model's stated objective was to blur the line between theory and practice, specifically "pure" and "applied" science, and bring about its synthesis in the general interest – that of the working class (Korolija 2023).

The extent to which Yugoslavia attempted to emulate this model and the position of science it aspired to achieve is evidenced by the position presented by communist thinker and chairman of the Committee for Science and Education of the FPRY Government Boris Ziherl, published in the journal *Yugoslavia-USSR*. In his praise for Lenin, Ziherl emphasized his enormous contribution to social sciences, as his "teachings and works erased" the division between exact (natural) sciences and inexact (social) sciences, "demonstrating" that social phenomena can also be studied with exactness, with revolutionary social practice serving as "the scientific criterion that confirms or rejects the propositions of social science" (Ziherl 1948: 4). More precisely, Marxism, according to this perspective, is a social science

> "whose objectivity stems from its class character; it is the science of the most revolutionary class in history, a class that is not only not interested in maintaining itself as a class but one that is fighting for the abolition of itself as a class, for the abolition of classes and class differences as such, and the establishment of a classless communist society" [Ziherl 1948: 6].

In this context, Ziherl points out that Lenin "indicated that in a class society, where hostile classes with different interests and different worldviews stand against each other, science cannot stand above classes, and that thus there is no such thing as a classless, impartial, nonpartisan, 'objective' science" (Ziherl 1948: 4).

Thereby, we conclude that *partisanship* in science represents the basic conceptual difference between the class-positioned perspective and the autonomous, value-neutral perspective that dominated the Western Bloc in that period. Emphasizing the impossibility of apolitical science in a society (and about a society) marked by conflicting class interests implies that, from a Marxist standpoint, the discourse on independent science was more of a false consciousness than a genuine desire for true objectivity. According to this perspective, true objectivity is achieved not only by examination but also by placing science at the service of working-class interest, all with the goal of creating a classless society (Bernal 1939; Lukacs 1971; Korolija 2020).

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[24] *Napredna Sovjetska nauka (Advanced Soviet Science)*

However, the Marxist perspective did not negate the possibility of scientific objectivity. Marx alone "seems to claim something like scientific objectivity for his own theory" (Railton 1984: 813). Marxist critique of science in bourgeois societies is based on the premise that the prevailing ideas in class-organized capitalist societies are always the ideas of the ruling class. Thus, the function of dominant ideas within the system of social inequality is reflected in the fact that the interest of the ruling class which, from the Marxist point of view, is always a particular interest, is represented as a common interest. That is why the ideas of a ruling class are seen as universal, rational and valid. According to Marx "modern industry [...] makes science a productive force distinct from labor and presses it into the service of capital" (Marx [1867]1967: 361). In bourgeois society, in the final instance, science also reflects dominant material relationships (see e.g., Marx and Engels [1846] 1974). In this way, it represents particular interests – only the interests of the ruling class, which implies that it cannot entirely be in the service of true objectivity, which for Marxists is always universal, that is in relation to the general interest of society (e.g., Marx and Engels [1848]1986; Lukacs 1971).

This means that class-oriented science is in the service of the interests of the largest part of society – the working class. According to this perspective, true objectivity is achieved not only by examination but also by placing science at the service of working-class interest, i.e. the class which strives to destroy class-established social relations and abolish itself, all with the goal of creating a classless society, which according to Marxist theory represents the general social interest. In this way, through connecting with social universality, and not to particularity, the universal character of science and scientific objectivity, according to Marxists, become possible (e.g., Marx and Engels [1848]1986; Lenin [1909]1977; Bernal 1952; Bernal 1953; Lukacs 1971).

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Researchers noted that in the USSR "[t]he special connection [...] between Marxist philosophy and science [...] allowed for the expansion of Marxism into the natural sciences, both theoretically and institutionally" (Aronova 2011: 179). The tendency to make this approach to science a fundamental feature of Yugoslav science can be observed in the translation of texts about Soviet science. An example of this is the translated and published booklet by the Soviet physicist and (as already mentioned) president of the Soviet Academy of Sciences Sergey Vavilov from 1947, where Vavilov (1947) provides the basic outlines of Soviet science, emphasizing its superiority compared to other scientific frameworks.

According to the Bolsheviks, the "fundamental characteristic" of socialist Soviet science lies in the "clarity of its philosophical worldview, which, in turn, provides the necessary basis for research" (Vavilov 1947: 12). The Bolsheviks' scientific worldview was embodied in Marxist-Leninist philosophy, or "dialectical-historical materialism, with its comprehensive breadth, and unwavering conviction of the objective reality of the world and the world's state of constant progressive change and development" (Vavilov 1947: 13). Bolsheviks believed that science globally developed "based on a spontaneous materialistic worldview," as "only materialistic views, often formally denied, were capable of leading science in the right direction" (Vavilov 1947: 12). However, the "spontaneous materialism" of science is often exposed to infiltrations of various idealistic philosophical tendencies, which attempt to replace the scientific materialistic basis (Vavilov 1947: 12-13). Due to the continuing dynamic between "spontaneous" and "mechanistic" materialism and metaphysical tendencies, which, according to the Bolsheviks, represent reactionary, ideological tendencies in the philosophy of science, it was necessary for dialectical materialism to "prevail" over "the idealists in philosophy and the natural sciences" (Vavilov 1947: 12-13).

Moreover, a similar connection between Marxist philosophy and science is observed in Yugoslav natural science journals published before the break with the USSR. Accordingly, the first two issues

of the Yugoslav popular science journal *Nature* [*Priroda*] (February 1945), re-launched after the war by the Steering Committee of the Croatian Natural History Society, were clearly critical of the notion of "science for science's sake." The journal's ideological character was described as being close to the "People's Government," while the journal's founders ("our anti-fascist-natural-scientist") advocated for the connection between science and social practice (Korolija 2023).

> "By breaking down the old barriers to progress, our people emerge from the darkness left by the old regimes and turn to science as a reliable guide to a brighter future. The people's government creates the necessary conditions for the country's reconstruction to be carried out according to a unified plan and at a higher technical level. [...] Science, which in the past was separated from the people and their everyday lives, breaks out of old academic boundaries and merges with society's overall aspirations into a powerful surge of progress. Its field of inquiry has become the entire country, and its institutes and schools the weapons of the entire nation. [...] The natural sciences have developed closely connected to industry, agriculture, and health, and they will continue to receive the strongest incentives from the life of the people. Accordingly, our journal, with its contributors, will take part in the new and powerful front of homeland construction" [Inicijativni odbor "Prirodoslovnog društva" 1945].

A similar promotion of the connection between science and social practice can also be found in the aforementioned booklet by Soviet academician Deržavin titled *Academy of Sciences of the Soviet Union* [*Akademija znanosti Sovjetskog Saveza*], which was translated and published in Yugoslavia in 1945. In it, Deržavin (1945) emphasizes how "[p]articipation in the annihilation of fascists is the greatest and noblest task that science has ever had" (Derzhavin 1945: 24). Additionally, Deržavin (1945) underscores the importance of scientists in the defense and construction of the "Homeland."

The same journal underscores Lenin's criticism of idealistic deviations in the interpretation of more recent findings in natural sciences (seemingly incompatible with materialism), warning the reader that a good natural scientist does not necessarily make a good philosopher, as well as of the dangers of relativism and the traps of anti-scientific tendencies lurking inconsistent materialists (or those who are not dialectical materialists).

> "The vast majority of natural scientists, Lenin argued, fervently stand and cannot help but stand on the positions of materialism; that is, they are natural-historical materialists. Machism, idealism in physics in general, wrote Lenin, is a 'fad', a 'temporary zigzag', 'superficial enthusiasm for idealism by a negligible number of experts', etc. The gnoseological distortions of Avenarius, Mach, and others were and are professorial inventions, attempts to found their own little philosophical sect. But for every such attempt, for every such distortion, for every such sect, the camp of idealism and fideism, the camp of reaction, seizes them and uses them to fight against science, against the materialist worldview, against the revolutionary social movement, drawing benefits for maintaining the power of the counter-revolutionary imperialist bourgeoisie" [Maksimov 1949: 243-244].

The journal *Science and Nature* [*Nauka i priroda*] was founded by natural science societies and researchers and was aimed at "all those" who wanted "to complete and enlighten their knowledge of the natural sciences with a materialistic understanding and interpretation" (Editorial staff 1950: 713). Apart from presenting achievements in the natural sciences, the journal made it known that its task was to clarify the role that "*science plays in the construction of socialism and the achievement of the five-year plan"* (Editorial staff 1950: 713).

Interestingly, the same journal published in 1949 a text in honor of Trofim Denisovich Lysenko, where Lysenko is referred to as the celebrated "innovator" of science. Moreover, in the same year, a text was published about natural sciences in the system of communist education, emphasizing the significance of natural sciences in the development of a dialectical-materialistic worldview. This worldview is deemed necessary for the full development of man, which is the goal of the Soviet school, because "[n]ature is dialectical. Properly founded exploration of nature – r e p r e s e n t s a p o w e r f u l t o o l f o r d e v e l o p i n g d i a l e c t i c a l t h o u g h t. Beginning with the first

step of schooling, children become accustomed to seeing natural occurrences in their i n t e r r e l a t i o n s h i p s a n d c o n n e c t i o n s" (Skatkin 1949: 395).

The journal *Science and Technology* [*Nauka i tehnika*] (1947) features a text by Sergey Vavilov about Soviet science. In this text, Vavilov makes a comparison of science in Russia before and after the October Revolution, pointing out that science realized its full potential only after the Russian revolution. In the same text, he highlights the importance of the role of science in the Second World War, emphasizing the significance of the Soviet model of scientific organization, and so forth. It is worth noting that, according to Vavilov, although the significant role of science in society had already been emphasized after the October Revolution, the Second World War was crucial to demonstrating the power of Soviet science and the importance of partisanship.

> "Soviet scientists and engineers exerted all their efforts to justify Comrade Stalin's trust in Soviet science, to assist the Red Army and the entire nation during the difficult years of the great war [...] The views of the Soviet people toward nature and society have undergone profound changes; the basis of these views is a healthy, invincible dialectical materialism. The Soviet scientist armed with the knowledge of dialectical materialism boldly confronts and fights against attempts to disfigure science, against idealistic obscurity, which occasionally obstructs the path of scientific development" [Vavilov 1947: 1002-1003].

In the same vein, in the (already mentioned) preface of Vojin Gligić's book, Siniša Stanković (1945) talks of "full" and "real" democratization of science, which, according to him, is only possible in socialism, as demonstrated by the USSR. According to Stanković (1945), science in the USSR no longer belongs solely to the "chosen intellectual elite"; rather, it has become the "property of millions."

> "Today in the Soviet Union, millions of manual workers, through socialist competition and the Stakhanovite movement, rationalize methods of practical professional work through their own efforts, discovering new paths and procedures within their professional activities. They manage to master science and technology, becoming inventors and innovators, and break down old barriers between intellectual and physical labor. With unlimited opportunities for professional training, Soviet workers directly transfer living scientific thought to practical work, cultivating and perfecting it on an unprecedented scale. Connecting science with the broad working masses has revealed entirely new reserves of fresh energy, initiative, and inventive activity. The renowned Soviet physicist Joffe found among the Stakhanovite workers of the Leningrad factories new, unsuspected scientific talents and utilized them as active scientific collaborators. The close integration of the planned activities of scientific research institutions with the inventive activities of the working masses represents a completely new path for the development of science and scientific creativity, one which could only be discovered under the conditions of socialism" [Stanković 1945: 7].

According to Stanković (1945), this feature of science was the key reason why Soviet science was advancing unstoppably and represented the "new science," which was finally in the "hands of the masses," which in turn developed society "in all directions" due to their orientation to constant changes in society and themselves. "Elevated to the level of social force, Soviet science is on the best path to lead society 'from the realm of necessity to the realm of freedom'" (Stanković 1945: 7).

Vojin Gligić (1945), while promoting Soviet natural scientists (Timiryazev, Michurin, Lysenko, Cicin, Vavilov), expresses the view that science is actually a reflection of society ("like society, like science"). Gligić (1945) emphasizes that the failure of ordinary people to understand the importance of science, which is a situation inherited in Yugoslavia as well, is the fault of a "society of selfish individuals" that used or rather misused science for "selfish purposes." He believes that for science to serve the majority of the population in a particular society, become accessible to all and related to the community's needs, society itself must strive for the good of the broadest layers and the progress of the community. In the context of Yugoslavia, in addition to this key factor, he attributes the public

skepticism toward science as a means to a better life to the horrors endured during the war, such as the misuse of airplanes and radios.

> "I will never forget what a doctor told me, around fifteen years ago, about his experience in our main village. They sent him there in the spring to treat syphilis. He found hunger, permanent starvation, twelve-year-old children who looked like they were only five. When he explained to the gathered people that the treatment was free but that the medicine for each individual cost the state a thousand dinars, they asked him with an angry look why the state wouldn't use that money to buy bread instead of injections. In that situation, the people rightly could not see science as a means to a happier life. Moreover, people regarded science as the idleness of the rich, because of, among other things, the withdrawal and seclusion of selfish, genuine, and false scientists into the 'temples of pure science' far from the hustle and bustle of life" [Gligić 1945: 9-10].

It is interesting to note how Gligić (1945) understands and describes the significance of Lysenko for the development of agriculture, whom he sees as a good student of Michurin, someone he also writes positively about. He believed that Lysenko succeeded in refuting the "lie" that science and life "are based on opposing truths, rather than a single truth" (Gligić 1945: 26). For Gligić (1945), it is hard to find a better example "for the need for unity of theory and practice" (Gligić 1945: 28) than what Lysenko demonstrated in his scientific work. According to Gligić (1945), Lysenko's significance lies precisely in his ability to "show" the mutual relationship between theory and practice, namely that theory must necessarily be tested in practice to discard "false theories," as well as that without true theory, practice "stands in place." This is particularly interesting when viewed from today's perspective, considering the Lysenko affair, its place in the history of science, and the way his fraud was exposed.

> "Just as Michurin's teachings emerged from practical life and were confirmed by a colossal number of experiments, so Lysenko's theory of plant development in stages, a theory he developed based on Michurin's teachings, was repeatedly tested in the practice of Soviet socialist agriculture […] As a tireless researcher, Lysenko sought and found ways to influence the nature of cultivated plants by changing their characteristics according to the demands of agricultural practice in the Soviet Union" [Gligić 1945: 26-27].

Yugoslav agricultural engineer Dušan Stanković also promotes Michurin's work along these lines. Stanković (1946) portrays Michurin not as "an agricultural expert, nor someone involved in fruit cultivation" (Stanković, 1946: 7), but rather as "[a] self-taught, humble, and unnoticed traffic official from a small town ... [who] harbored grand and extraordinarily bold plans for transforming Russian fruit cultivation" (Stanković 1946: 7), which, Stanković (1946) believes, he managed to achieve through "very hard and prolonged work" (Stanković 1946: 7). In imperial Russia, as described by Stanković (1946), good fruit trees could only be grown "in greenhouses," a situation that Michurin was determined to change. As he says, "exhibiting innate abilities, [he] was able to observe natural phenomena with open eyes, to read from the 'book of nature', and thus embark on new paths of Darwinism and dialectical materialism, which led him to such brilliant successes" (Stanković 1946: 9).

The brochure about Darwin's theory and its importance for agriculture, translated from Russian to Serbo-Croation and published in Yugoslavia in 1947 in the popular- scientific series *Science and Life,* emphasizes the significance of Darwin's theory for the work of Soviet scientists, who applied it in their creative work in service to the Soviet "Fatherland." "The works of famous Soviet scientists – I. V. Michurin, T. D. Lysenko, and their followers – show how powerful the wings that Darwin gave to science are" (Keler 1947: 23). This is illustrated through the example of Michurin.

> "Darwin explained how evolution occurred, and how it is ongoing. Michurin directed it according to a preconceived plan. Darwin elucidated how animals and plants change during the process of evolution, and how various adaptive traits happen to emerge in them. Michurin teaches us how to

> create plants, particularly suitable for adapting to new life conditions, making it easier to change their nature in the desired direction. Darwin demonstrated that experience in breeding new animal breeds and new species of cultivated plants helps explain the theory of evolution in the wild. Michurin reveals to us inexhaustible sources of resistance and fertility in wild plants. He shows us how using these 'cinderellas' that are often overlooked, we can elevate the world of cultivated plants to new heights" [Keler 1947: 25-26].

In the same brochure, one of the subtitles emphasizes the need for a "proper understanding of Darwin's theory, against the anti-scientific fascist babbling about social Darwinism." The text points to the insights of the Russian naturalist Sechenov, who argued that "all races and nationalities are absolutely equal in their psychophysiological characteristics; all have the power to perfect themselves" (Keler 1947: 20). These scientific insights, further emphasized in the text, exposed "the entirely false science of fascist babbling about 'higher' and 'lower' races and tribes" (Keler 1947: 20). Later in the text, Keler (1947) addresses Darwin's thesis "that man descended from ape-like animals," not denying the validity of evidence for this claim. However, he argues that it was not until "genius sociologists" Marx and Engels that it became clear how man "advanced so far" from animals. According to Keler (1947), they pointed out the importance of humans' ability to produce tools for labor. And, "under the influence of social labor, human nature itself is transformed" (Keler 1947: 21).

> "In our socialist country, free, creative, socialist work elevates man to unprecedented heights. Based on that work, we have created an invincible, great brotherhood of peoples. To this brotherhood of peoples, the German fascist bandits opposed their terrible death camps, gas vans, and mass murder of millions of innocent people, including children, women, and the elderly. But to the joy and happiness of all freedom-loving countries and peoples, our Soviet Union broke the spine of the German fascist beast and saved European civilization from it. Before us is a historical lesson of poignant power and persuasiveness: the strongest wave of robbery and barbarism was shattered against the unyielding fortress of brotherhood and humanity" [Keler 1947: 22].

Furthermore, there was a tendency to shape the humanities and social sciences following the Marxist-Leninist paradigm, through numerous translated works of Soviet thinkers (Marković 1996: 359). This is evidenced by brochures from the *Science and Society* [*Nauka i društvo*] series, which were published by Yugoslavia in 1946 and promoted a Marxist-Leninist outlook on social science and philosophy, as well as their role in society. Accordingly, one finds criticism of the attempt by "some scholastics or mechanists to turn philosophy into empty, detached reasoning, with nothing in common with human practice…" (Pavlov 1946: 64), as well as criticism of the "bourgeois" Feuerbach materialistic philosophy, and the explanation what kind of materialism sociology must adopt, as the science about society, in order to properly analyze social processes:

> "Materialism is an energetic opponent of the sociology that starts from human consciousness, psychology that starts from spiritual principles, and physics derived from a priori forms of reasoning, etc. And, finally: materialistic objectivism is not vulgar objectivism that simply ignores everything subjective. Materialism subordinates the subjective to the objective, deduces the first from the second, objectively explains from the subjective, and emphasizes that the subject (epistemologically, psychologically, sociologically) is actually a feature, expression, or revelation of the objective course of things. The subjective is not denied but subordinated to objective reality as its characteristic, its part" [Bihovskij 1946: 47].

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Despite Yugoslavia's relative autonomy in comparison to other countries of the Soviet Bloc, it nevertheless aspired to follow the Soviet model of scientific organization, financing, and views on nature and the role of science in society. This was manifested as a sharp criticism of autonomous science and the continuous emphasis on the necessity and advantages of the principles of planning, partisanship, unity of theory and practice, and a highly centralized organization – which Yugoslav

officials, as well as some scientists, saw as important traits of Soviet science. Nevertheless, as Tito and Stalin ceased cooperation in 1948, the Yugoslav scientific sphere also faced significant consequences. Still, it is important to stress that although, when looked on a formal level, the process of implementing the socialist system according to Soviet principles lasted a relatively short period, the mechanisms and effects of this process were rather noticeable in Yugoslav society over a longer period, even after 1952, when a different socio-political system – socialist self-management - was officially established (see Kuljić 1998).

Structural and Ideological Shifts in Yugoslav Science After the Break with the USSR

Following the sudden, bitter, and tumultuous break with the USSR, resulting in an exceedingly hostile relationship with the entire Eastern Bloc, Yugoslav foreign policy underwent critical changes, notably, an opening to the West (Bogetić 2000; Jakovina 2003). Despite this shift, Yugoslavia maintained its own socialist ideology (which differed from that of the USSR) (Jović, 2003: 130-131; Bakić 2011: 26; Čalić, 2013: 234-252), and accordingly, science in Yugoslavia remained under the dominant influence of socialist ideas (Najbar-Agičić 2013). Despite the fact that Yugoslavia never abandoned socialist ideology, the geopolitical shift toward the West contributed, to a certain extent, to the strengthening of "the pragmatic course of Yugoslav foreign politics" (Kuljić 1998: 258), which was reflected in internal socio-political and cultural circumstances in the country. Herein, we analyze the emergence of novel scientific tendencies in Yugoslavia, that appeared after the split, as well as their compatibility with certain aspects of the "pure," autonomous, and apolitical science perspective. The intention of this section is not to exclusively point out the changes and imply their (in)congruence with Marxist-Leninist ideological assumptions regarding science, but also to discuss the importance of certain geo-political and socio-political dynamics when these changes are at issue.

To better comprehend changes in the official ideas governing Yugoslav science and its organization and financing in the Cold War context, we begin with a summary of the basic assumptions of a "pure," autonomous, and apolitical science. This view holds that science should be relatively independent of society because the pursuit of knowledge is its most fundamental value and goal, whereas the insistence on planning and centralization subordinate science to the state (e.g., Polanyi 1962; Merton 1938). According to sociologist Robert Merton, the scientific ethos, autonomy, and validity of scientific knowledge are all interconnected in such a way that "freer scientific communities who have institutionalized ideals of 'pure' science are more likely to produce true knowledge" (Panofsky 2010: 142). In other words, a scientist must be "free to do good science" (Krige 2006: 146). This is not how the West viewed scientists in the USSR, which was characterized as a totalitarian system in the Western Cold War discourse. This ideological demarcation was often used, ostensibly for professional reasons, to discriminate against scientists of communist affiliation in the West (see Krige 2006: 115-153). The concept of a "party line" was presented as a "key factor that distinguished Western from totalitarian science" (Wolfe 2018: 32). Because political demarcation was transferred to the level of "pure" professionalism, the idea that intellectual merit, rather than political preferences, was the deciding factor in selecting scientific projects was considered a determinant of American science during the Cold War, although the reality was somewhat different (Wang 2002; Krige 2006; Aronova 2012; Wolfe 2018).

The split with Stalin in 1948 initiated the process of ideological transformation in Yugoslavia, whose key advances occurred in the early 1950s with the inauguration of the new ruling paradigm – that of socialist self-management (Jović 2003: 130-131; Čalić 2013: 238-242).

After the break, the USSR went from being a socialist ideal (celebrated in all social spheres as the opposing force to the capitalist West) to an example of "state capitalism," under which the working class was "far worse off than in most backward capitalist countries" (Tito according to Rajak 2011: 25). Thus, the USSR influence should be resisted in every possible way (often more than capitalism in the West), in order to prevent the demise of socialist and democratic Yugoslavia, as Yugoslav communists saw it.[25]

[25] For criticism of the USSR see also The Congress of the Union of Communists of Yugoslavia, 1952.

This negative attitude toward the USSR was reflected in the statement of the Congress of the League of Communists of Yugoslavia (a new name adopted by the Communist Party of Yugoslavia after the split) in 1952: "At the same time, the Congress points out the dangers that can and necessarily will become an obstacle on the democratic road of the working class and working people: first, the danger of bureaucratic state-capitalist tendencies..." In the Yugoslav context, the term "state capitalism" was used to describe the crisis of the capitalist system. In the words of Milentije Popović, during a crisis, state capitalism serves as "*proof that contemporary capitalist society is in a permanent crisis from which it can be freed only by constantly and increasingly, objectively, legally, abolishing itself*" (Popović [1953]1964: 15). According to Popović, in all previous stages of capitalism, it was "capital that enabled the socialization of production…" (Popović [1953]1964: 14). In this phase, the process of socialization was performed by the state itself.

Accordingly, it was concluded that contemporary class struggle was increasingly taking place inside the context of state capitalism. Yugoslavs thought that such a circumstance frequently resulted in bureaucracy becoming a dominant social force, and that when other authorities were unable to "direct social life, it acquired this basis through political force. That is why clerkship – bureaucracy, inevitably established in society so-called totalitarian regimes or dictatorships" (Popović [1953]1964: 36). According to Popović and other Yugoslav officials at the time, bureaucracy in the Soviet Union was the "ruling force of the social system," subjecting the working class and its interests – which correspond to the general interest according to Marxism – to its own particular interests (Popović [1953]1964: 37). Unlike the USSR, Popović considered socialist Yugoslavia as a sort of state capitalism where "the working class subjected itself to a system of state capitalism, only to ultimately destroy it at a turning point" (Popović [1953]1964: 37).

Weakening of the Soviet Organization Model in Yugoslav Science

The novel tendencies that emerged after the break with Stalin brought about structural changes in Yugoslav society, but also problems on multiple levels. Importantly, changes at the economic level had a significant impact on science. Decentralization of the economy began even before the formal introduction of "workers' self-management" (Šetinc 1978: 25). At the time, it was a necessary requirement for introducing socialist self-management. As early as 1952, at the Sixth Congress of the CPY, there were open appeals to weaken the state's influence on Yugoslavia's economic system in favor of a freer market. The involvement of Boris Kidrič, the President of the Economic Council of the Government of Yugoslavia and member of the Secretariat of the Executive Committee of the Central Committee of the LCY, is particularly noteworthy in this sense. According to him, "the new economic system should be based on objective economic laws and avoid administrative suppression of those laws to the greatest extent possible" (Kidrič 1952: 130). He criticizes the "Praxist" approach to the economy (Kidrič 1952: 94-95). Although he emphasizes that he is basically in favor of "planned" economic research, he criticizes "planned formulas" in the scientific work of the economy (Kidrič 1952: 99-101). Accordingly, Kidrič (1952) took a critical stance on distributive plans as well, saying: "Comrades who believe that a distributive plan can solve everything, forget that the source of national income, social wealth, its rich assortment – is production, not distribution" (Kidrič 1952 102).

Socialist self-management in Yugoslavia was closely intertwined with calls for less state interference in the economy, in contrast to an important element of Marxist economic theory – the planned economy. This being deviation from the Soviet ideological and economic stance is evident in positions presented in the pamphlet *Komsomol and Science*, translated and published in Yugoslavia in 1947, which states the following:

> "Soviet society – the first in history – was built on the solid foundation of science. Its development was not ruled by haphazard laws but planned deliberate direction. The socialist state defines the direction of development of the national economy guided by a scientifically-based plan" [Komsomol i nauka 1947: 3].

During the early stages of the split, certain Yugoslav officials viewed increased state intervention in the economy as a trend in contemporary society as a whole. According to Milentije Popović, "The increasing interference of the state in the economic state of society became one of the main laws of development of contemporary society" (Popović [1953]1964: 12). Therefore, these dynamics between the state and society was not seen as unique to the USSR. The basis for this claim from the 1950s can be seen in the legacy of the interwar period of the twentieth century and the Second World War. The foundation of what was said can also be found if we take into account the post-war "Three Glorious Decades", during which the social welfare state was created and developed in the Nordic countries and the European Economic Community (EEC) (Bakić 2019: 30; 54-57). However, while the socialist self-management system never denied the structural intertwining of the state and the economy, and while some saw the strengthening of state influence in the economic sphere as a path to development, the new system's overall economic course advocated for the reduced influence of the state element in economic life. The Yugoslav leader, Josip Broz Tito, speaking of workers' self-management at the Sixth Congress of the CPY in 1952, stated that "true democratic management begins where state control over economic affairs through its apparatus ends" (Broz (Tito) according to Šetinc 1978: 25).

At the Sixth Congress, the CPY (Communist Party of Yugoslavia) 1952. changed its name to LCY (League of Communists of Yugoslavia). It modified its role to adapt the Party to new social circumstances – self-management. "League of Communists as an avant-garde of the working class cannot be the leading ideological and political force in society if it assumes the role of state executive authorities, but only as a creative force in the system of socialist self-management, primarily through its influence on the masses" (Kardelj according to Šetinc 1978: 25). In 1958, (Seventh Congress of LCY), the League highlighted in its program that it considers "unsustainable dogma the declaration of absolute monopoly of the communist party in political power as a universal and 'eternal' principle of the dictatorship of the proletariat and socialist construction" (from the LCY's program, according to Pašić 1978: 37).

But, as researchers have noted:

> "The deeper the integration of the economy in the world market, the more directly the latter's competitive logic became expressed within Yugoslavia, and the more it caused friction on the shop-floor, bringing into question the legitimacy of the governing apparatus" [Unkovski-Korica 2016: 3].

Market reform in Yugoslavia was pursued, even though "it supported dynamics that generated social inequalities" (Lebowitz 2012: 165).

> "What the market yields, after all, differs for all working groups. As commodity-sellers within a market, the fortunes of each working group depend not only upon their own efforts but also upon luck and access to particular means of production. In the absence of a focus upon solidarity with other workers or society as a whole, the probability of significant inequality (as occurred in market self-management in Yugoslavia) is high" [Lebowitz 2012: 165].

This is especially evident in Tito's later criticism of the implemented reforms: "certain forces and exaggerated idealization of the effect of the law of value and free supply and demand" (Tito 1958: 56) are to blame for the population's lack of supplies: "Here, one forgets that planned socialist production necessitates more or less planned distribution of products, greater control of the market and prices" (Broz (Tito) 1958: 56).

According to Leon Geršković, a prominent Yugoslav jurist and participant in the drafting of all of Yugoslavia's constitutions from 1946 to 1974, the contradiction between "planned economic management and the unrestrained market mechanism characterizes the whole economic mechanism in Yugoslavia" (Geršković 1958: 20). In his view, this contradiction was undoubtedly reflected in other social spheres. Geršković (1958) believed that "overcoming these contradictions was possible only through the development of productive force and maximal social self-management" (Geršković 1958: 20).

> "Yugoslavia had to introduce a system of distribution because of the scarcity of goods and underdeveloped productive forces. Maintaining that system more than was objectively needed (if that was the case, which is worth investigating) is the result of the ideological influence of Stalinism, whose system of distribution makes it impossible to adopt a market mechanism. Today, it is obvious that Yugoslavia can implement the principle of 'to each according to their distribution' only through a market mechanism. If there exists a tendency to abolish the market, it exists either to satisfy certain socio-political goals (in residential construction, for example) or because of insufficiently clear basic theoretical assumptions about the social and economic system and its implications for practical economic policies" [Geršković 1958: 18].

Already in the early 1950s, discussions began in Yugoslavia regarding the organization of science and the Yugoslav approach to the issue of the status of universities and academic institutes in the framework of the socialist model of scientific organization following the break with the USSR. Leopold Ružička's[26] (1950) critique of the Soviet paradigm, which focused on academy-associated institutes, emerged as very significant. He openly opposed the Soviet organization of scientific and research work. He considered a major shortcoming of the Yugoslav organizational scientific system "the establishment of institutes at academies of science and art, which set goals that corresponded to those of modern universities" (Najbar-Agičić 2013: 126). According to Ružička (1950), the situation in Yugoslavia, where there was a great lack of young scientific talent and resources for science, supported the view that the Soviet model was damaging. He believed that establishing academic institutes and investing resources in them was damaging because it was more important to focus on university courses and contribute to the development of a future generation of young scientists. Moreover, Ružička adds that the model of establishing an institute outside of a university is not common in nations with a longer scientific tradition.

> "In countries with a vast and long scientific tradition, there exists – except for a small number of institutes established with private funds, such as the Rockefeller Institute for Medical Research in New York – only a very small number of scientific institutes established with national funds, that are worth anything, outside of higher education institutions. I will highlight the Institut de France and Institut Pasteur in Paris, the National Institute for Medical Research in London, and the Max Planck Gesellschaft in Germany. In these same countries, the number of scientific higher education institutions when compared to the number of the country's residents and income is vastly bigger, and the institutes have much greater resources than in Yugoslavia. However, there is a much lower scarcity of scientific professionals and necessities in these countries than in Yugoslavia, therefore the existence of this comparably small number of institutions is not as detrimental to university lectures as it would have been in Yugoslavia. Not to mention, the aforementioned institutions were formed in these countries only when the science was qualitatively and quantitatively at a higher level" [Ružička 1950: 4].

One can notice that Ružička (1950) does not hesitate to make comparisons with Western models of organizations, noting that one of the reasons for the better state of science in Western countries was

[26] Lavoslav (Leopold) Ružička (1887-1976) was a Yugoslav-Swiss scientist of Czech origin. He held eight honorable doctoral degrees (in science, medicine and law) and was one of the recipients of the 1939 Nobel Prize in Chemistry.

because institutes were established there only after science would advance to a certain degree. Ružička (1950) further asserts with confidence: "If the Soviet scientific initiative is already underway in some places in Yugoslavia [...] it's not too late to halt it and take the right way" (Ružička 1950: 4), suggesting merging the existing institutes with universities, noting as a good example "the establishment of the microbiology center in Cambridge [England] by the Medical Research Council. The University of Cambridge granted permission for the establishment of this institute, provided that it becomes the property of the University's biochemical lab within a maximum of five years. Vivant sequentes in Jugoslavija" (Ružička 1950: 4).

Ružička (1950) expressed doubts about the very idea of planning scientific work because he feared that it was impossible to separate planning from centralization. This fear played a significant role in his attitude toward the role of academies in the scientific community, as he believed that they achieved a monopoly on science by this means. Accordingly, his criticism was directed toward the centralization of resources in national funds. "There is a grave danger in centralizing resources for the scientific research of a country…" (Ružička 1950: 4). He further said that this mistrust stems from the fact that scientific work cannot be foreseen, and that the higher quality and original the work, the more accurate this was. When reading Ružička's (1950) reflections on the organization of science in Yugoslavia, it is difficult not to notice that for reliable and good models of scientific organization, he suggests looking exclusively to the liberal-democratic West. They are also explicit and sharp criticism of the Soviet model of scientific organization, as the following words testify:

> "In one country, however, there exists a relatively large number of scientific institutions outside of the university framework, the so-called academic centers, and that country is the Soviet Union. But it is the comparatively mediocre and weak results of Soviet science compared to other advanced states, that show the inadequateness of the Soviet system of organizing science. If such a system were to achieve more success than it does now in the Soviet Union, it would inevitably result in a significant, and eventually complete, stifling of scientific endeavors in higher education institutions. One reason for the demise of higher education institutions is that academic institutes recruit the best scientific workers from universities. The other is that the departure of the best experts sanctions the post of those university workers that do not like research work – and there are always many such workers – and who do not deserve to be university professors. As a result, universities have become vocational schools. […] The current Soviet system of scientific organization leads to the demise of the very academic institutes. The existence of such institutes would only be justified if they could permanently preserve the quality of higher education institutions. But their quality inevitably decreased because of the lack of young, highly qualified scientific workers, which cannot be produced by a university degenerated into a middle school. The current Soviet system necessarily leads to the mutual harm of scientific institutions outside and inside universities. One should hope that the Soviet State would soon see the harmful effects of such a system, and restore to universities their former significance" [Ružička 1950: 4].

In light of Ružička's (1950) concerns about scientific planning, it is worth considering Rudolf Bićanić's response. Bićanić (1951) challenges the notion that the Academy is solely responsible for monopolization. "[If] there is a danger to scientific work from the monopolization of academies, would the monopolization of universities give us greater guarantees for the free development of scientific work?" (Bićanić, 1951: 1). Moreover, Bićanić (1951) expands upon Ružička's criticism of the concept of planned scientific work. He agrees that centralization and administrative intervention negatively affect the work of scientists. However, for Bićanić (1951), this is not planning, but "conducting."

> "[O]rganizing scientific work on a national scale is not the same as centralization. We've had enough bad experiences with centralization, so now we take caution, so as not to make the same mistake. In a relatively poor country, the only sources of scientific research are general government funds. And it is more appropriate to allocate those funds in a planned manner from one center in each republic, through

> the very scientists and according to scientific criteria, rather than based on the criteria of connection and a person's persuasiveness" [Bićanić 1951: 1].

Starting in the 1950s, several discussions focused on the issue of organizing scientific and research activities in Yugoslavia, which was assumed (and tended) to follow the path of growth of the USSR's organizational model prior to the break in 1948. If we look more closely at some scientific conversations in which diverse proposals and points of view were made about the organized scientific system, we can generally divide them into two opposed stances (Najbar Agičić 2013: 127-138). One position defended the academies of sciences and arts and their role in the organization of scientific and research work, while the other criticized the Academy's role, claiming that it was harming the University, whose role in society had to be strengthened. The claim that the conflict between the academy of science and university was due to the academies in Yugoslavia being "built on a Soviet model, with all scientific work focused on academies," while university work was organized "based on Western universities as a scientific and educational institution," (Najbar Agičić 2013: 136), serves as a good illustration of the ideological framework of the debate on the organization of the scientific system in the Yugoslavia.

It is noteworthy that the majority of advocates of the existing role of academies in the scientific system neither claimed that the position of academies was the Soviet model of organization, nor emphasized the advantages of that model. Accordingly, one should turn to the words of academic Antun Barac[27] (1951), who writes that the organization was not the same as in the USSR, as academics were both university professors and teachers, supporting in this way the faculty as the driver of science (Najbar-Agičić 2013: 128).

> "A university must not be a college, aimed at the development of highly skilled experts; it must disseminate and cultivate science. The two conceptions are not mutually exclusive; rather, one stems from the other. Universities improve science while simultaneously providing as many staff members as possible with experts trained in scientific methods" [Barac 1951: 1].

Barac (1951) also emphasizes the significance and specific development of individual faculty institutions, as well as the employees working there. When it comes to work quality, he believed that these factors are far more important than the amount of funds.

> "The motto, long considered the highest principle of Yugoslav university policy, has been rejected: all faculties of the same kind should teach the same courses. Instead of leveling, a noble and brotherly competition should take place, with the goal of each university and each of its members giving their all and producing the best they can. The ultimate goal of every university, even the smallest, must be to continue to advance scientifically and to rank among the finest universities in the world, both in terms of representative and scientific output. For it is widely known that the scientific reputation of the individual and faculty is often unrelated to funds and depends most on hard effort, dedication to science, and belief in science" [Barac 1951: 1].

In the context of this discussion, it is worth noting that Božo Težak[28] (1951) suggested establishing an Advisory Board for scientific research, above the academy, university, and research institute. In this way, it would be possible to discuss "directly with the participation of interested parties" not only the "order of realization" of scientific projects but also the distribution of funding. Težak's (1951) argument suggests emulating the United States in this aspect.

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[27] Antun Barac (1894-1955) was a noted Yugoslav historian and a professor at the Faculty of Philosophy in Zagreb.

[28] Božo Težak (1907-1980) was a noted Yugoslav chemist and professor of Faculty of science in Zagreb. He is considered to be founder of the activities related to physical chemistry at the Ruđer Bošković Institute in Zagreb.

> "In that direction, one should draw a lesson from a special legal provision by which in the US the most powerful foundation for the direct support of fundamental science was formed, the National Science Foundation, which explicitly forbids that the foundation has its own laboratory or any research institution. This was established so that non-objective elements are not consciously or unconsciously introduced in the allocation of financial help" [Težak 1951: 4].

Academician Jovan Hadži[29] (1952) in connection with the reorganization of scientific and research institutions, wrote about the idea of reducing the number of institutes in Yugoslavia, up to 90% of the total number, because a certain number of "scholars" considered them "unnecessary" to scientific and research organizations and "unfit for life." Unlike them, he believed that this was unnecessary, or at least not to the extent proposed, because they were actually mostly small work units. Instead of reducing the number of institutes, Hadži (1952) proposed their reorganization within three larger institutions tasked with establishing institutes, namely, the academy of science, university, ministries (councils), as well as determining which institutes could become affiliated, and which could stay independent while holding a certain rank. Following this, it could be considered "which of the independent and merged institutes of the three founders should stay, whether in smaller or greater number, and which could be usefully consolidated regardless of their previous affiliation with the founder. At the same time, it would be decided under whose auspices each institute should fall" (Hadži 1952: 1).

As someone who was essentially a supporter of Ružička's argument for the need for universities as the bearers of science in Yugoslavia, rather than academies, Hadži (1952) further states that it is unfair and useless that scientists at institutes within the academy perform only scientific research work, while scientists working at university-affiliated institutes, in addition to performing scientific research work, also have to perform educational work (due to the small number of teachers at that time), significantly more than their colleagues at academies. As a result, scientists at university-affiliated institutes must disregard their research. Hadži (1952) argues that engaging in educational work is beneficial for scientific workers, particularly specialists, as it "forces them to follow the progress of the profession and maintain an ever-widening horizon" (Hadži 1952: 2). He argues that while educational work is more prominent in university-affiliated institutes, "the tasks of both institutes, those related to academies and those related to universities, are similar" (Hadži 1952: 2). Hadži (1952) also argued that while both institutes have comparable tasks, university-based institutes have an advantage in terms of educational activity and the development of scientific personnel.

> "Academies and academic institutes do not and cannot exist without universities. Where there is no academy, scientific effort continues, but in universities and industries. [...] It is clear that universities must have institutes for all of the sciences that are practiced here, regardless of whether there is an academy in the same location or not, and whether or not they have their own institutes. [...] University institutes prepare new scientists from the academy; academics are called sit venia verbo, and they are regularly recruited from the ranks of university professors. The logical conclusion is that for the sciences and professions studied at universities, it is unnecessary to establish a comparable or related institute at academies or elsewhere. Thus, the majority of the institute's revenue should come from universities…" [Hadži 1952: 2].

In the context of this and similar problems, Hadži (1952) critically reviews how scientific research was previously organized, i.e. the period of Yugoslav emulation of the Soviet Union, focusing on the role of academies and the Academic Council of the FPRY in establishing institutes and universities, which is particularly relevant to this topic. According to Hadži (1952), this situation provoked Professor Ružička's memorandum and subsequent discussion.

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[29] Jovan Hadži (1884-1972) was a prominent Yugoslav zoologist and academic.

> "After the liberation, under the evident influence of the situation in the Soviet Union, our national Academies of science emerged as founders of new scientific research institutions. Some more suddenly and exuberantly, others more slowly and thoughtfully, and often beyond the bounds of practical possibilities, institutes were founded in greater numbers at our Academies. We cannot argue that they were founded based on a well-conceived plan. [...] It appeared that our Academy of Science would like to take the lead in building and leading scientific research institutes while slightly damaging or pushing university-related institutes in the foreground. [...] However, there was also a third scientific forum, with ambitions to establish or lead scientific research institutes. That was the Academic Council of FPRY as the common coordination body of our national academies… Again, the task of the Academic Council was decided based on the Russian model that was hovering overhead" [Hadži 1952: 1].

It is important to note that, as Hadži himself makes clear, there was some skepticism as early as 1952 regarding the high degree of centralization and hierarchy, and the authorities' extremely broad responsibilities arising from such an organization, which was related to the Soviet idea or organization itself, particularly in connection with the Academic Council. As a result, after the split from the USSR and the change that took place during that period, the criticism of Soviet aspirations prevailed, with the aim of changing direction. Hadži's (1952) remark regarding the competencies of the Academic Council should be viewed accordingly.

> "In taking over the already existing institutes – the Academic Council had not yet established new institutes – it was determined that all institutes of a federal significance would fall under the higher leadership. […] It is my humble opinion that the tasks of the Academic Council lie in another field – necessary and useful – and not in taking over and leading individual or large and single research institutes. Besides controlling and leading our relations with the international scientific community, the Academic Council should perform the duties of an inter-academic center with a comprehensive program" [Hadži 1952: 1].

Andrija Štampar[30] defended the function of the Yugoslav Academy of Sciences and Arts (JAZU), arguing against the claim that the Academy is closed in on itself and seeks to acquire a monopoly on science (Najbar-Agičić 2013: 130). He argued that it was not about JAZU acquiring a monopoly, but that it was there "to help everyone" (Najbar-Agičić 2013: 130). According to Štampar, JAZU was an important institution that coordinated scientific and research efforts, which he believed was "crucial for the 'economy of scientific work'" (Najbar-Agičić 2013: 130). However, despite attempts to defend the Academy's organizational structure (in this case, JAZU), criticism of it as a Soviet-style model emerged at Academy Assemblies. In a 1953 report, JAZU secretary Marko Kostrenčić concluded on the matter discussed before the Assembly:

> "During one stage of our postwar development, we mindlessly imitated other people's models and attempted to apply them to our reality as a template. However, it became clear that the Yugoslav peoples, in terms of politics and economics, as well as science and art, should forge their own path, which is shaped by their unique circumstances. When constructing that path, they should draw on the experience of others, but not in such a way that their acts and modes of work serve as inviolable models" [Kostrenčić according to Najbar-Agičić 2013: 130].

In the context of the aforementioned discussions and topics concerning the organization of academies of sciences, institutes, and universities as the bearers of scientific life in Yugoslavia, it is necessary to turn to the Serbian Academy of Sciences "SAN" (which was renamed the Serbian Academy of Sciences and Arts "SANU" in 1960). The reform of this institution, which occurred in 1954, took

[30] Andrija Štampar (1888-1958) was a noted Yugoslav scholar in the field of social medicine. He founded the School of Public Health in Zagreb in 1927. He was professor at the Zagreb University since 1939, its rector in 1945/46 and a dean of the Medical faculty in Zagreb.

place following criticism of SAN's connection with the university. In 1951, academician Ivan Đaja[31], criticized the Academy's ties with university institutes. He claimed that the productivity of university institutes had dropped because the best professors were working at the Academy. According to Đaja (1951), such a relationship between academies and universities in Yugoslavia was problematic, as he believed that academies could not replace universities, and accordingly, that universities had to be further developed (Đaja according to Godišnjak SAN 1951: 48).

> "By attracting manpower, the Academy pursues a slightly egoistic policy (he cites the example of two assistants whom the University requested to work part-time but the Academy denied this). Nowadays, the SAN Geographical Institute is preferred over the well-known Jovan Cvijić Institute at the University. The university has been neglected and ruined in many aspects. The Academy has recently begun to issue doctorates, albeit he believes this is not proper. He believes that it is in the interest of science to show greater regard for the University" [Đaja according to Godišnjak SAN 1951: 48].

To Đaja's criticism of the emphasis on the Academy and its institutions, it was stated that this was due to a lack of staff, and that the situation would remain that way until there were more personnel (Belić according to Godišnjak SAN 1951: 48). It was also commented that there was no antagonism between academy institutes and university institutes, as described by Đaja, because the Academy could not create large institutes, as well as that many of the Academy's institutes were located within faculties where they create and develop scientific staff. It was also added that the Academy's institutes "can develop their members much faster than the University, and that what they do at the Academy benefits and extends to the University. The major goal is to increase scientific work. One must wait patiently until the institutes reach full strength, at which point one shall see that the University is fully supported by the Academy" (Belić according to Godišnjak SAN 1951: 49).

However, a few years later, academician Đaja stated that the success of the Academy's institutes was largely due to the University, including higher education institutions, "whose best scientific workers transferred their activity from the University to the institutes" (Đaja according to Godišnjak 1953: 50). According to Đaja (1953), the Academy "gained" while the University suffered. Đaja argued that while the University's seminars and institutes were active prior to the conflict, they became less active afterward.

> "Academy institutes create science; the University creates scientific professionals, which is something that should be considered. There will be no future without scientists. […] The working circumstances at the University are less favorable than at the Academy. The University is neglected, and the University's privilege to issue doctorates has been taken away. A university that confers knowledge cannot grant a Ph.D. The number of associates has been limited to those required for lessons. The Academy's institutes can have an unlimited number of scientific associates. The Academy should take this into account and consider the full body of scientific activity, rather than just its narrow circle of interests. It should take care of the University. The establishment of the Academy's institutes was not intended to deprive the University of its personnel, although this did occur" [Đaja according to Godišnjak SAN 1953: 50].

This criticism of the Academy's institutes is softened by Đurđe Bošković (1953), who points out that the fears are not justified because institutes exhaust the university. According to Bošković (1953), SAN institutes can only contribute to the work of the University by directing it toward proper development. The fact that some professors work at SAN also contributes to the University, as they raise its "scientific potential," which is then "felt in their work at the University" (Bošković according to Godišnjak SAN 1953: 52). He also says that teachers and other University workers should be

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[31] Ivan Đaja (1884-1957) was prominent Yugoslav biologist, pyschologist and philosopher. He was professor at the Faculty of Philosophy in Belgrade, member of Serbian Rolay Academy and Yugoslav Academy of Science and Arts, as well as of French Academy of Sciences.

allowed to use the Academy's institutes, as this would be "an appropriate collaboration between the Academy and the University for the advancement of science and scientists" (Bošković according to Godišnjak SAN 1953: 52). Belić (1953), meanwhile, states that while some academic institutes are "flourishing" and some university institutes are not, "[one] should be satisfied that the institutes of the Academy will be able, some even today, to return to the University the loan" (Belić according to Godišnjak SAN 1953: 54).

Despite Bošković's, Belić's, and similar claims, the 1954 SAN Yearbook (Godišnjak SAN) shows that the institutes associated with the Serbian Academy of Sciences received "special grants for the first quarter" in 1954 (Godišnjak SAN 1954: 48) This transitioned the SAN institute from "being able to generate income" from its work to a financially and administratively independent model of institutes, operating under the Academy's scientific leadership. The decision was announced by Milka Minić, then a member of the People's Republic of Serbia's (NRS) Executive Council. The NRS Executive Council later resolved that all SAN-associated institutes, which have autonomous financing, should operate as budget-funded entities. This did not apply to the Mechanical Engineering Institute, which was determined to operate as a company. In addition to the fact that the scientific connection between the Academy and the institutes was left to mutual agreement, it was announced that certain provisions of the Regulations would be relaxed for the institutes to develop more effectively. Accordingly, the then-president of SAN Belić envisioned the scientific relationship between the Academy and its now-independent institutes as the former submitting their work to departments of the Academy for revision (Godišnjak SAN [1954]1957: 49-56). The 1958 SAN Yearbook also briefly mentioned the Academy's work related to its institutes in the context of the reorganization and resolutions brought in 1954.

> "It should be emphasized that the Academy's institutes continued to operate in 1958, following the reorganization and decisions taken in 1954, as independently financed institutions, with three institutes directly contributing to the Academy's budget. However, it should be noted that, in accordance with the Law on the Organization of Scientific Work, extensive preparations and new decisions were made, resulting in all of the Academy's institutes becoming budget-funded scientific institutions, which means that each institute has its own budget within the Academy's budget. As a result, this year, all of the Academy's institutes operate as budget-funded scientific institutions" [Godišnjak SAN [1958]1959: 119].

Despite establishing the institute's independence from SAN, not everyone agreed with the organizational changes. According to academician K. Todorović (1955), the SAN Institute was founded as a working institution, distinguishing it from the previous Academy as well as the University and its institutes. The Academy is a scientific institution that creates scientific workers, while the University is primarily an educational institution. Todorović rejects the argument that the Academy's institutions are redundant given that the University already has them (Godišnjak SAN [1955]1957: 31-32).

To roughly present the further direction of the discussion in connection with the question of the organization of science, including the main structures carrying scientific work in the country, as well as Yugoslavia's deviation from the Soviet line, it is important to note that in the preface to the book *Science in a Small Country* (*Nauka u maloj zemlji*) by M. Mlađenović in 1969, Siniša Stanković wrote

> "Faculties, on the other hand, must serve as both teaching and scientific centers, with fundamental research taking precedence. The presence of independent research institutes does not benefit the development of science at the university if they are not affiliated with it. Transferring research to autonomous institutes diminishes the university's role and places it in a disadvantaged position, with fragmented research challenges and limited resources" [Stanković 1969: 10-11].

Previously, Stanković criticized SAN's unclear role in the scientific life of socialist self-managing Yugoslavia, particularly after the break with the USSR. According to him, the ambiguity of SAN's status in science might also be attributed to the institute's prior independence from academies. In this way, one can see how the organizational changes caused by the breakup with the USSR were mirrored in the conception of the nature and role of SAN. Stanković's presentation, featured in the 1957 SAN Yearbook, provides evidence for this claim. Stanković questions the Academy's current social status in light of legal and organizational changes in science over the previous decade. He thus highlights the need to focus on and address this matter.

> "As you are aware, in the Soviet Union and Eastern countries, academies serve as central scientific entities that, in addition to developing scientific research services, are also responsible for guiding the country's scientific activity. We tried it in 1948, and as you know, the Academic Council was established at the time, with the hope that it would eventually grow into such a central organization. […] Some speculated that a government academy of sciences could emerge from it. However, it soon became clear that, on the one hand, such problems cannot be solved administratively, and on the other, the true development of our country in certain areas of our material and spiritual culture necessitated other forms of work, other forms of scientific organization. It turned out that neither the Academic Council nor the Academies could [...] take on such a responsibility. […] On the other hand, our Academy attempted to broaden [...] its activities by creating a number of research centers [...] However, what did the progression of our lives reveal? It emphasized the importance of distinguishing between the top institutes and Academies […] and now the question remains: what role should the Academy play in the further growth of the community?" [Stanković according to Godišnjak SAN [1957]1958: 209-211].

Regarding Stanković's question, the 1959 Yearbook provides insight into SAN's tasks. It was stated that the basic tasks of this scientific institution, as prescribed by the Law on SAN of 1947, had already been completed and that it was necessary to "extend them from the scope of the tasks of one scientific institution to the domain of scientific research activities of the entire country" (Godišnjak SAN [1959]1960: 114). This meant that SAN should collaborate with universities and other scientific organizations. This way, it would be possible to harmonize scientific activity and ensure scientific connections, creating the circumstances for "harmonizing activities related to observing, studying, and solving current scientific and professional problems" (Godišnjak SAN [1959]1960: 114). In the 1960 Yearbook, there was also a discussion of the new SAN Law of 1960, which gave these insights their due. When it comes to academy institutes, under the new legal laws, the established base "for the work of independent scientific institutes" (Godišnjak SANU [1960]1962: 155) allowed for the "merger of existing scientific institutes" (Godišnjak SANU [1960]1962: 155). In connection with the reorganization of the institutes, it was also agreed "that the Academy's previous institutes be reorganized to be independent, with the founders being the Executive Council of the People's Republic of Serbia, the Serbian Academy of Sciences and Arts, and the University" (Godišnjak SANU [1960]1962: 155). In accordance with these developments, the 1961 SAN Yearbook noted that the institute's reorganization had been accomplished effectively and that the academy could now focus on scientific departments (Godišnjak SANU [1961] 1963: 128). In the 1962 Yearbook, it was stated that some institutes, despite their independence, remained in the SANU building while also sharing a number of common interests with SANU, in addition to the fact that the Academy was their co-founder. However, "[d]uring 1962, the independent institutes took over the personnel service, while sharing the financial service and some parts of the material supply, which was under the care of the Academy's Accounting Department" (Godišnjak SANU [1962]1964: 271-272).

This socioeconomic transformation of the Yugoslav system brought about changes in the financing of scientific research. "[F]ollowing the enactment of the Federal Law on the Organization of Scientific Work in 1957 and the establishment of the Federal, Republic, and Provincial Funds for Scientific Work, the process of establishing a more direct relationship between science and the users of its services began" (Blagojević 1982: 316). Although scientific activity was still government-

funded, science began to be supported "through special social funds or direct contracting with economic entities and other users" (Blagojević 1982: 316). In other words, novel socio-economic tendencies arose within Yugoslavia, with further integration into the market economy, which in turn influenced science, bringing about changes in terms of financing that were in line with the economic turn (Korolija 2023).

Moreover, these tendencies led to the weakening of centralization in scientific organization. A good example of this was the substantially reduced role of the Council of the Academies of Sciences in the management and supervision of scientific activity. At the meeting of the delegates of Yugoslav Academies in 1959, it was decided that the Yugoslav Council of Academies would terminate its role as the leader and supervisor of scientific and artistic work in the country, and cease being the advisor to the federal government regarding scientific issues. This meant that the Council lost its position[32] defined by the above-mentioned founding meeting. Thus, the Council was left with the role of a representative at international events and loose coordination between the Yugoslav republics' academies, which were to an overwhelming degree also responsible for their own funding. At this meeting, it was decided that for the financing of scientific activities, the Council must address the federal council in charge of scientific work. Hence, the federal budget would cease to directly finance scientific activities (a reversal of the decision previously made at the founding meeting of the Council in 1948), shifting the financial burden to the republics' Academies (Korolija 2017: 1167-1168; Meeting of the delegates of Yugoslav republics' academies in 1959).

> "Each of the academies contributes funding to the maintenance and administration of the Council of the Academy of Sciences of FPRY (0.5 percent of their budget each). Federal authorities will also set aside funding for the Council's maintenance (1/4)" [Meeting of the delegates of Yugoslav republics' academies in 1959].

One of the consequences of taking power from the Council and stripping it of its primary functions by decreasing its range of tasks and subjecting it to a certain position was partly decentralization of the very scientific activities. This is a good example of how changes in the economic base are reflected in science. However, in order for this to happen at all, there had to be ideological and political changes and decisions. Accordingly, it is necessary to recall Kidrič's position (which was expressed in the part of the text in which the establishment of the Yugoslav socialist system after Second World War is presented) on the necessity of harmony between the base and the superstructure, that is, in the specific case of the political, ideological and economic spheres. Nevertheless, after the break with the USSR, changes in the base, which were dictated by further and greater integration into the international capitalist order, are inseparable from changes in the structure and ideology of Yugoslavia. The cancellation of a planned economy and the introduction of a market economy brought along changes in science politics as well. The idea of more autonomous science was propagated (Korolija 2023). That being the deviation from the principle of Soviet science can be found in the position presented in the publication we mentioned earlier:

> "Soviet science ... it embarked on a broad path, created the necessary material basis in the form of hundreds and thousands of scientific research institutes and laboratories, and established a close, direct connection with practice, which fertilized the development of theoretical thought" [Komsomol i nauka 1947: 4].

On the basis of the effects of socioeconomic changes in scientific sphere, in terms of organization, one may notice that in the case of Yugoslav science the process of decentralization in organizational sphere have matched the new impulses of deregulation in economic sphere. Decentralization, which was not necessarily opposed to socialist theoretical principles (see e.g., Supek, 1971; Kardelj 1977),

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[32] Position that was established based on the model of the Academy of Sciences in the Soviet Union.

nor to the values of Western science, was related here to the introduction of economic deregulation. In this way, science in Yugoslavia, in a structural sense, due to the geopolitical shift in Yugoslavia in 1948, serves as an illustration of the socialist adaptation to geo-political and socio-economic socio-political processes, which aligned more with Western Bloc values during the Cold War era.

Change in the Official Discourse of Yugoslav Science

Geopolitical and societal dynamics after the break with the USSR also influenced the nature of the dominant scientific discourse in Yugoslavia, which was mainly defined by the Cold War context. The concept of more autonomous science was propagated on a theoretical level (Ristić 2013), which marked a departure from the thereto-dominant view that science must be closely related to the realities of society. Structural changes in Yugoslavia's economy were brought about by request from the West (Bogetić 2000: 14, 90)[33], in the context of weakening the planned economy and introducing a market economy (Korolija 2023).

These correlated with changes in certain aspects of science. At first, these changes were structurally relatively subtle and occurred at a slower pace. However, in the speeches of Yugoslav party officials and ideologues, these changes were considerably more explicit and could be detected shortly after the break with the USSR. This was evidenced by the party's dissatisfaction with Yugoslav (scientific) publications, due to the inclusion of translations of articles authored in Russian, etc. In accordance with new political changes that took place in 1948, journals had to be directed toward a more local perspective (Duančić 2019: 69).

At the second plenum of the Central Committee of the Communist Party of Yugoslavia (CPY) held at the beginning of 1949, important party official and ideologist Milovan Đilas underlined in the discussion that "old clichés and formulas" should be abolished and that copying the experiences of others should forever be abandoned, as this leads to "narrowing the horizons of our cadres" and to a "dogmatic approach" to the problems (Dimić 1988: 240). Đilas highlighted this in the context of neglected domestic experience, for which he blamed the USSR. Based on the following words and the remainder of the text, his criticism is clearly a particularist criticism of the Soviet understanding of internationalism from the perspective referred to in the text as "domestic experience," "our construction of socialism," etc.

> "The issue of processing domestic experiences appears to have been overlooked at all of our party schools, some more than others... It is an urgent task for all higher party forums and their bodies to begin working on the correct interpretation and generalization of those experiences, to oppose any neglect of them, *and any declaration of practical experiences and organizational forms of other countries as eternally valid theoretical laws and principles of Marxism-Leninism*" [Đilas [1949]1985: 191-192, *italics added*].

Furthermore, Đilas accuses the USSR of nationalistic tendencies, interpreting the Informbiro's claim of nationalism as a projection of the USSR. He claims that critics of the CPY in general, and especially those from the USSR, "overlook everything new that has appeared... and convulsively defend the *old, surviving formulas*, thereby falling [...] into revisionism [...] whose strongest offshoot is nationalism, for which the CPY is neither guilty nor responsible" (Đilas [1949]1985: 180, *italis added*). Several pages later, after accusing intellectuals-Stalinists in the FPRY of objectivism and of distancing themselves from its own people, Đilas criticizes the idea of people fleeing Yugoslavia for other socialist countries. "For example, they [intellectuals-Stalinists] argue that those fleeing Yugoslavia to

[33] For more detail about the effects of the Yugoslav economic reform after the break with the USSR from a Western perspective see: CIA report (1967). *The Fiat-Soviet Auto Plant and Communist Economic Reforms, The Yugoslav Economic Reform*, pp. 43-47.

socialist nations are not traitors to socialism since they are fleeing to communist countries rather than imperialist countries. Such a theory obviously means agitation for disintegration in the Party, for anarchy within *our* socialist construction" (Đilas [1949]1985: 182, *italics added*). However, the emergence of such demands, which at that time already hinted at a new direction in cultural policy, was not included in the Resolution of the Second Plenum, and it would thus be wrong to conclude that a new ideological orientation in cultural policy was fully proclaimed at this plenum (Dimić 1988: 240).

At the Third Plenum of the Central Committee of CPY held at the end of 1949, the Party's leadership demanded that in ideological and scientific activity, focus be placed on the study of the so-called Yugoslav experience. This was accompanied by a softer stance on the part of the Party leadership toward academic workers, subjects of "bourgeois" ideology, who, before the break with the USSR, were seen as a major problem and obstacle to the construction of socialism. Such an approach now became "sectarian" (Petranović 1988: 319). In this context, Milovan Đilas, asserted that it was "necessary to vigorously suppress the wrong, sectarian attitude toward old experts and old scientific and teaching staff" (Đilas [1949]1985: 312). At issue was a certain weakening of the idea of philosophical struggle understood necessarily as class struggle in theory by Marxists-Leninists (see e.g., Lenin ([1909]1977). In the same speech, Đilas criticized the USSR's administrative apparatus, as well as the exaggerated planning in education and science (Đilas [1949]1985: 288-289).

He argues that "the human consciousness cannot be changed through administrative measures, nor can it be 'planned' with deadlines [...] The administrative apparatus in socialism cannot appropriate an ideological monopoly without violating the principles of socialist democracy, without restraining the initiative of the masses and limiting the scope of a healthy and ideological struggle between the old, the surviving, and the new, which is born on the basis of the further development of productive forces and new social relations" [Djilas [1949]1985: 288-289].

That all this was said in the context of deviating from the prevailing Soviet line in science and education, is further attested by his criticism of education in the FPRY in connection with textbooks:

> "The fundamental shortcoming of our teaching plans, however, is not them [teaching plans], but the textbooks that should be used to carry out the program... I would like to focus on what is most important: our textbooks, particularly those in the social sciences, *are simply translated from Russian, and they contain not only major general ideological flaws but also an incorrect, unscientific, underestimating treatment of not only other peoples but also of our own national history*. That is why it is critical to mobilize all available resources to create *our own – if not all, then the majority – original textbooks for the social sciences* as quickly as possible, even if they initially have small flaws" [Đilas [1949]1985: 300, *italics added*].

The very idea that glorifying one's own particular experience (see e.g., Ignjatović and Stojiljković 2024: 183), which was until recently a part of the Eastern Bloc, in which the experience of the Soviet Union was glorified, and whose lessons were now seen as suffering from "ideological weakness" and "unscientificness," speaks of a departure from the Soviet line in this field as well. It is also interesting that, although the Council for Science and Culture of the Government of the FPRY[34] has primarily written documents in the languages of Yugoslav peoples (Hofman, 2006: 26), when it came to foreign languages, the "[d]ominant ones were English, French, and German, and some documents were also written in Italian and Spanish" (Hofman 2006: 26). As a result, the Russian language, the dominant

[34] The Council for Science and Culture of the Government of the FPRY was established on May 24, 1950, by decree of the Government of the Federal Republic of Yugoslavia, with the aim of managing the affairs of education, science, and culture under the jurisdiction of the federal administration, as well as coordinating the work of republican bodies responsible for the same affairs (Hofman 2006: 22).

language of the USSR until its disintegration, lost its primacy overnight in the FPRY's scientific and cultural areas.

In this sense, it is worth mentioning details from the Report on the Second Congress of the International Association for Political Science in Hague (1952), published by the Academic Council of the FPRY (1952):

> "The characteristic of this Congress, as well as the entire International Association for Political Science, is *tolerance toward all scientific viewpoints and democratic aspirations*, although metaphysical viewpoints continue to prevail among the majority of the Association's members, and even skeptical attitudes regarding the possibility of scientific treatment of political institutions and problems" [Akademski Savet FNRJ 1952: 17, *italic added*].

Given that scientific partisanship entails an ideological fight in the field of science, this is a deviation from the Leninist concept on a practical level, and in the framework of an ideological struggle, one could say *a change in the strategy of the struggle with the ideological enemy*.

The insistence on weakening centralization and other elements of the Marxist-Leninist ideological line in science was also reflected in Đilas's view of the role of the Ministry of Science and Culture (MSC)[35] and the Committees for Science and Culture. According to him, "[t]he Ministry of Science and Culture should limit its activities to solely federal educational, cultural, and scientific matters and the appropriate federal institutions" (Đilas [1949]1985: 308), In other words, Đilas was in favor of ridding the MSC of the role of "administrative and bureaucratic leadership." Đilas believed that this would help the development of science and culture by "reducing bureaucratization." He also criticizes committees as becoming "onerous bureaucratic structures with a branching apparatus" (Đilas [1949]1985: 309), despite being originally envisaged as "small units with the purpose of resolving basic, philosophical, organizational, and other concerns" (Đilas [1949]1985: 308). According to Đilas, it was important to deprive them of their functions and reduce them "to the tasks that were intended for them" (Đilas [1949]1985: 309). Đilas believed that reducing bureaucracy could aid in the advancement of science and culture. This also applied to rectorates:

> "Rectorates have also evolved into onerous administrative structures. We believe that the center of labor, whether organizational, educational, or ideological, should be situated where life itself occurs, where problems emerge and mature. And these are not rectorates, but rather faculties and higher education institutions. The focus of organizational and other activities should thus be in deaneries, not rectorates" [Đilas [1949]1985: 309].

It is interesting to note that in this (above) stated tendency to oppose the Soviet organizational model, more precisely the principle of centralization, it is also possible to see the idea of organizational decentralization. It is also possible to ask the question whether this tendency is the root of today's autonomous status of the faculties in Serbia - a relatively unusual status if viewed on a global scale.

The Third Plenum of the Central Committee of CPY marked an undeniable formal ideological break with the cultural model of the USSR (Dimić 1988: 241-245). Thus, in the eyes of Yugoslav authorities, the organizational model of the USSR went from being the most efficient organizational model to the most ineffective one shortly after the break.

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[35] For more on the MSC see Bondžić, D. (2004). *Beogradski univerzitet 1944-1952*. Beograd: Institut za savremenu istoriju (ISI), pp. 144-148.

That same year (1949), a party official and key Yugoslav ideologist Edvard Kardelj (in his acceptance speech to the Slovenian Academy of Sciences) talked about the "anti-scientific" tendencies of the USSR, which "turned science into bureaucracy lackeys" (Kardelj 1950: 4).

> "Today, under the constraint of Soviet practice, this science has reached a point of stagnation in which all imaginable anti-dialectical and anti-scientific tendencies emerge. [...] In such conditions, theory, that is, science, is no longer the tool that should support practice in discovering the proper road, while also correcting and completing the product of that practice, but rather becomes an *unprincipled lackey of practical bureaucracy*" [Kardelj 1950: 4-5, *italic added*].

Such criticism of Soviet bureaucracy (and its attitude towards science) was characteristic not only of the opposing camp during the Cold War (e.g., Polanyi's criticism) but also of political organizations whose criticism of Stalin's regime remained affirmative of Lenin's teachings (e.g., Trotskyist organizations). In accordance with this, it seems that changes within socialist Yugoslav science, especially in the context of the critique of the USSR, represent an attempt to overcome what was often emphasized as one of the main negative aspects of Soviet science, which prevents its scientific development – the extremely bureaucratic system of USSR (Korolija 2023).

Bošković (1981) noted that Kardelj declared science to be autonomous from the state apparatus. This is particularly evident in Kardelj's words that "true science in our country cannot serve anybody or anything other than truth and progress, and such a role of science is especially useful for our people's, socialist state" (Kardelj 1950: 6). Kardelj's speech represents a negation of Soviet science in stating that:

> "[W]e can talk about partisanship in science only in the sense of its social, class determination of human knowledge. In contrast to that, however, the creators of the pragmatist concept of 'partisanship' declare as truth all that in their short-sightedness they consider useful for a certain political tactic and socio-economic practice, while in reality they are confusing their desires and needs for objective truth" [Kardelj 1950: 4].

In other words, Kardelj (1950) rejected partisanship in science as a perspective in which science is part of the "state apparatus." Accordingly, Bošković (1981) wondered whether Kardelj "*generally rejected the concept of partisanship* by specifying the conditionality of knowledge in this way" (Bošković 1981: 3).

> "Kardelj denounced partisanship in science, which announces as true only what benefits 'certain political tactics and social-economic practices', and emphasized the importance of the criterion of objective truth in research. Is such an announcement a sufficient guarantee of the existence of such cognitive value in science? It is a necessary but not sufficient requirement, which is why Kardelj attempted to demonstrate, through criticism of the Soviet experience, what mistakes should be avoided in scientific advancement. The conclusion that 'our science undoubtedly serves and must serve the people and their social and economic progress', taken cumo grano salis, certainly does not reflect a need for 'partisanship' in science" [Bošković 1981: 3].

Kardelj criticized the cult of Soviet science (in the first place Soviet social science), which he referred to in his speech as the "theory of Soviet science's leading role". In this regard, he stated as early as 1949 that "recently, some people have crossed the threshold of ridiculous trying to justify that role" (Kardelj 1950: 5). Kardelj went on to elaborate (1950) on his remark by claiming that the authors of this theory do not present concrete results of Soviet (social) science, but only refer to "some kind of right of inheritance," by which he means "that only the leading cadres of the USSR are able to provide for the whole world the final and conclusive determinations of certain social phenomena, anywhere on the globe" (Kardelj 1950: 5).

> "As soon as Soviet sages stated, for example, that there is no socialism in Yugoslavia, it simply does not exist in the opinion of Soviet scientists, regardless of objective facts. The entire Soviet social science – instead of evaluating actual facts about the country – was preoccupied with scholastic collecting citational 'evidence' that Yugoslavia did not have socialism. It is a stark illustration of where the present neopragmatist stream of Soviet science is going" [Kardelj 1950: 5].

At the same time, Kardelj's speech declared that the road to freedom of intellectual creativity was paved in Yugoslavia: This marked the beginning of a new relationship between science and creativity in Yugoslavia in general (Dimić 1988: 255; Kašić 1989: 210). A segment of Kardelj's speach which proclaims freedom of science and illustrates that shift states:

> "We feel that our scientific workers must be free in their work. Particularly because without differing opinions, scientific discussion, critique, and verification of theoretical positions in practice, there will be no progress, nor will there be a successful struggle against reactionary concepts and dogmatism in science. Our scientists must address scientific issues courageously and without awe in the face of petrified dogmas" [Kardelj [1949]1950: 6].

The contribution to the shift of scientific discourse in Yugoslavia can also be seen in the text *Addition to the major annual meeting of the "Association of University and College Teachers"*[36] (1951), published by the Zagreb University Gazette. Examining the new decisions related to the work of this society in the future, as well as analyzing its work thus far, it was concluded that the professional sections had proven to be the most successful when it came to "the correct adoption of various forms of social activity as necessary and useful, and not only as some empty forms, fruitless meetings, or other 'formal' duties" (Sveučilišni list 1951: 1) As a result, the text mandates, among other things, "the fight for the purity of science" as the path in which progress must be made.

> "In this view, it is noteworthy that the expert sections – which knew how to structure their work in such a way that the problems discussed at meetings were truly the problems that their members were interested in – achieved the most success in their work. Avoiding so-called double tracks (e.g., processing of the same problems within non-faculty professional associations and professional sections in the Society, etc.) and putting in the center of the work those problems that are fundamentally related to the specific issues of teaching a certain profession, i.e., *with the issues of purifying concepts and scientific methodology, the fight for the purity of science against revisionism and reactionary positions*, was a path on which the membership could be successfully gathered" [Sveučilišni list 1951: 1, *italic added*].

The freedom of scientific creativity in Yugoslavia, proclaimed after the break with the USSR, was a result of the country's political choices and decisions. Similar observations were made regarding American scientific freedom during the Cold War, which "had to be constructed and maintained through a series of political choices" (Wolfe 2018: 2). It is important to observe how, when viewing Kardelj's speech as a whole and in light of the break between the FPRY and the USSR, one gets the idea that scientific innovation was independent of political processes in the FPRY. However, the freedom declared following the breakup with the USSR is a direct result of the FPRY's political processes, whereas its social role, which Kardelj discusses is reflected in the fact that it represents more of a sphere in which the Yugoslav leadership's political showdown with the Soviet Union occurs, that is, self-managing socialism versus Soviet socialism. The fact that it is an introduction speech to the Academy of Sciences and Arts, published in the scientific magazine *Science and Nature* in 1950, and that it is full of ideological clashes with the USSR, lends credence to this claim. If this is true, we must consider if and to what extent scientific freedom was implemented in practice, as well as what it meant in that setting. After all, aren't contemporary historians of science, such as Audra Wolfe (2018), indicating that "autonomous science" in the West, during the Cold War, played

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36 *Uz glavnu godišnju skupštinu "Društva nastavnika sveučilišta i visokih škola"*

a role similar to what we perceive the role of "relatively autonomous science" was in the FPRY after 1948? However, we must also not forget that in the setting of the Soviet Union, science, particularly social science, was vulnerable to Party pressure, as proven by the history of science in the USSR.

In this sense, when analyzing the nature of science in Yugoslavia, it is necessary, at least roughly, to contextualize the aforementioned processes of shaping Yugoslav science towards greater autonomy after the break with the USSR, while keeping in mind that the entanglement of politics and science is a feature of the Cold War in general (see Solovey 2001; Oreskes and Krige 2014; Aronova and Turchetti 2016), and not unique to socialist systems. The proclaimed change in the social position of science that Kardelj announced is Titoist, i.e., an ideological break in the sphere where a political showdown between Yugoslav leadership and the USSR was taking place. The "official line" character of this anti-Soviet speech was evident, as it was published in multiple places, including the scientific journal *Science and Nature* in 1950 (Korolija 2023).

Đilas (1951) continued to criticize the ideology of the USSR while advocating for "socialist democracy," which he primarily opposed to "bureaucraticism." He compared Soviet ideology to dogmatism, emphasizing its lack of scientific and dialectical rigor, and argued that its subjects are "those who learned Marxism from Stalin rather than [learning about] the process of transforming reality from Marx himself..." (Đilas 1951:6). Moreover, he appeared to believe that scientists in Yugoslavia do not need to be Marxists, because science is a progressive social force in and of itself thanks to the unrestrained materialism, even when scientists:

> "know nothing about Marx, nothing about dialectics, nor are they even willing to completely abide by quotations as such. Moreover, in the fight against religion, mysticism, idealism, vulgarity, non-science [...] they are our allies in action! But not allies in the usual, political sense. For, we will win even without these allies. It's not about that! It is simply about an easier or a more difficult victory, and essentially: about the development of science, breaking down all of those barriers that impede or may impede its development, which for us in a concrete situation is identical to inhibiting the development of socialism" [Đilas 1951: 14 -15].

Marx and Engels, as well as Lenin, criticized this particular view of scientists and science as inconsistently materialistic and non-dialectical, claiming that such a position eventually leads to a politically reactionary, i.e., idealist philosophical camp (Marx [1846]1969; Engels [1877]1947; Lenin [1909]1977). Prior to the Second World War, it was precisely the CPY that criticized heterodox scientists and philosophers who considered themselves Marxist-Leninists and expressed views in a similar spirit, deeming them to be revisionists (Kovačević 1989).

Later in the text, Đilas points out that true cultural and scientific "communist workers" in Yugoslavia are obliged to fight for their people side by side with the Party, for moral reasons because "moral obligations are stronger and more difficult than all others" (Djilas 1951: 11), and not because the Party (as in the USSR) demands it. As he himself says: "Our Party never dictated what or how people should create" (Djilas 1951: 10).

The LCY (League of Communists of Yugoslavia) Program from 1952 provides some confirmation that Dilas' ideas of partisanship were nothing more than a facade for, in some aspects, a more liberal view of scientific creativity than the "socialist democracy" of Yugoslav society implied:

> "A socialist society must, and is the only one that can, *fully unleash the creative forces in science and allow scientific workers to freely develop their abilities* in discovering the laws and forms of movement of nature and society, in order to harmonize the subjective activity of social forces with objective movement..." [SKJ 1952: 370, *italic added*].

At the Fourth Congress of the People's Front of Yugoslavia in 1953, which changed its name to the Socialist Alliance of Working People of Yugoslavia (SSRNJ), Edvard Kardelj sharply criticized and rejected the monopoly of the state as a method by which Stalin solved the management of fields such as science, because "it produces the faint-hearted, brings mediocrity to responsible positions, and stifles scientific and every advanced thought" (Kardelj 1953: 224). This criticism is consistent with Kardelj's support for the independence of scientific and artistic innovation, as well as important internal changes in social development, such as the decentralization of economic administration and the implementation of worker and societal self-management (see e.g., Kardelj 1977).

Issue no. 10 of the journal *Science and Nature* (1949) featured a speech by renowned Yugoslav communist and the Minister of Science, Rodoljub Čolaković, delivered at the First Congress of Yugoslav Mathematicians and Physicists, at the time when the break with the USSR began to be felt in all areas. In contrast to its former unity with the USSR, socialist Yugoslavia now displayed a distinctively unique interest in "our way of building socialism" (Čolaković 1949: 574).

> "In addition to the typical challenges of socialist development, we must face the problems caused by the USSR's discriminatory policies toward socialist Yugoslavia and countries of people's democracy. The Information Bureau's liars and slanderers, who claim to wish to make *our country* happy using *their own recipe*, have become *direct adversaries of our country and its socialist creation*" [Čolaković 1949: 574, *italic added*].

Despite Čolaković's emphasis on the role of science in building a socialist society and his insistence on the connection between science and practice, his views on science, such as the one that "major scientific and cultural issues cannot be solved by any administrative measures" (Čolaković 1949: 573), demonstrate the abandoning of the ideas of Soviet science and an orientation toward greater autonomy in science.

> "*Major scientific and cultural concerns cannot be handled through administrative measures*: no 'think tank' can approve one solution over another. Our country wants and can, and does so with open arms, to create conditions for scientific work, to materially support its organization, to create a material base; however, it is up to you, comrades, workers of science and culture, to initiate a discussion on a number of issues concerning our science and culture, *to discuss them freely*, and to arrive at a solution for which our social practice will be the ultimate judge. We want as much initiative and boldness as possible in this sense, as much creative work as possible from all of you, since we believe that by going that way, we will achieve the best results" [Čolaković 1949: 573, *italic added*]

As for the journal *Science and Nature*, one could clearly see in the letter by the editorial staff to readers in 1954 that it was subject to ideological change. In the address, the role of science in building society is no longer stressed, with the propagation and popularization of natural sciences becoming the journal's only task. In the same year, the journal became an organ of various scientific societies, "independently published and distributed...", while the new editorial board was made up of these societies' members (Editorial staff 1954: 50).

However, in an announcement made in 1959 (multi-issue volume 1-10), the journal's editorial board informed its readers and subscribers (from whom the publication partially funded itself) that the journal, "due to the reduction of subsidies after 1956 and their subsequent complete removal, had to be published irregularly at first, before temporarily ceasing publishing…" This occurred precisely during the aforementioned processes of decentralization in the model of scientific organization and increased autonomy in financing, and after the state loosened control over the economy. These types of difficulties often revealed systemic problems with the Yugoslav form of socialist self-management.

According to Rudi Supek (1971), a Yugoslav Praxis[37] theorist, the issue was not decentralization as such, but rather an unrestrained market economy, which only intensified class tensions in society, created an insufficiently functional economy, etc. In other words, according to Supek (1971), not only was there a weakening of the "centralized administrative planned economy in Yugoslavia but also of every *development planning concept* (regardless of whether it was implemented 'from above' or 'from below'" (Supek 1971: 354).

Novel Yugoslav Approach to Science

In 1952, the journal *Pogledi* (*Views*) was launched "to meet the need to address issues in social and natural sciences, particularly those that affect the creation of a complete scientific worldview and the building of socialist culture more directly" (Editorial staff 1952: 1). The journal incorporated and promoted a Marxist humanist approach to scientific and philosophical issues. Criticizing the "phenomenological and positivist interpretation of reality" as well as the "purely pragmatist attitude to truth, morality, and individual freedom," (Editorial staff 1952: 1-2), the editorial staff concluded that these were negative tendencies, corresponding only to "undemocratic and inhumane social practices" and appearing not only in the context of "decadent bourgeois philosophy but also in Soviet revisionism of Marxism" (Editorial staff 1952: 1-2).

In contrast to the "authoritarian" and "ideologically discriminatory" approach, the journal's editorial staff promoted "open dialogue" and "battle of ideas." The fact that this approach to scientific issues was essentially consistent with the new official state line was demonstrated by the Resolution of the Sixth Congress of CPY, which was also reported on in *Views*, owing to its relevance for schools and scientific institutions: "The Congress also points out that preventing a clash of opinions could only hinder the development of science and culture" (Editorial staff 1952: 65). Another issue of the journal confirmed that "there is no doubt that our entire social development, and thus activities at the highest scientific research and teaching institutions, is heading toward greater autonomy..." (Editorial staff 1953: 285).

An example of the continuation of this process in Yugoslavia in social sciences was the establishment of the Sociology Group at the Faculty of Philosophy in Belgrade in 1959, as this department was frequently marked by tensions with "dogmatic Marxism," for which sociology was often viewed as a "bourgeois" and reactionary discipline (Bogdanović 1990: 23). Another similar case was that of sociology in the USSR, where the situation began to change after Stalin's death (Weinberg 1974; Osipov 2009). It is interesting to note that since 1949 there has been a sudden increase in the number of published philosophical works in Yugoslavia, as well as the beginning of the institutional organization of philosophers (Marković 1996: 360).

In accordance with these ideological conditions in scientific and cultural spheres, it is useful to consider the case of psychoanalysis too, which "generally speaking [...] did not fare well in most of the Marxist-Leninist world" for historical as well as ideological reasons (Savelli 2013: 262). Moreover, "Western radical and politically engaged psychoanalysis generally existed on the social and political margins" (Antic 2022: 7-8). However, Savelli (2013) points out that psychoanalysis in Yugoslavia, in which there was greater intellectual freedom than in the rest of Eastern Europe, despite all obstacles that it encountered, nevertheless managed to inform the psychiatric practice to a larger extent (for example in relation to social problems of alcoholism and suicide). Regarding the examination of the specificity of Yugoslav psychiatry as related to East-West division, it is worth mentioning that it was the profession which incorporated the influence of Marxism, that is Communist

[37] *Praxis* was a Marxist humanist journal (1964-1974) and dissident circle of philosophers and social scientists in Yugoslavia.

ideology, there occurred a partial Westernization too, and in the following years, there were also some anti-colonial tendencies – as such, it also had an active role in these processes (Antic 2022). On the other hand, an important aspect of it, which was also very noticeable, was the aspiration to actively participate in modernization processes both of its own profession and of society in general, with the aim of revolutionizing the consciousness of individuals, but also of the family and social relationships in general within Yugoslav society, and in a wider sense to act in the direction of progressive, humanistic, creative values (Antic 2022).

The specificity of Yugoslav science, initiated by the break-up with the USSR and by the initial firm turn towards the West, is also well attested by the case of Yugoslav biology. Before the breakup, Yugoslav biology, following its role model the USSR, tended to conform itself to Michurin's biology, that is Lysenko's doctrine. However, due to the change of geo-political circumstances in 1948, the process of de-Stalinization in Yugoslav biology began (Marković 1996: 347-355; Duančić 2020). The particularity of this process may be seen in the fact that Yugoslav Michurinists had opted not to reject Michurinist biology, labeling it as Stalinist deviation, but "carefully weighed its political and ideological implications, trying to negotiate the Stalinist origins of Michurinist biology with political and ideological reconfiguration in post-Stalinist Yugoslavia" (Duančić 2020: 159). As a result, in the early 1950s, initiatives were made in the Yugoslav scientific community to defend Michurin's biology against both formal genetics and Stalinism, with a concentration on attacking the Soviet bureaucracy (Duančić 2020: 159). Certain scientists, in the context of specific ideological shifts of the then LCY, strove to mold this topic appropriately (e.g., Milorad Piper 1950). However, this particular approach gained little traction, even though it could have been utilized as a tool in the struggle against Stalin (Duančić 2020).

> "Piper proved to be skilled in reading the signs of changing times. His solution to the problem of what to do with Michurinist biology in anti-Stalinist Yugoslavia fit perfectly with the contemporary political-ideological reconfigurations of the CPY and the modifications to science policy implemented in the aftermath of the Soviet–Yugoslav split. [But] most *mičurinci* resorted to simpler reasoning. They believed their subscription to Michurinist biology was in accordance with the party line because the CPY supported progressive, dialectical materialist science, and that was precisely what Michurinist biology was" [Duančić 2020: 181].

Although Yugoslav scientists more inclined toward Michurinist biology successfully promoted Michurianism among younger agronomists, students, biology teachers, it encountered significant resistance from higher ranks in academia (Duančić 2020). The strategy that proved more successful in changing scientific policy in relation to this topic linked Michurinist biology to Stalinism, separating it from socialism. They claimed it lacked scientific validity, was unrelated to socialism, and was only present because of Stalinism (Duančić 2020). Mirko Korić, a renowned agronomist who pioneered genetic research in agriculture in Yugoslavia, was assigned this task.

> "And it is not surprising that, when Korić used the term lisenkizam in a critical sense, the term did not entail anti-communist connotations or the critique of state control over science, as it did in the West (deJong-Lambert and Krementsov 2012, p. 381), for the nascent Yugoslav self-management system was supposed to deliver a form of democratic spirit and freedom to science, which would still be employed in the service of building socialism in Yugoslavia. Korić was keen to emphasize that only informbirovci supported Lysenko's claims. Would not standing aside them spell treachery to the CPY? Glossing over the earlier period, Korić was grateful for the political wisdom of the CPY leadership that created a political-ideological environment in which Lysenko's doctrine could be recognized for what it was—nonsense" [Duančić 2020: 185].

As for this topic, there was no Party directive from above, but there were, besides "negotiations within a scientific community," also "negotiations of the scientific community with the party," which did not show any particular interest in that situation (Duančić 2020). During the 1950s an intensification of scientific research appeared in Yugoslavia, as well as greater possibilities for cooperation and visits

of young scientists in institutes in the West. This "proved to be more important for the withering of Michurinist biology than the Yugoslav political and ideological distancing from the Soviet Union" (Duančić 2020: 187). In this way, within the socialist system with more freedom than in the Eastern bloc, the popularization of Michurinist biology in Yugoslavia, which during the Cold War represented the first socialist state renegade from the USSR, was finished only around 1956 (Duančić 2020).

After Stalin's death, there were some improvements in the relationship between the USSR and Yugoslavia, albeit this relationship was subject to numerous changes in the years and decades to follow. However, despite the USSR's desire to return Yugoslavia to the "socialist camp," this did not happen (Dimić 2014: 10-19). This initial short-term normalization of the relationship between the USSR and Yugoslavia had no significant ideological consequences for the official scientific discourse in Yugoslavia, as evidenced by Tito's speech, delivered at the Seventh Congress of the LCY, in which he once again emphasized the positive effects that reduced bureaucratic interference had on scientific work (Korolija 2023).

> "The gradual liquidation of bureaucratic interference in anything and everything has liberated our scientists, artists, cultural workers, and pedagogues from former bureaucratic impediments and provided them with an opportunity for unhindered creative work" [Broz (Tito) 1958: 80].

A good indicator that science in Yugoslavia continued to open to the West was the fact that, during that time, the US Information Agency of the American Embassy in Belgrade, Yugoslavia, published the journal *Science and Technology* (1957-1958) in Serbo-Croatian. This monthly publication covered advances in American science, medicine, technology, and economy. An important factor in Yugoslavia's ideological positioning at the time was the development of the policy of *non-alignment* in which Yugoslav President Tito played a key role (Rajak 2011: 107-108).

Milentije Popović (1960) confirmed Yugoslavia's official deviation from Soviet scientific principles, claiming the impossibility of Soviet-style planning in science. Providing an example of using science to solve problems related to corn production, Popović stated:

> "Therefore, we can – and we must – use a program to direct scientific and research efforts towards solving the *corn problem*, but we cannot plan what we will, what we should (and whether we should) discover" [Popović 1960: 8].

Popović goes on to state that he aims to overcome one-sidedness and find a middle way between "free science" and "planned science" – viewpoints he believed only seem to be opposed (see Popović 1960: 9-16). He undoubtedly introduced the elements of "free science" into the Yugoslav scientific discourse, which clashed with certain aspects of the perspective of Soviet scientific activity, particularly in his emphasis on the importance of freedom of scientific work and his understanding of the nature of "pure science" (see Popović 1960: 8-9).

> "However, the so-called 'pure science' understood as the development of ideas, hypotheses, and theories, as the search for, or the discovery, of new laws, of new properties of nature (or part of nature) and society (or part of society), thus as a thinking human activity cannot be quantified, it cannot be 'planned' – simply because of the nature, the essence of the matter in question. In this sense, there must be 'freedom of scientific work' (because the nature of things is such that no one can be ordered or planned to discover new things), and 'freedom' of choosing the subject of work (also due to the nature of things), because it is about the individual's abilities and preferences. In this way, science determines its programs and tasks" [Popović 1960: 8-9].

Popović further deviated from the idea of Soviet "planned science" later in the text, when he tackled the specific problems of organizing scientific work in manufacturing, agriculture, etc., in Yugoslavia at that time, claiming that these organizational forms "cannot be predefined" (Popović 1960: 54). Not

only that but he goes a step further and introduces the idea of a market functioning of science, highlighting the possibility of independent entry into business affairs of small enterprises and research centers.

> "The development of production necessitates the establishment of relevant research centers within all production and other organizational divisions and activities … Smaller companies, which find it more difficult to establish their own special development centers, can form joint research centers or enter into a *variety of contractual arrangements* with particular centers. *It is important to understand that design alone, and the construction design department alone, are no longer sufficient for modern production*" [Popović 1960: 54, *italic added*].

Popović distinguished between two ways of financing in Yugoslavia: the first phase, characterized by full budget financing of scientific institutions, "which lasted for several years after the liberation" (Popović 1960: 56) and coincided with the period of the highly centralized model of scientific organization in Yugoslavia; and the second phase, which began after the break with the USSR and aligned the organization of science in Yugoslavia with market logic.

> "In this regard, it is planned that, in principle, scientific and research organizations be as independent in their work as economic organizations, and that the method of distribution of scientific institutions' income be aligned with the system of economic organizations, with the exception that scientific institutions will return the entire amount of contributions to their funds" [Popović 1960: 59][38]

That it is a matter of adapting to new economic structures in Yugoslavia rather than scientific principles, is also visible in the part where Popović describes the establishment of special authorizations for companies-founders of scientific institutes, such as:

> "… the right to appoint three-quarters of the scientific institution's council, half of the management board, and to choose and dismiss the scientific institution's director. Furthermore, companies, as founders of a scientific institution, approve the scientific and research work program and give permission for money to be distributed and brought into the scientific organization's funds. Finally, the company, as the founder, remains the rightful owner of the scientific institution's funds in the event of its dissolution" [Popović 1960: 61].

Nevertheless, Popović recognized that the rules governing scientific organizations do not align with the concept of "pure" science, or fundamental research, which he valued. That is why, in addition to scientific institutes' special funds for financing fundamental research, a major portion of the funds from the Federal Fund for Research Work, as well as funds established by the People's republics, were also to be utilized. Popović believed that all this was needed to achieve "freer working conditions" for scientists and eliminate "excessive practicalism and routine" (a result of bureaucracy). According to Popović, budget financing "hides the danger of introducing and deepening administrative-budgetary relations in this area of social life" (Popović 1960: 58). This suggests that self-managing socialism, the original Yugoslav creation that is truer to the original Marxism than Stalin, can only in many aspects imitate bourgeois science, which had to be wrapped in socialist wafer for ideological purposes.

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[38] With regard to these tendencies, a CIA report from the early 1970s on science in Yugoslavia is particularly revealing. We observe that the CIA noted Yugoslav propensity toward politics along the lines of Popović's ideas: "The government's policy since the 1960s has been to reduce state funding of scientific research and technical development and to increase the contribution of the end users of research and development. The goal is for research organizations to become self-supporting by independently earning and controlling their income, primarily through contracts, and by using part of the income for their own expansion and development" (CIA Report 1973: 4).

In Kardelj's acceptance speech to the Serbian Academy of Sciences and Arts, given on February 22, 1960, in which he talks about social sciences and their importance for the continuing development of a self-managed socialist society, he stressed at the very beginning that science

> "should not be a servant to a certain political practice or certain ruling ideological notion. It sets its own tasks and goals, based on the needs and tasks generated by living social praxis, current human realities, and the development of science itself" [Kardelj [1960]1981:7].

Kardelj's entire speech was riddled with references supporting the idea of free science, independent of political influences, but also a science that "must not become a mere abstraction," which is a real threat if one "loses sight of people's praxis," because "the end result of the multifaceted process of scientific research finds application in people's praxis" (Kardelj [1960]1981: 10). One gains the impression that Kardelj attempted to connect the perspectives of an autonomous and socially engaged science in his address (Korolija 2023).

> "In other words, if we stand on the principled point of view that science should be independent of current political understandings and narrowly or dogmatically understood ideological positions, then we must also protect ourselves from the danger that our specific research methodology does not become the very ideology that will lead research to the path of idle speculation and verbalism" [Kardelj [1960]1981: 10].

Looking into this connection, however, it appears that it comes down to the role of science in society being that to encourage certain institutions to carry out socially relevant research (Kardelj [1960]1981: 10), which is a practice that is also present (with some differences) in "bourgeois" societies (Korolija 2023).

> "Specifically, I would only like to plead for an even greater engagement of the Serbian Academy of Sciences and Arts in encouraging all factors in those areas of social sciences that deal or can deal with the study of contemporary social movements and relationships, to engage even more actively in setting and achieving the tasks of building and further developing socialist relations in our country, i.e. to provide the greatest possible assistance to our socialist practitioners" [Kardelj [1960]1981: 10].

One gets the idea that social sciences, by definition, are inextricably linked to social practice, even when they are not party-oriented. From the insistence on the role of science in the further development of socialist relations and assistance to socialist practice in the sociopolitical context, which is ultimately determined by the party, it can be assumed that the Yugoslav leadership has not (completely) given up partisanship. However, it is important to note that the concept itself is no longer mentioned. The following lines also indicate a similar attitude of Kardelj towards (social) science, as well as the avoidance of mentioning the concept of partisanship.

> "Therefore, no matter how harmful and unsustainable the understanding that interprets the social conditioning of science as the need for its dependence on a given political constellation – even within a socialist state – is just as unsustainable as the tendency toward the so-called 'neutralization' of social sciences. *In that field*, neutralization is nothing more than relegating science to the realm of abstract speculation and removing the goal and task of scientific study. Without such a goal and task, scientific study is blind and destined to fail" [Kardelj [1960]1981: 9, *italic added*].

Moreover, if we connect this speech by Kardelj from 1960 with the text of Milentije Popović (1959), it seems that by the further construction of society, Kardelj is primarily referring to further economic and any other liberalization, with self-managing socialism serving only a framework that needs to be filled with that content, in which social science should also help.

> "First and foremost, it is about solving the problem of harmonizing socialist relations in production with relations in distribution, economic relations between people in the enterprise and the commune, and so on, about creating such relations that will not only correspond to the achieved level of development of the productive forces but also have their own internal strength to continue to develop independently while the material base of society is strengthened, i.e. *with increasingly fewer elements of state coercion*" [Kardelj [1960]1981: 8, *italic added*].

Kardelj expressed his support for the Resolution on Scientific and Research Work, adopted in 1965 and discussed later in the text, during his presentation to the joint session of the Federal Council and the Federal Assembly's Educational and Cultural Council in October 1964. In addition, he decided to comment on the stated problem of scientific research lag, as well as on specific directions for enhancing scientific work conditions. Considering the limits of financing scientific work as a whole, "the fact that Yugoslavia is still a relatively poor country" (Kardelj [1964]1981: 14), but also the connection between the possibility of financing and the development of social productivity of work, Kardelj points out that the "problems of improving scientific and research work *today* must primarily be viewed through the prism of faster development of production forces" (Kardelj [1964]1981: 14). Accordingly, Kardelj emphasizes the necessity to reposition scientific work "in terms of its organic connection with social work in all areas of social life" (Kardelj [1964] 1981:15). Kardelj rejects the fear that science will become commercialized in this way, believing that "it is the only way to gradually free our society in that area as well from the remnants of administrative management of people" (Kardelj [1964] 1981: 15), because the administrative form of management in the scientific field "led to certain deformations that negatively affected the development of science" (Kardelj [1964]1981: 17).

Kardelj believed that, in order to overcome the problems of scientific and research work, to improve scientific development, and for science to have a progressive function in the further progress of Yugoslav society, it is necessary to enable "the greatest possible independence of both scientific institutions – based on unique socioeconomic principles – and those of social factors that are interested either in certain types of scientific research or in the development of science in general" (Kardelj [1964]1981: 18). "Our starting point should be, above all, the independence of scientific work, the independence of scientific institutions..." (Kardelj [1964]1981; 22). Kardelj ([1964] 1981) believed that scientific funding should be tailored to the interaction between science and society. To make this possible, scientific activity should be as directly tied as possible to concrete parts of the social work process, rather than relying exclusively on financial and administrative funding.

Kardelj names companies as the primary funders for scientific and research work, believing that in this way "various processes and possibilities of unifying funds, their joint use, creation of joint institutes, etc., but based on the interests of companies, will be opened" (Kardelj [1964]1981: 20). As the second funders, he mentions social services such as health and education, but claims that for them to take on the role of funding scientific and research work, as well as develop scientific work in a more direct way in relation to their own activity, they first must regulate the status of their financing, which has not been fully resolved. As for the third source of funding, Kardelj proposes academies, universities, and so on, arguing that their role in funding scientific and research activities should be expanded. Academies' funds should be allowed more independence, but not at the expense of social responsibility. He then adds that in the process of financing scientific research activities, state budgets would continue to have certain crucial financing functions.

> "Appropriate linkage and collaboration of all these components as financers [...] might produce a more stable material base for scientific and research work, while also allowing for appropriate integration of scientific/research operations on the basis of self-management" [Kardelj [1964]1981: 21].

Kardelj also addressed the problem of fundamental research during his lecture. In his view, there can be no applied science without fundamental research, which is critical for the overall functioning of

modern civilizations. “If we only apply other people’s scientific results, we will always trot far behind the rest of the world” (Kardelj [1964]1981: 19). According to Kardelj, funding for fundamental research should continue to be included in the budget, but additional methods of financing this type of scientific activity should also be explored.

> “Some institutes, for example, are funded solely on the basis of specific services they provide to companies; nevertheless, according to the contract with service users, a set amount of the resources remains entirely at the institute’s disposal – specifically for fundamental research. Other institutes are again financed through a combination of the direct participation of society, i.e. states, and directly interested organizations. I think that we could also find similar forms of funding that would enable universities and other scientific research organizations to have funds for fundamental research” [Kardelj [1964]1981: 19].

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In the context of two dominant ideological views on science during the Cold War, we examined changes in Yugoslav science after the county’s break with the USSR, in terms of the organizational model, financing, and scientific discourse. Through comparison of the governing standpoints on science in Yugoslavia prior to the Tito-Stalin split in 1948 and following this event, we showed the compatibility of these changes with certain aspects of the perspective of science as autonomous and apolitical. Market forces and their control, as well as (de)centralization, (de)bureaucratization, and changes in the international position of Yugoslavia in the Cold War context proved to be elements of particular importance in this analysis. Understanding their relation to Yugoslav science allows us not only to position it more clearly during the Cold War, but also to better comprehend the nature of the ideological framework that supported various dynamics of de-Stalinization of specific scientific issues in Yugoslavia.[39] These elements are still structurally and politically relevant; they underscore the relevance of science as an activity woven into social processes. Accordingly, these insights could be useful for a better understanding of the present-day dynamics between science and society (Korolija 2023).

By contextualizing the nature of these changes in Yugoslav science, while presenting the dominant ideological views on science during the Cold War and considering how both sides deviated from their proclaimed principles, the question arises as to what these changes can tell us about the nature and role of “autonomous” and “partisan” perspectives of science during this period? Bearing in mind the importance of the Yugoslav geopolitical shift for the issues dealt with in this work, it seems that for a more complete insight into the nature and roles of these views it is necessary to approach them in the context of the struggle for ideological hegemony during the Cold War. Judging by the examples provided by Yugoslav science in this era, the analysis is incomplete without considering the socio-economic changes and contradictions of the society in question. For Yugoslavia, this was embedded in the case of a socialist country that after 1948 turned to the Western Bloc. These unusual Cold War circumstances made Yugoslav science in this period an interesting case for research (Korolija 2023).

It is evident that the earlier simplified ideas of science in the West and the East are mostly mundane today (Kojevnikov 2004: 46; Aronova 2011: 198-199), and that science in both blocs was politicized. However, this work suggests that it is possible to observe some objective changes in terms of the scientific organization model and financing, as well as in the official and dominant discourse of Yugoslav science, which were caused by the shift toward the West. Perhaps a more thorough analysis of the practical and cultural factors that influenced certain aspects of science in Yugoslavia would allow us to draw a more comprehensive picture of the relationship between science and ideology in the Cold War? This would require expanding this research with additional and more detailed examples of concrete scientific practice. In this regard, in the future, we see the need for further research into the roles and positions of science that are not limited to the Cold War’s major actors. I believe that the specificities of certain (semi)peripheral societies’ experiences during this period would be fruitful to gain novel insight into this subject (Korolija 2023).

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[39] e.g., de-Stalinization of biology (Duančić 2020)

History of the Use of Nuclear Energy: The Path to the Nuclear Bomb in the Second World War

Mathematician and philosopher Alfred North Whitehead was not alone in believing that physics in the late 19th century would continue to be based on the mechanical view of the world, notably the theories of Newton and his colleagues. "The physicists of the 1890s, who believed that the foundation of physics was fixed once and for all, implicitly assumed that all the important phenomena of nature were already known" (Kragh 1999: 27). At the time, the general view of physics was that it was a science that would not surprise anyone. "[P]hysics at the end of the century was a somewhat dull affair" (Kragh 1999: 3). Despite this widespread view of the science of physics, it surprised everyone, including physicists, who themselves did not expect – nor were they ready – for the scientific shift that followed and which proved significant for the entire world (Kragh 1999: 3). Already at the end of the 19th and beginning of the 20th century, a series of scientific discoveries resulted in the discovery of phenomena like radioactivity (the process of transforming an unstable nuclear nucleus into a more stable nucleus by emitting electromagnetic radiation or particles) and radiation (emission of "any type of ray or particle" from the source) (Bondžić 2016: 9, 17).

In 1895, physicist Wilhelm Röntgen noticed something peculiar while experimenting with high-voltage electricity in vacuum tubes in a dark room. He observed a faint glow coming from a nearby screen covered with light-sensitive film. This unexpected phenomenon led him to the discovery of high-energy electromagnetic radiation, which he named X-rays, using 'X' to signify the unknown nature of the radiation. Röntgen promptly published his work titled *On a New Type of Radiation* [40]just 50 days after the discovery of X-rays, following their intensive study. For this achievement, he received the Nobel Prize in Physics in 1901, marking the first Nobel Prize awarded in this category. This type of radiation, later named X-rays and, in many languages, referred to as Röntgen radiation in his honor, was quickly employed in medicine. The emergence of radioactivity was a true scientific miracle whose nature was extensively discussed in scientific circles (Kragh 1999: 28-29; Wilhelm Conrad Röntgen – Facts, Nobel Prize Outreach AB 2024).

> "Back in the late 1890s, Röntgen's sensational discovery caused a minor revolution in physics and inspired a great many physicists to start investigating the new phenomenon. Rarely has a discovery been received so enthusiastically by scientists and non/scientists alike. According to a bibliography, in 1896 alone there appeared 1,044 publications on x-rays, including 49 books" [Kragh 1999: 30].

A year later, in 1896, physicist Antoine Henri Becquerel, one of the scientists interested in X-rays, discovered radioactivity. He studied the qualities of uranium (traces of luminous salt on a photographic plate) and discovered that "the radiation released by uranium, in addition to leaving a trace on the photographic plate, ionizes the air" (Bondžić 2016: 17-18). In the beginning, when Becquerel first noticed penetrating rays, he attributed them to fluorescence, or sun exposure, as a crucial cause of this phenomenon (Kragh 1999:31). However, when he repeated the experiment after a few days, "the sun failed to shine" (Kragh 1999: 31). Becquerel realized that it was a scientific discovery, because uranium salt, despite this situation, emitted penetrating rays. Therefore, it was a phenomenon that "does not depend on exposure to light or electricity but is a property of the element itself" (Bondžić 2016: 17-18). He soon realized that uranium salts, as non-fluorescing metallic uranium, emit rays. This contributed to the rays' first name, "uranium rays" (Kragh 1999: 31).

[40] Röntgen, Wihlem (1895). Ueber eine neue Art von Strahlen. Vorläufige Mitteilung. In: Aus den Sitzungsberichten der Würzburger Physik.-medic. Gesellschaft Würzburg, pp. 137–147.

On the heels of such realizations, the period from 1900 to 1914, or the beginning of the 20th century, was characterized by a fundamental shift in the conception of "matter" in physics (Cantelon, Hewlett, and Williams 1991: 1).

> However, "[t]he uranium rays did not cause nearly the same sensation as X-rays and for a year or two, Becquerel was one of a handful of scientists who actively studied the new phenomenon. After all, the effects of the uranium rays were weak and many physicists considered them as just a special kind of X-rays, although with an origin that defied explanation" [Kragh 1999: 31-32].

Becquerel himself believed that uranium rays are related to the "peculiar spectra of uranium compounds" (Kragh 1999: 32), and accordingly he did not believe that other compounds can also emit these rays. However, scientists Marie Curie and Pierre Curie managed to discover substances that were "much more active than uranium" and so "radioactivity made headlines and became a phenomenon of great importance to the physicists" (Kragh 1999: 32). They continued to examine the radioactive properties of uranium, but also of thorium (whose radioactivity was discovered in 1898). These two scientists were the first to use the term radioactivity (Bondžić 2016: 18; Kragh 1999: 32).

Physicist Ernest Rutherford was also interested in X-ray and radioactive research. Through his examination, he discovered the presence of various forms of radiation, each with a different charge and penetrating ability. At the beginning of the 20th century, Rutherford described radioactive decay as:

> "[P]rocess occurring within the atom itself that leads to it spontaneously transforming into an atom of another chemical element and determines the rate of decay, which refers to the half-life characteristic of each element, as in the time required for the radioactive sample to decay to half of its initial value. It was observed that unstable nuclei of certain elements decay into atoms of lower weight, or a series of new unstable elements (as it was later shown, in a precisely defined sequence, from uranium or thorium to the stable nucleus of lead) and that a large amount of energy is released in the process" [Bondžić 2016: 20].

In 1900, physicist Max Planck developed quantum theory, which states that a "heated body emits energy in intermittent jumps known as quanta rather than continuously" (Bondžić 2016: 19). Planck's quantum theory teaches us that energy at the atomic level may be absorbed or emitted "only incrementally in the form of multiples of one quantum" (Bondžić 2016: 19).

> "The [Quantum] theory went through many evolutionary stages and gives us today a deep insight into the structure of atoms and atomic nuclei as well as that of bodies of the sizes familiar to our everyday experience" [Gamov 1966: xi].

The celebrated physicist Albert Einstein expanded upon this theory in 1905. Einstein's thesis was that all forms of rays were actually moving in "discontinuous swarms of energy" (Bondžić, 2016: 19). He developed the theory of relativity, which, contrary to classical physics of the time, shows that space and time are not constant nor the same for all viewers, nor are they independent from the material world and man's experience (Bondžić 2016: 19).

> "Theory of Relativity called for radical changes in the classical Newtonian concept of space and time as two independent entities in the description of the physical world, and led to a unified four-dimensional world in which time is regarded as the fourth coordinate, though not quite equivalent to the three space coordinates" [Gamov 1966: xi].

In addition to this, he equated energy and mass, viewing them as different versions of the same "physical essence." Mathematically, this is summarized through the famous formula $E=mc^2$ (Bondžić, 2016: 19). This discovery gave rise to the assumption of the possibility of transforming a very small amount of matter into a large amount of energy, "proportionate to the square of the speed of light, a constant" (Cantelon, Hewlett, Williams 1991:1). Furthermore, these theoretical

assumptions led to the discovery that the atom, which was previously considered the smallest solid and indivisible particle in nature, is divisible and composed of even smaller particles (nuclei and electrons) (Cantelon, Hewlett, Williams 1991:1; Bondžić 2016: 19). "The theory of Relativity introduced important changes in the treatment of the motion of electrons in an atom, the motion of planets in the solar system, and the motion of stellar galaxies in the universe" (Gamov 1966: xi).

Einstein did not directly contribute to nuclear energy research; however, a finding from his special theory of relativity provided the essential explanation for why enormous amounts of energy may be produced from a nucleus' little mass. One of Einstein's most significant discoveries was that energy may be defined as mass times the square of the speed of light (Ferguson 2011: 21-22). Even a little mass multiplied by an enormous quantity (e.g., 90 billion kilometers squared per second squared) produces a comparatively large amount of energy. The two processes that can release the vast quantity of latent energy in matter are fission and fusion. Einstein did not know how to release this latent energy, but his theory laid the groundwork for later researchers to do so (Ferguson 2011: 21-22).

The aforementioned theoretical assumptions drove a revolution in physics at the end of the 19th and beginning of the 20th centuries. This circumstance helped to overcome the notions of classical physics, related to the previously mentioned nature of atoms, and led to the thesis that everything in space occurs according to the principle of cause and effect, and continuity. The previously accepted assumption that time, space, and objective reality are independent in regard to observers, started to be disputed. This also laid the groundwork for more in-depth research of the structure of matter, enabled scientists to examine the structure of relations within the atom, and allowed for a more detailed explanation of phenomena such as radiation and radioactivity (Bondžić 2016: 19).

At the beginning of the 20th century, Rutherford, drawing upon prior discoveries, succeeded in establishing a model of the atom. At the center of this model was a positively charged nucleus, with negatively charged electrons circulating in free space around it. Rutherford's proposal for a model of the nuclear atom is regarded as an important turning point in physics. However, upon its presentation, the model was met with disinterest and was hardly recognized as a theory describing the composition of the atom. Not even Rutherford himself acknowledged the significance of the model of the nuclear atom. Rutherford primarily presented his theories as a scattering theory, with the atomic theory being secondary. This secondary status might explain the early lack of interest in nuclear atoms. Only by incorporating the electron system into an atomic theory would it become truly compelling. After all, this element of the atom was what made it possible to investigate the vast majority of atomic matters. It was not until a prominent physicist Niels Bohr transformed Rutherford's picture of the nuclear atom into a proper theory of the nuclear atom that this crucial component was provided (see Kragh 1999: 52-53; Gamov 1966: 32-36). The theoretical issues of the experimentally proved Rutherford model of an atom were of interest to Bohr. "He realized that the nuclear atom needed to be completed with an electronic structure and that this would require some non-mechanical hypothesis in order to make the atom stable" (Kragh 1999: 54). In 1913, based on the idea that certain physical quantities can only have discrete values as per quantum theory, Niels Bohr developed a theory for the hydrogen atom. According to the theory, electrons can move around a nucleus only in their prescribed orbits; if they deviate from this path and jump to a lower-energy orbit, the energy difference is released as radiation. In addition to proving that electrons can migrate from one orbit to another, Niels Bohr also demonstrated that the movement of electrons between different orbits cannot be anticipated (for more on Bohr's theory, see Gamov 1966: 32-49; Perović 2021: 59-103).

"In 1917, Rutherford 'disintegrated' the nitrogen nucleus using α particles, opening up the possibility of nuclear structure" (Hughes 2012: 1). Rutherford and his colleagues at Cambridge's Cavendish Laboratory investigated the composition of the nucleus. Rutherford focused his research school on the topic of nuclear physics with the help of other scientists (Hughes 2012: 1). In 1919, Rutherford carried out the first nuclear reaction and, "using the impact of alpha particles, split the nucleus of the

nitrogen atom into an oxygen atom and a hydrogen atom, which he called a proton, and concluded that the nuclei of atoms of other elements are composed of it" (Bondžić 2016: 20). The discovery that a chemical element "could decay into another in a process of transmutation that gave off new sources of energy" (Cantelon, Hewlett, Williams 1991: 1) seemed like the realization of alchemical ideas (Cantelon, Hewlett, Williams 1991: 1).

In general, during the 1920s and 1930s, the revolution of physics was further deepened by new scientific discoveries, such as photons, which represent released energy and sometimes behave like particles, sometimes like waves; and the discovery that small particles at high speeds can be located and measured, but "only with a finite degree of uncertainty" (Cantelon, Hewlett, Williams 1991:1). Also, during this time, experiments showed that the center of an atom, called the nucleus, is made up of positively charged particles called protons and neutral particles called neutrons (Cantelon, Hewlett, Williams 1991:1).

The neutron was discovered in 1932 by scientist James Chadwick. While it was crucial to arrive at this understanding of the physical universe, it was not enough to discover fission. Scientists realized bombarding substances with neutrons could lead to the creation of new chemicals. This, in turn, inspired efforts to discover ways to produce substances heavier than uranium, the heaviest element known at the time. In the 1930s, some nuclear physicists had reservations about the possibility of splitting heavy elements. As a result of these suspicions, four major research groups began competing. The leaders of these groups were Enrico Fermi in Italy, Otto Hahn and Lise Meitner in Germany, Frédéric and Irène Joliot-Curie in France, and Ernest Rutherford in Great Britain. The German team was the first to demonstrate nuclear fission. However, success was far from certain, given the challenges that Meitner faced because of Nazism, and biases against female scientists. Despite these difficulties, she was able to secure a job at the Kaiser Wilhelm Institute for Chemistry in Berlin during the 1930s. There, she worked alongside scientist Otto Hahn (see Ferguson 2011: 19, 20, 21). However, Nazism eventually drove Meitner to flee Germany. She was able to maintain a scientific correspondence with Hahn, who was at the time working with Fritz Strassmann, a German scientist, on an experiment that involved bombarding uranium with neutrons. In December 1938, the two chemists discovered that the reaction produced barium, a medium-mass element. Meitner and the physicist Otto Frisch were informed of this discovery. Meitner and Frisch were also the first to explain the theoretical mechanisms underlying fission. They employed the previously developed liquid drop model (see Ferguson 2011: 19, 20, 21). According to this model, similar to liquid, the uranium nucleus began to elongate and constrict in the middle until it ultimately split into two droplets, i.e., two cores. They calculated that the energy required for this nuclear division is approximately 200 MeV, corresponding to the mass difference between uranium and the two resultant products. Thus, Einstein's formula was once again confirmed (Britannica 2020). This insight was published in January 1939, and the publication of this article paved the way for future fission research. It is interesting to mention that Meitner was aware of the potential repercussions of nuclear weapons and so refused to participate in the Manhattan Project (see Ferguson 2011: 19, 20, 21).

However, this groundbreaking discovery attracted the attention of numerous researchers. They recognized the potential for a controlled chain reaction of uranium nucleus splitting, leading to the amplification of energy release (Bondžić 2016: 22). For the purpose of this work, which focuses on science in Yugoslavia, it is important to highlight the contributions of Yugoslav scientist Pavle Savić. Pavle Savić, a French government scholarship holder in the 1930s, participated in the experiments conducted by Frédéric and Irène Joliot-Curie, who continued their research with heavier elements (uranium and thorium) and came close to the discovery of nuclear fission (Bondžić 2012: 241). In 1937-38, Irène Joliot and Pavle Savić discovered a radioactive element with a short half-life in irradiated uranium samples, behaving like lanthanum despite having a lighter weight. Unable to

explain this, Hahn and Strassman repeated the experiments in late 1938, confirming the production of lanthanum and barium. In 1939, Lise Meitner and Otto Frisch coined the term 'fission' to describe uranium nucleus splitting into smaller fragments, elucidating the substantial energy release - which we already mentioned (Bondžić 2016: 22).

In the midst of a tumultuous historical period, with developments pointing toward war, the use of the vast amount of energy released through fission began to be explored for the purpose of creating weapons. A considerable number of scientists in Germany were forced to leave the country, particularly when Hitler took control, and many of them, including Albert Einstein, fled to the United States (Bondžić 2016: 22-23). There, the knowledge of European scientists aided military efforts. For example, after moving his nuclear research program from Rome to Columbia University and subsequently the University of Chicago, Enrico Fermi managed the first controlled nuclear chain reaction (Martin 2016: 188). In this context, Einstein contributed to President Franklin D. Roosevelt's awareness of the possibility of nuclear weapons. After emigrating from Germany in 1932, Einstein lived and worked in Princeton, New Jersey, at the Institute for Advanced Study. Following the discovery of fission, émigré scientists Leo Szilard, Edward Teller, and Eugene Wigner convinced Einstein to sign two letters (one in August 1939 and the other in March 1940) to Roosevelt informing him of the implications of the recent discoveries in fission and the possibility of Nazis in Germany developing nuclear weapons. However, Einstein was not involved in the Manhattan Project, which resulted in the creation of the first nuclear weapons (Ferguson 2011: 21-22).

In line with these developments, the Uranium Committee was founded in the United States in October 1939 for the purpose of uranium research. It is worth mentioning that Bohr determined that the probability of fission is higher when using uranium-235 (U235) and slower neutrons, a finding confirmed by physicists Leo Szilard and Enrico Fermi using the next moderator, i.e., a neutron moderator. After some time and a larger number of research facilities, it was determined that uranium-235 was the most suitable material for producing a nuclear bomb. However, uranium-235 is the least prevalent element in natural uranium. For this reason, methods for its separation were sought. In 1941, plutonium was found, which is derived from natural uranium and can be used to create a nuclear bomb. After the Japanese attack on the US Navy installation at Pearl Harbor in 1941, the United States joined the war against the Axis Powers in the Second World War, launching the Manhattan Project, aimed at developing an atomic bomb (Bondžić 2016: 22-23). This was a state-funded "big science" project, where approximately $20 billion was invested in the development of the atomic bomb, with almost 130,000 people involved. In 1942, it was decided that the work, which had previously been split between the Army and the Office of Scientific Research and Development (OSRD), should be fully centralized and under the total control of the Manhattan Engineer District (more will be said on this model of organizing scientific projects in the context of the big science phenomenon later in the text). Army Colonel General Leslie Groves of the US Army was tasked to spearhead the project. He was considered inflexible, crude, and without diplomatic skills. The earlier mentioned Robert Oppenheimer was appointed as director of the Manhattan Project's Los Alamos Laboratory. He was a theoretical physicist, and this was his first military project. The development of the bomb required enormous state support, total secrecy, and, accordingly, great state control (Rhodes 1986; Marcovitz 2015: 28-29; Wallerstein 2021: 51-95).

> "Stirred by the fear of Nazis acquiring the bomb first, Roosevelt launched a secret effort in cooperation with the United Kingdom. The program known as the Manhattan Project, directed by US physicist Robert Oppenheimer and General Leslie R. Groves, involved over 30 different research, production, and testing sites. These included both plutonium and uranium enrichment facilities as many paths were pursued in parallel to ensure success and speed up the program. By the end of the war, four different technologies were industrialized, and implosion and enrichment strategies succeeded at about the same time" [Charnysh 2009: 2].

The 1938 discovery of fission in Germany caught the attention of Soviet physicists as well. In 1939, prominent Soviet physicists started their experiments in an effort to replicate the fission experiment carried out by Otto Hahn and Fritz Strassmann in Berlin. Their goal was to figure out the exact parameters for a nuclear chain reaction to occur. After learning that the United States and Germany had begun manufacturing atomic weapons, Soviet leaders initiated their own program in February 1943. It was led by nuclear physicist Igor Kurchatov and political director Lavrentiy Beria. The Soviet atomic program during the war was significantly smaller than the Manhattan Project (see Soviet Atomic Program 1946; Атомный проект СССР n.d). Soviet scientists studied the reactions required for building nuclear reactors and atomic weapons. They also began researching methods for producing sufficient graphite and pure uranium, as well as methods for isotope separation. American President Truman informed Joseph Stalin about the US atomic bomb program during the July 1945 Potsdam Conference. Following this, the Soviet government scaled up its initiatives. The project was directed by an engineering council helmed by General Boris L. Vannikov, who has been compared to General Leslie Groves. After the bombing of Hiroshima and Nagasaki, Stalin called for an all-out crash program in atomic research and development (see Soviet Atomic Program 1946; Атомный проект СССР n.d.).

By the time the United States carried out its first nuclear test in 1945, Germany had already surrendered. On the other hand, the Japanese armed forces refused to surrender, despite multiple defeats in 1944 and the first part of 1945. In August 1945, a plutonium implosion-type bomb named *Fat Man* destroyed Nagasaki, followed by a gun-type uranium bomb named *Little Boy* that devastated Hiroshima (Charnysh 2009: 2; Marcovitz 2015: 55-68). Much of the city of Hiroshima was destroyed by the atomic bomb, and 68,000 people were killed. In the weeks and months that followed, another 70,000 people died from radiation exposure. Thirty-eight thousand people died in Nagasaki after the *Fat Man* bomb was dropped on August 9, 1945. An additional 35,000 people died in the following weeks and months. The Japanese consented to an unconditional surrender on August 14 (Marcovitz, 2015: 68). "The Second World War was finally over, and the world was introduced to the destructive power of the new, atomic weapon" (Bondžić 2016: 24). In this context, it is interesting to mention that science-fiction writer H.G. Wells predicted the outbreak of global warfare in his novel *The World Set Free* ([1914]2022). In this book, atomic bombs dropped from aircraft by armies entirely destroyed cities. When Wells published the book, aviation and atomic science were still in their infancy. Nonetheless, he correctly anticipated that an army would use aircraft to drop atomic bombs on target cities some 30 years later (Marcovitz 2015: 10, 11).

Pavle Savić, a physicist who contributed to the development of fission, admitted to grappling with his conscience regarding the long-term effects of the nuclear bomb in Japan. In 1957, he visited the hospital in Hiroshima for people who were exposed to radiation, as well as the memorial museum, built around 300 meters from the epicenter of the explosion of the first atomic bomb (Senćanski 1986: 65-66). The visit in 1982 only just added to his sorrow and haunted him. Upon receiving the Lomonosov Gold Medal at the Presidium of the Academy of Sciences of the USSR in Moscow, Pavle Savić made the following speech:

> "A researcher studying natural phenomena is inevitably driven by curiosity, which leads to the discovery of the laws of nature. He behaves like an adult child with inquiring mind, whose curiosity is a part of human nature. The history of science is nothing but a series of results acquired through reason and effort, as a result of this curiosity. There is no threat of corruption in this motivation. Without this curiosity, there would be no progress of civilization. The threat of the corruption of scientific findings arises from the practical implementation of scientific discoveries. [...] [I]n today's world of extreme contrasts and divisions into big and small, developed and underdeveloped, the rich and the poor, the full and the hungry, potential differences have grown to dangerous proportions, and there is a possibility that at any moment everything that people have painstakingly build for centuries, will be destroyed. The accumulation of stocks of nuclear weapons, if they were used for military purposes, would present a real possibility of destroying not only acquired goods but also the very

> human race. The first use of fission in the bomb unleashed on Hiroshima serves as a sufficient warning. And this was only an episodic event in the devastating potential of nuclear arsenals. I had the opportunity to visit Hiroshima 12 years after the explosion in 1945. Many impacts have been erased over time, but what I have witnessed continues to burden humanity's conscience. With today's catastrophic potential of nuclear weapons, humanity stands on the verge: to be or not to be. We must do all in our power to stop the arms race and production of nuclear weapons and to use the current increase in nuclear fission material as an energy source for beneficial ends" [Senćanski 1986: 67].

In an article from 1999, Slobodan Ribnikar writes that Savić, most likely, was not aware that his work with Irène Joliot-Curie would be used for such destructive purposes until the atomic bomb was dropped on cities in Japan, as he was not involved in scientific research during the Second World War (Bondžić 2015: 94). The scientific engagement during the war demonstrated to the world that fundamental research could influence political outcomes and be converted into military might. The most obvious and potent effect of wartime physics was nuclear bombs. In line with this, it should be noted that for a comprehensive understanding of the phenomenon of big science during the Cold War (discussed in the next chapter), it is necessary to consider the unprecedented mobilization of research and technology in the service of the state during the Second World War (Hallonsten 2016: 43; Martin, 2016: 188). However, it should be noted that the next chapter will also highlight significant overlaps between the phenomenon of Soviet science and the concept of big science, which initially, due to the Cold War, was primarily associated with Western science (Graham 1992; Kojevnikov 2004: 45-46).

Big Science: Main Features, Cold War, (Nuclear) Physics in the US

The previous pages, besides summarizing and describing the scientific path leading toward the creation of the atomic bomb, point to the significance of these discoveries for the big science phenomenon, to which we turn in this part.

"Early years of the 20th century saw the birth of Big Science proper" (Coles 2000: 4-5). If we were to compare modern science and its beginning (Galileo and Newton) with modern science in the 2000s, one sees that "science has been getting bigger and bigger" (Coles 2000: 4). Sciences like chemistry, physics, biology, etc. have endured drastic changes since the beginning of the 20th century until 2000s. The application of scientific principles brought about significant changes in people's lives, especially when contrasted to the period of pre-modern science (Coles 2000: 3). Along with the changes, various scientific disciplines were developing. This particularly applies to physics. Nuclear physics, which studies protons and neutrons, and the physics of elementary particles (i.e., high-energy physics), which investigates even smaller particles, the building blocks of protons and neutrons, as well as the interactions between them, inherently constitutes a large-scale scientific endeavor. This is due to the requirement of enormous energy to conduct such studies, hence, the necessity for the existence of large research facilities.

> "In the physical sciences, developments have been particularly remarkable. Physicists have unraveled the structure of matter on the tiniest accessible scales, breaking up atomic nuclei into elementary particles and studying the forces that cause these particles to interact. Astronomers discovered in this century that the Universe is expanding [...] These daring adventures of the mind are based on foundations of experiment, observation and theory [...] Likewise, their experiments and observations become more and more expensive to make, and more and more difficult to subject to independent test. 'Big Science' has become the preserve of a very few specialists, distancing it even further from popular understanding than science generally" [Coles 2000: 4].

Such changes in this period can be connected to Western science, which was, to a greater extent than the USSR (at least nominally, i.e. ideologically), oriented toward the "little science" phenomenon.The expression "little science" is often used to reflect a sentiment of longing for the era where researchers had the freedom to work independently or with students on self-selected projects (Dennis 2017).[41] The term "big science" was coined by Alvin Weinberg and Derek J. De Solla Price, but they attached different meanings to it. Price thought of big science as a term describing a "general growth of science in nearly all aspects" (Hallonsten 2016: 14). Weinberg, on the other hand, thought that the phrase referred to the development of government-sponsored research, particularly physics research in the United States; specifically, growth in the sizes of teams and equipment required for scientific progress, as well as an increase in the complexity of scientific endeavors in terms of theory, method, and organization (Hallonsten 2016: 13). Price also referred to the growth of instrumentation, research teams, organizations etc., which he saw as "byproducts of a science otherwise growing in most respects" (Hallonsten 2016: 14). Price did not see big science as a pathological condition, but rather an "extreme condition that science finds itself in right now..." (Hallonsten 2016: 14). Meanwhile, Weinberg thought of big science as pathological and was concerned about this phenomenon. "He warned that the inevitable bureaucratization of science would overtake classic academic science and eventually extinguish its natural (and crucial) creativity and serendipity" (Hallonsten 2016: 13-14).

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[41] The question whether the idyllic era of "little science" ever truly existed lost its significance. With the rise of high-tech warfare, scientific research became crucial for national security, promising substantial support for scientists and engineers during the Cold War era (Dennis 2017).

Given that the rest of this paper focuses mostly on physics, it should be noted that the roots of the big science phenomenon in physics in the West may be traced back to the 1930s. Examples of this are room-sized cyclotrons (the work of physicist Ernest O. Lawrence), as well as enormous telescopes, built atop the Palomar and Kitt Peak mountains (Galison and Jones 1999: 504). Government-sponsored particle accelerator programs paved the way for prewar embryonic big science. The 1930s also saw the establishment of performing organizations (such as research universities and institutes), various disciplines, institutionalized professional posts, peer review systems, and the widespread publication of works in journals and printed books all over the world (Hallonsten 2016: 43-44).

However, the defining features of the big science phenomena are related to the organizational aspects of scientific work. The Second World War brought about a tendency for centralization, expansion, and hierarchization, i.e. the fundamental reorganization of research (Galison and Jones 1999: 504). According to physicist, science historian, and computer scientist Derek J. de Solla Price, up until the Second World War, the cost of research per person and in terms of the gross national product stayed stable throughout history. Only with the start of the war did it begin to rise in line with the expansion of the scientific manpower (Solla-Price 1986: 84).

> "As late as 1941, MIT's Radiation Laboratory (where radar was being designed) was still a fairly small, quasi-academic entity employing but a score of physicists and their graduate students. Under the enormous pressure of war-driven research, that intimacy had to change. A wide debate ensued about how to think about the structures and processes of the 'Rad Lab', as scientists transformed a few rooms at MIT into a multibillion-dollar military-academic-industrial complex. Those at Los Alamos had similarly seen the Manhattan Project grow from a handful of men in a few rooms to a $2 billion enterprise that altered war, physics, industry, and what it meant to be a scientist, all at once. And finally, the wartime nuclear weapons facility at Oak Ridge was not just the largest physics plant in the world, it was the largest factory of any type, anywhere" [Galison and Jones 1999: 504].

Prewar scientists thought of themselves as solitary in their work. By the mid-1940s, the small-scale laboratories and studios that had previously supported this self-perception were starting to crumble as scientists came into contact with places of production and work patterns that had been transformed by the massive factory production quotas imposed by companies such as the Austin Company and Albert Kahn Associates. Hanford, Oak Ridge, and Los Alamos are prime examples of government-sponsored factories-laboratories where physical plants, social ordering, and a new subject position came together to create a new model of scientific organization (Galison 1999: 18-19).

In this context, it is interesting to turn to a notable example of the transition from (fundamental) physics to the big science phenomenon – Fermi National Accelerator Laboratory (Fermilab), one of the premier institutions that specializes in the field of high-energy particle physics. While directing Fermilab, Robert R. Wilson, the institution's first director, supported a decentralized approach to organization, believing that scientists should be solitary in their work. This idea of physics corresponds to that of the early 20th century, upon which Fermilab was founded. However, after Wilson stepped down as director, this approach was changed (Perović 2014: 69).

> "The main argument was that usual tests performed on such a huge apparatus took too long, leaving insufficient time for other experiments. As a result, the new strategy aims to maintain only the most significant and successful experiments, and to dedicate to them the time that was primarily allocated for those deemed failures. Consequently, the number of experiments was dramatically reduced" [Perović 2014: 69].

The big science phenomenon, because of its scale, among other things, cannot exist independently from other (non-scientific) societal spheres, like the economic and political spheres, which are its integral parts. "With that transformation, the practitioners of large-scale research have drawn, sometimes consciously, sometimes unconsciously, from the resources of their societies" (Galison

1992: 17). In this sense, exploring this phenomenon implies examining the dynamics between technology, society, and the army (Galison 1992: 17). Different scientific institutions took a different approach to outer, non-scientific factors, like the industry and the army. When it comes to Western science, we can observe certain institutional differences in the way the big science phenomenon was considered (Galison 1992: 8).

Connected to this, it is interesting to turn to a text by Silvan Schweber (1992), which illustrates these differences through the example of physical research, in the context of its alignment with outer factors, at two universities – Massachusetts Institute of Technology (MIT) and Cornell University. On the one hand, Schweber (1992) emphasized that MIT cooperated with the industry since the outset, having formed a collaborative relationship before the start of the Second World War. Because of the already-established link between industry and university/academia, the collaboration easily continued during the Second World War and expanded even further. Accordingly, from the very start of the conflict, the president of MIT (Karl Compton) believed that MIT should play its part in the war because technology would be the deciding factor. "Simultaneously, with the infusion of hundreds of millions of dollars of government money; ties to the military also grew strong" (Galison 1992: 8) Major changes took place during this time in physics research, and the result was "centralized government-funded enterprise" (Galison 1992: 8). Unlike MIT, since its beginnings, Cornell University opposed mercantilism and militarism. Although the president of Cornell University was also opposed to fascism, unlike Compton, he believed that values were more important than technology, and that the US, by improving the social and economic conditions of its people, should strengthened itself against internal divisions. According to Schweber (1992), universities could make a positive impact by strengthening the cultural life and upholding the core principles of the liberal heritage. This meant encouraging fundamental research in physics even when it strayed from a path with obvious applications. "By the mid-1930s, Cornell had established one of the strongest nuclear physics groups in the country and embarked on a decades-long commitment to this branch of research" (Galison 1992: 9). After the Second World War, both MIT and Cornell University experienced great change in the field of physics when faced with big science military projects. However, the two institutions parted ways. MIT focused on the development of the reactor, nuclear energy, and electronics, primarily for the army. At Cornell, too, there was an increased fusion of physics and engineering. However, in terms of physics research, Cornell University devoted itself to the development of the accelerator, which was not primarily connected to the practical use of science (Galison 1992: 9).

It therefore follows that, when it comes to the concept of big science (particularly with respect to Western research), in order to acquire a deeper understanding of this phenomenon, it is necessary to analyze the role of the military in it. Massive military projects had a significant impact on physics research at numerous universities. Connected to this, the text by Allan Needell (1992) mentions Berkner – one of the postwar scientific administrators in the US – who saw the role of science for national defense after the Second World War as a necessary scientific model that had to be preserved during the Cold War. During the 1940s, it was Berkner who participated in the founding of the Weapons Systems Evaluation Group. This was a post-war link between civilian physicists and the provision of new military weapons systems. Accordingly, Berkner advocated for preserving the federal and military connections of science, opposing the breaking/weakening of this bond, which was a development championed by Vannevar Bush and Frank Jewett (Galison 1992: 14).

> "At the end of the war, the leaders of the wartime science – Vannevar Bush and Frank Jewett – wanted desperately to reinstate the prewar scientific institutions they so valued. In speech after speech, they emphasized the temporary nature of wartime dislocations and advocated a shift from big, federally funded scientific projects to private, philanthropic support, administered by a network of honorary and advisory committees. It was not to be" [Galison 1992: 14].

Opposition to the big science organizational model, as seen by Berkner, did not wane, but despite this, when the "Cold War began burning in Korea, the national security link to science grew stronger" (Galison 1992: 15). According to Kevles (1992), the Korean War was a key factor in deepening the relationship between scientific research and the state, "as the national security apparatus pumped ever greater funds into science" (Galison 1992: 15). In this regard, it was also noted that, in terms of proportions, funding for the development of "things" had grown more than funding for fundamental research since the end of the Korean War (Wang 1995: 356).

The change toward state-sponsored scientific projects was so drastic, that even those who (like Du Bridge) opposed science feeding on military crumbs, rarely continued "to serve in key positions of coordination between scientists and the military, such as his membership on the Atomic Energy Commission's powerful and elite General Advisory Committee and the Science Advisory Committee to the Office of Defense Mobilization (ODM)" (Galison 1992: 15). The leadership of the scientific community was often faced with the possibility that the arms race would continue without their influence if they broke the connection between the civilian scientific community and military planning. On the other hand, they would have tied civilian science to military objectives if they joined the numerous coordinating boards (Galison 1992: 15).

During 1949 and 1950, due to increased tensions between the United States and the Soviet Union, political circles discussed the likelihood of a third global war. In this general atmosphere ("general increase of military preparedness"), it seemed unrealistic to expect scientists to remain outside of the military processes that arose. According to Kevles (1992), the global situation at that moment (Berlin blockade, Czech coup, Russian A-bomb, etc.) prepared the ground for the mobilization of civilian science. "Some argued that the new National Science Foundation (NSF) ought to address military needs, along with pure science; others argued for the creation of a new Office of Scientific Research and Development (OSRD)" (Galison 1992: 15) In this context, William Golden, an American investment banker, was instrumental in making science as useful a social endeavor as possible. He interviewed military leaders and academic, industrial, and government scientists to understand why civilian science should be mobilized for defense activities. Kevles (1992) sees Golden as a representative of the changes that ensued in the relationship between science and society during the Cold War period.

> "In a way, Golden's experience could stand in for that of the scientific community at large: the defense mobilization of the Korean War brought them recognition at the highest level of government, but at the price of working within the constraints imposed by an enormously augmented military establishment" [Galison 1992: 16].

Following the end of the Second World War, among the most obvious macro-sociological changes in science were the dramatic increases in investments, the increased number of professional scientists and engineers, and the growth of scientific publications. During the Cold War, the three major sectors – government/military, industry, and (academic) science – became intricately linked. The term "military-industrial-scientific complex" emerged during the post-war period. The phenomenon was most prominent in the United States. Regarding governance, one noteworthy aspect is the growing participation of professional scientists, notably physicists, with highly privileged posts in military and government activities (Hallonsten 2016: 48, 50).

> "Physics was the most prestigious branch of science, which gave prominent physicists direct access to high political levels and put them in charge of important authorities such as the federal Atomic Energy Commission (AEC), which governed all US atomic energy R&D, military and civilian alike, and oversaw the system of National Laboratories that was created in 1946/1947 out of the remaining physical assets and human resources of the Manhattan Project" [Hewlett and Anderson 1962: 714–722 according to Hallonsten 2016: 48].

Scientists in the field of physics, not just those working with subatomic particles, quickly grew accustomed to their government-granted privileges and were able to obtain nearly anything they desired. Nobel laureate and physicist Luis Alvarez said that the physicists had blank checks from the military so they never had to worry about money. A growing emphasis on using accelerators to explore the subatomic realm allowed particle physics to become separate from nuclear physics and establish itself as a separate sub-discipline (Hallonsten 2016: 46). "If World War II instilled a sense of unity and common purpose in the American physics community, the Cold War presented the opportunity for newly established specialities to go their own ways" (Martin 2016: 188) In its essence, the main goal of particle physics is "to expand human knowledge about the inner structure of nature's smallest building blocks" (Hallonsten 2016: 46). This made particle physics a supplement to nuclear physics, which remained related to the military, and became a very important research branch in the Atoms for Peace (Hallonsten 2016: 46).

After the USSR launched Sputnik, the first artificial satellite, into orbit in 1957, the United States responded to what became known as the Sputnik crisis. In this context, the President's Science Advisory Committee (PSAC) was appointed to assist the government in formulating defense and science policies. With the appointment of PSAC, a formal channel between science and the highest level of government was established for the first time during peacetime. The launching of Sputnik further blurred the line between science and state in the United States. There was a significant increase in federal budgets for basic research at universities. Stanford Linear Accelerator Center – SLAC was the product and example of big science in the United States during this period. The construction of SLAC is a symbol of the American decision to become a leader in science after Sputnik, which, while intriguing to scientists, remained mostly an exclusive activity (Wang 1995).

> "Unable to make plausible utilitarian promises, however, Big Science practitioners such as the Stanford physicists had to use the Cold War competition for national prestige and rely on a network of scientists in government to achieve their scientifically meritorious but financially difficult goals" [Wang 1995: 354].

US physics grew larger and more diversified as it gained recognition as a major scientific force on a global scale, inspiring different ideas on how to best use the prestige, resources, and political influence of the field. The identity of a physicist, and thus the nature of physics in the US after the war, was shaped by wartime research. "Nuclear, high energy, and solid state physics all trace their roots to groups of researchers and sets of problems brought together by the war" (Martin 2016: 188). The Office of Naval Research and the Air Force Office of Scientific Research, in particular, supported a wide range of projects, while the legislative machinery behind the NSF worked deliberately through the late 1940s. "The National Science Foundation (NSF), established in 1950, was the official federal organ for supporting basic research" (Geiger 1992 according to Martin 2016: 188).

> "The end of World War II heralded a new age for American physicists, who enjoyed a measure of social and economic stability that war-ravaged Europe could not match. After competing as underdogs against their better-established European colleagues for much of the early twentieth century, American physicists emerged from the war with an intact and cohesive community, tremendous momentum, generous federal support, and widespread social approbation" [Martin 2016: 188].

For the purposes of this study, I shall concentrate on nuclear physics: its dynamics, structuring, relevance, and application within the context of the big science phenomena in the United States during the Cold War. As previously said, with the emergence of Nazism and the outbreak of the Second World War, which was raging on European land, a large number of European experts, including physicists, moved to the United States. Some of their contributions were critical to the development of nuclear weapons. In a number of respects, the Manhattan Project set the standard for postwar physics. "It sensitized a generation of researchers to science on a grand scale" (Martin 2016: 189). It weakened the barriers between science and politics. Most importantly, it normalized large government expenditures for scientific research. The federal government's interest in science

benefited nuclear physics the most, but this type of financial support came with a cost (Martin 2016: 190).

During the Cold War, US security interests were closely linked to nuclear physics, which was governed by mission objectives and secrecy systems (see Wellerstein 2021: 135-284). Secrecy systems gained traction in the late 1940s and after. However, unlike the "absolute secrecy" characteristic of the Manhattan Project, these new systems of secrecy "did not quite embrace the most fearful articulations of control, either" (Wellerstein 2021: 176). The United States Atomic Energy Commission was established with the idea that civilian, rather than military, authorities would be in charge of the development of nuclear weapons and nuclear power. Even though the steps for declassifying information were slow and weighed down by bureaucratic procedures, they still managed to move forward, albeit slowly. Even when international oversight initially fell short, it eventually came back in the form of nonproliferation efforts (Wellernstein 2021: 176).

> "The postwar system attempted to have everything both ways. Science needed to be open, but the bomb needed to be contained—a statutory formulation that was acknowledged as contradictory by its congressional author. […] The US Atomic Energy Commission was given a deliberately ambiguous mandate: be a force for technocratic good in the world through simultaneous application of dissemination and restriction of scientific and technical information, with dangerous consequences for failure at every level" [Wellerstein 2021: 176-177].

Following the discovery that the Soviets possessed nuclear weapons, and consequently the end of the US monopoly in that field, restrictions related to intelligence were loosened. However, loosening restrictions for "technical information" meant that "the security focus was moving from the information to the scientists themselves, now seen as the most unreliable component in the secrecy regime" (Wellerstein 2021: 229). In that sense, despite loosening restrictions in one field, in reality, this meant that the Cold War secrecy regime fused an ever-growing infrastructure of government secrecy with a fresh, compelling perspective on nuclear weapons (see Wellerstein 2021).

"A field that began with theoretical questions about atomic structure became a technical enterprise directed at exploiting atomic energy either through bombs or reactors. Los Alamos, which had housed the laboratory charged with theoretical research and bomb assembly, remained a weapons lab." (Martin 2016: 190). President Harry Truman gave top priority to developing a fusion bomb after the Soviet Union conducted a test in 1949. The first thermonuclear bomb was detonated at Enewetak Atoll in 1952. The effects of nuclear weapons against civilians in Japan horrified many veterans of the Manhattan Project, who opposed efforts to increase the nuclear arsenal. The early 1950s saw a rise in hostilities between skeptics and weapons researchers, and due to the Red Scare, any resistance to a stronger nuclear deterrence was often portrayed as backing for communists. "Both the virulence of American anti-communism and the political clout of the defense establishment were tested in the Atomic Energy Commission (AEC) hearing on Oppenheimer's security clearance" (Martin 2016: 190), which we have mentioned at the beginning of this doctoral dissertation. The defeat Oppenheimer and several others of his colleagues who testified on his behalf suffered illustrates the degree to which the defense establishment had seized control of nuclear physics. Following the war, various Manhattan Project research facilities across the state were transformed into National Laboratories, an endeavor controlled by the AEC. Despite being deemed non-military, research conducted within the National Laboratory System, ranging from reactor and cyclotron research to biological and ecological inquiries, was strategically aligned with US national interests. Civilian nuclear power arose from research on nuclear reactors, such as that carried out at Argonne National Laboratory outside of Chicago. Cold War defense and economic objectives were thought to depend on nuclear supremacy in all spheres, including armaments and electricity production (Martin 2016: 190-191).

> "This duality defined Cold War nuclear research. A field that seemed remote from daily life, not to mention geopolitics, in the early part of the century became deeply enmeshed in a global ideological struggle by the 1950s. Nuclear physics no longer meant simply the study of the nature and structure of the atomic nucleus, but rather the exploitation of a few heavy elements in the service of national aims. The influence physicists could have over these aims shepherded them from obscurity to the center of American civic and political life. Nuclear physics became an outgrowth of national defense during the Cold War. Some physicists, however, were not content to let postwar public approbation and federal funding be directed entirely toward technological projects. No field exemplifies the new opportunities the postwar boom enabled better than high energy physics" [Martin 2016: 191].

The Cold War period is often associated with McCarthyism, witch hunts, espionage mania, etc. However, the Cold War mindset was also driven by a desire for capitalism and free-market "solutions" to national and international issues. This perspective in the nuclear domain would eventually drive declassification efforts, all in the interest of producing affordable and peaceful electricity (Wellerstein 2021: 232). "It is this contradictory dyad – hugely invasive policies to govern everything deemed 'secret', with a nearly opposite desire for openness regarding anything deemed 'peaceful' or that would promote atomic industry – that makes up the somewhat schizophrenic regime that emerged in the Eisenhower years" (Wellerstein 2021: 232).

Soviet Science as a Predecessor to the Big Science Phenomenon and the USSR Nuclear Program

Big science was viewed as a new phenomenon in the 1960s, corresponding to changes to scientific research organizations following the end of the Second World War (primarily in the West). However, after some time, historians of science began using the phrase as an analytical category to study not only science during the Cold War but also sciences from earlier decades or even centuries, such as imperial sciences of the nineteenth century, etc. In other words, the term "big science," although from the 1960s, has been used by some researcher to refer to similar scientific projects with a big business and big state at their core. These researchers viewed these scientific projects as the forerunners of big science (understood as a mode of research characterized by large scale and extensive state involvement in its funding) (Aronova 2014: 393).

In accordance with this, and taking into account the studies of historian of science Alexey Kojevnikov (2004), the conclusion is that Soviet science, a system established after the October Revolution, was, in essence, the precursor of big science. Although contemporaries saw it only as socialist science, examining its fundamental elements from this perspective, one cannot neglect the significant parallels between Soviet science and the big science phenomenon. Assumptions about new forms of scientific organization existed both before and throughout the First World War, but their systematic establishment and shaping were essentially the result of socialist, or revolutionary, inclinations in the postwar period. This was further intensified by the fact that "[t]he values and interests of scientists and of the Soviet government overlapped, particularly, in the idea of a research institute, which helped materialize the proposed reform and gave it its specific spin" (Kojevnikov 2004: 45).

One should also highlight several global tendencies in science, which contributed to creating, at the time, new scientific assumptions, such as the increasing professional appreciation of science, the development of close ties between (military) technology and science, and the start of the state's interest in science. However, due to the limited access to valid information during that time about the scientific situation outside of Russia, as well as idiosyncratic interpretations, scientists in Russia "designed what was, in fact, a novel system of research and development" (Kojevnikov 2004: 45). Moreover, unlike the mentioned scientific initiatives in other parts of the world, some of which were unsuccessful in their development, disappeared over time, or were only partially successful, in civil war Russia, the existence of a revolutionary movement and the desire for a radical transformation of society enabled scientists to realize their scientific ideas in a much more comprehensive way and

under a Socialist model of research (Kojevnikov 2004). Marxism, in its Soviet version, inspired an almost limitless faith in science and technology (Josephson 1996: 299), in accordance with the concept of the charisma of reason (previously mentioned several times in this paper).

In line with revolutionary, radical ideals, which spread through all pores of society, and aimed to overcome "old schemes" and create more progressive, new schemes, a "scientific worldview" was being formed. Planning, centralism, collectivism, practical (and sometimes unrealistic) goals, placing hopes in radically new technologies and scientific theories, etc., were the basic organizational principles that sought to be established and expanded in Soviet science in this period. These new theories and technologies often carried "revolutionary symbolism, such as radio, aviation, automobile, genetics, X-rays, or radioactivity" (Kojevnikov 2004: 44). The government organized and provided funding for new research institutes across the USSR. These institutes tended to function separately from universities and other higher education institutions. Rather than teaching, their staff members were paid for doing their research. These institutions tended to be far bigger than the average university-based institutes, and they tended to monopolize or even centralize a certain area of study. Typically, they were structured around significant multidisciplinary projects that called for the collaboration of scientists and engineers from several fields. These projects combined basic research with the development and production of innovative, highly sophisticated technology or the pursuit of some other significant practical aim, either civilian or military, or both (Kojevnikov 2004: 23-24).

This is supported by the fact that, after the October Revolution and the end of the Civil War, the magazine *Science and Its Workers* mentions, as one of the most important tasks of Soviet scientists, the need for new collective forms of organizing research, as well as building a state network of scientific institutions with a focus on applied science (Kojevnikov 2004). Here, one can observe an orientation toward the interweaving of "pure" science and applied science, technology, etc., which is an important element that also characterizes big science. One can also observe a tendency toward establishing large institutions and multidisciplinarity. Kojevnikov (2004) rightly concludes that the history of the big science phenomenon often overlooks the Soviet version of big science.

The Soviet institutional research model began to spread internationally as early as the 1920s when the nationalist Guomindang leadership in the People's Republic of China adopted it (Kojevnikov 2008: 122). Similar changes occurred elsewhere later on, usually as a result of the Second World War, and survived afterwards under the unofficial name "big science," most notably in the United States (Kojevnikov 2004: 45-46). It is worth mentioning that after the Second World War, the scientific establishment in the USSR embraced 'gigantomania' even more fervently than before, intensifying its focus on grand-scale projects. Cities such as Novosibirsk, Pushchino, Dubna, Obninsk, and other regional hubs flourished into sizable 'science cities,' accommodating thousands of researchers in concentrated environments (Graham 1992: 58). In this context, it is noteworthy that the Hydro-engineering Laboratory of the USSR Academy of Sciences (later known as the Institute of Nuclear Problems of the USSR Academy of Sciences in 1953) launched the Synchrocyclotron in December 1949. This Synchrocyclotron held the title of the world's largest accelerator until 1953 (JINR n.d).

The term "socialist" (instead of "big science") could not be used during the Cold War in US. However, both approaches (US and USSR) to science are similar and seem to be products of the same social process, albeit under different names. As previously mentioned, they share certain characteristics, like gigantomania, state support, the cult of science in society, fusion between science and engineering, multidisciplinary research, collective or teamwork, complex bureaucracy, and militarization. During the Cold War, the emphasis was on the ideological contrasts between the opposing blocs, frequently obscuring or disregarding commonalities with other names. A less biased examination of the last century's events uncovers a large number of common patterns (Kojevnikov

2004: 45-46). Therefore, despite the social differences, similarities in the domain of organizational aspects of science were present.

In the remainder of the text, we will attempt to summarize the Soviet nuclear program, as an example of the big science phenomenon in the USSR, with a focus on its structure as well as the enthusiasm around socialist ideals about nuclear physics, with high expectations for its power. "Only the Chernobyl disaster and the decline of the Soviet Union were to shake the foundations of Soviet nuclear culture" (Josephson 1996: 322).

Soviet nuclear physics research mostly ceased in 1941 following Germany's invasion of the country. Engineers and scientists were given assignments to work on more urgent tasks, like the development of the radar. A few physicists, nevertheless, kept looking into the potential of uranium, and some also thought that the recent discovery of nuclear energy could be valuable in the fight against Germany. As already said, at the beginning of 1943, during Stalin, the Soviets started their own project of developing the nuclear bomb, led by nuclear physicist Igor Kurchatov[42] and political director Lavrentiy Beria. Daily project management was done by Vannikov and Kurchatov, but major decisions had to be approved by Beria, Stalin, and the Special Committee (Holloway, 1994: 173). The Soviets produced their first chain reaction in a graphite structure at the end of 1946. Several years later, in the fall of 1948, Soviet scientists succeeded in getting their first production reactor operating. In 1949, the Soviet Union successfully tested their first nuclear device, often known as *First Lightning* (Soviet Atomic Program 1946; Атомный проект СССР n.d.).

The Council of Ministers of the USSR supervised the Soviet nuclear energy program. L.P. Beria served as the program's administrative political director. According to the CIA report from 1954, although staff from these ministries had been assigned to it, Soviet atomic energy was independent of the Ministry of State Security (MGB/MVD). However, in 1946, many of the MGB's officials, including its chief, were moved to a new organization. This new agency was in charge of protecting the nuclear program; that is, it was responsible for counterintelligence. The Council of Ministers supervised this organization. The organization kept in touch with the MGB's Second Chief Directorate at the time, due to the nature of its activity. A few officials from the MGB's First Chief Directorate were also moved to the current nuclear energy agency. Presumably, also according to the CIA report (1954a), at Beria's request, some elite individuals from the MVD were deployed to the program. After being transferred, Beria became the individual supervisor of each of these MVD/MGB officers. The CIA report (1954a) indicates that one of the very important roles of the MVD was assisting the nuclear program with prison labor for uranium ore extraction. Moreover, the same report (1954a) mentions espionage that contributed to the Soviets gaining access to Western research data, while the fact that a certain number of scientists from Germany were brought to the Soviet Union is cited as a significant factor in the progress of the Soviet nuclear program (CIA Report 1954a). However, although obtaining information on the atomic bomb held technical significance for the Soviet nuclear program, according to Holloway (1994), considering the state of the Soviet Union at the time and the fact that it was a country "whose economy had been devastated by the war", "the creation of the atomic industry was a remarkable feat" (Holloway 1994: 192).

One should add that this was not the only big project depending on advanced technology, as missile and radar projects also demanded experts in science and engineering. Despite the severe economic devastation brought about by the conflicts with Nazi troops on Soviet territory, the USSR managed to produce new weaponry, including jet warplanes, rockets, etc., in a fairly short period of time following the Second World War (Ichikawa 2019). One should consider that there was a short period

[42] Igor Vasilyevich Kurchatov (Игорь Васильевич Курчатов), was a Soviet physicist. He was central scientific figure in organizing and directing the Soviet program of nuclear weapons. For more on Igor Kurchatov see (Игорь Курчатов (n.d.)).

of time available for the construction of the nuclear industry. Time was a significant factor that prompted Stalin and Beria to give their approval to the costly strategy of exploring alternative paths to the bomb. All in all, "there is a great gap between knowing what should be done and actually building the plants" (Holloway 1994: 193).

> "It showed that the Soviet Union had the scientists and engineers to create a whole new branch of industry. This was, moreover, not the only high-technology project being carried out in the Soviet Union at the time; the missile and radar projects also required highly skilled people" [Holloway 1994: 192].

Moreover, according to Holloway (1994) research, a command planning economy, and generally a command-administrative system, met the requirements to develop an atomic bomb in the USSR, particularly when it came to mobilizing resources on a massive scale, and then "to channel them into a top-priority project" (Holloway 1994: 193). In a war-ravaged context, although the decision to develop nuclear arms seemed overly ambitious and almost utopian, this economic system accelerated the development of the atomic industry.

> "The project was a curious combination of the best and the worst of Soviet society - of enthusiastic scientists and engineers produced by the expansion of education under Soviet rule, and of prisoners who lived in the inhuman conditions of the labor camps" [Holloway 1994: 172].

It is interesting to mention that the Manhattan Project represented a standard by which the Soviet Union assessed its decisions. It had a significant impact on the Soviet endeavor, because it was successful (Holloway, 1994: 173). However, although the atomic industry was effectively created by this system at the same time, the system was brutal. For example, prison labor, which was already mentioned, was widespread and widely utilized by the system, the natural environment was being destroyed, etc. (Holloway 1994: 193-195).

However, despite problems, there was enthusiasm concerning the role of nuclear physics in Soviet society. The promise that the power of the atom would stimulate labor mechanization, end all heavy, physically demanding and unpleasant work, and fundamentally change the nature of productive forces generally loomed larger than the technical limitations or military pressures that also influenced research and development, for both physicists and policymakers. Within this intellectual milieu, nuclear culture took off quickly. According to many of its early proponents, atomic energy was like "modern alchemy"—a force that could influence any sector of the economy (Josephson 1996: 305). This nuclear atmosphere (culture) in Soviet society served as a paradigm of technological achievement in the USSR. Originating from ideological rivalry during the Cold War, it aimed to prove the supremacy of the Soviet social system "through a series of technological 'firsts', the Soviet nuclear power establishment included, on the eve of the breakup of the empire, 1.5 million employees, 47 top-secret, closed and open research, development, and production cities, and scores of engineering and physics institute" (Josephson 1996: 304).

> "The Cold War provided impetus to the growth of the nuclear establishment, while secrecy and disregard for health and safety contributed to the operation of its facilities with inadequate attention to radioactive waste storage and disposal. Encouraged by the now time-bound practices of party officials and economic planners who embraced mass production as a way to minimize errors in assembly or construction to cut costs and save on materials and equipment, nuclear physicists sought early standardization of fundamental components in many nuclear technologies. Buoyed by their initial successes and convinced that they could do no wrong, technological arrogance and momentum came to dominate their programs. After all, the Soviets built the world's first reactor to produce electricity for a national grid (at 5,000 kW) in 1954" [Josephson 1996: 304-305].

Some Soviet intellectuals, like philosopher Maksimov, expressed doubts about quantum mechanics and the theory of relativity. Maksimov criticized this "Western," "bourgeois" physics, believing it to

be incompatible with Marxist-Leninist ideas. However, toward the end of the Second World War, the theory of relativity and quantum mechanics was accepted, because the atomic bomb worked, and the energy gained by fission came from the theory of special relativity. The neutron capture cross-sections required quantum mechanics. Beria and Stalin were informed that quantum mechanics and relativity were necessary for the creation of the atomic bomb. Soviet physicists, despite attacks from some of the Soviet intellectuals, were left to work undisturbed on the Atomic Project (Pondrom 2018: 642–647).

Maksimov's and similar criticisms do not apply only to the post-Second World War period. Similar criticism is tied to the 1930s, as well as the period of Stalin's rule. In this context, it is important to briefly present the more nuanced insights related to the relationship between science and ideology in the USSR through the example of physics from an earlier period. An examination of historical sources from that time period revealed that the traditional portrayal of debates between philosophy/ideology and physicists in the USSR, as well as what is sometimes depicted as repeated attacks on modern physical ideas by Soviet (state) philosophers-ideologues, had to be revised. "Attacks on leading physicists were not well-formed, except for the comparatively short period of the Great Terror. *Physicists also sought to find a way of describing physics which is compatible with Marxist ideology dialectical materialism*" (Kanayama 2013: 201, *italic added*).

Both the Soviet Union and the United States launched initiatives to expand their nuclear arsenals as the Cold War heated up. The USSR started their own hydrogen bomb development not long after the United States launched its own program in the early 1950s (Soviet Atomic Program 1946; Атомный проект СССР n.d.). During the 1950s, numerous scientific talents were deployed to various military-related research and development programs in both the United States and the Soviet Union as the Cold War intensified. Despite the expectations of Manhattan Project chief General Leslie Groves, the Soviet Union quickly achieved success in developing nuclear weapons. Besides this, in this period (during the 1950s), the world's first nuclear power plant for civil purposes started operating in Obninsk (Ichikawa 2019).

In 1957, as previously mentioned, the Soviet Union launched Sputnik-1, the world's first artificial satellite. The successful launch surprised the US because it had expected its experts and government to achieve this technological breakthrough first. Fears that the U.S. military had lagged behind in the development of new technology were increased by the Soviet Union's success. Thus, the Sputnik launch contributed to escalated Cold War tensions and the armaments race. As a result, government efforts and investment to create generally new technology were intensified (For more see Launius, Logsdon, Smith 2000).

There is no doubt that both blocs pinned their hopes on big science projects during the Cold War struggle for global hegemony. It seems that the biggest difference was that, for example, during the 1950s and 1960s, the Cold War, the West talked about "big science," while the USSR discussed the same phenomenon during the same period but under the name Scientific-Technological Revolution (STR). Following the accomplishments in nuclear physics by the Soviet Union in this period (the building of the first nuclear power plant and nuclear-powered icebreaker as well as the space exploration program, etc.), the term "Scientific-Technological Revolution" (Nauchno-Tekhnicheskaia Revoliutsiia), entered the political and philosophical discourse. It came to refer to the postwar scientific and technological developments that had occurred since the Second World War and that held the potential to change the socioeconomic landscape of the USSR (Aronova 2014: 409-410).

Nuclear Program in Yugoslavia: An Attempt to Create Big Science on a Semi-periphery in the Cold War Context

As previously mentioned, following the tumultuous split with the Soviet Union, Yugoslavia found itself in a situation of apprehension regarding a potential attack by the USSR, which had possessed atomic bombs since 1949 and led other states of the Informbiro. In this context, as also discussed, albeit not in relation to Yugoslavia's nuclear program, the US saw Tito as a potential ally due to his dissident role compared to the rest of the Eastern Bloc. Considering this highly precarious geopolitical context following the breakup with the USSR, the Yugoslav leadership decided to accept US assistance. Thus, particularly in the early stages of this period, Yugoslavia turned toward and heavily relied on the Western Bloc (Čalić 2013; Hobsbawm 1994; Bogdanović 2013: 147-148).

Furthermore, the aforementioned economic reforms in Yugoslavia, imposed by the West, resulted in structural and ideological changes in socialist Yugoslavia. In the context of these changes, as shown in this work, the party and state leadership of Yugoslavia nominally embraced elements of the discourse of independence and freedom of science, accordingly enabling greater decentralization in scientific organization. It has also been indicated in the paper that these changes in the field of science aligned with certain elements of the dominant understanding of the nature and role of science in the Western Bloc (Bogetić 2000: 14, 15, 90; Korolija 2023).

The Yugoslav state's desire for greater independence from both Cold War blocs, along with the need for increased security, also influenced the need for the creation of the Yugoslav nuclear program, with its qualitative leap represented by the establishment of the Federal Commission for Nuclear Energy (SKNE) in 1955. It is interesting and significant to note that despite the split with the USSR in 1948, the SKNE (as well as the Yugoslav nuclear program in general) initially operated following a Soviet organizational model (Bondžić 2016; Miljković 2021).

In this section of the paper, my intention is to illustrate, using the example of the nuclear program in Yugoslavia, specifically focusing on the period of the SKNE, that the new ideological and socioeconomic processes mentioned earlier had an impact on personnel, financial, and organizational changes within the Yugoslav scientific structure. Despite the initial structure of the SKNE (in accordance with the model of Soviet organization), these processes influenced to some extent its financing, policies, and organization. The SKNE generally directed nuclear policy in Yugoslavia. These processes were, as I show, aligned with the dominant Western narrative regarding the nature and role of science in society. After some time, primarily due to loss of ambitions (in that period) of Yugoslav state leadership for nuclear program for various reason, these processes led to the dissolution of the SKNE.

Prominent features of the big science phenomenon, mentioned several times in this paper, also characterized projects like the Yugoslav nuclear program. Gigantomania, state support, the cult of science in society, fusion between science and engineering, multidisciplinary research, collective work, complex bureaucracy, and militarization defined science in both blocs (Kojevnikov 2004: 46). In this section, I will turn to the Yugoslav nuclear program as a case study, with a focus on the aforementioned changes in the structure of the program, to contribute to a more nuanced analysis of the relationship between the dynamics of science and ideology in the context of the Cold War.

Drawing upon Gramsci's theories and his view of the concept of hegemony, along with world-system and dependency theories my intention is to illustrate, through the lens of science in a (semi)peripheral state, industrially and thus in terms of modernization backward – traits that characterized Yugoslavia after the Second World War – the dynamics of relationships and intertwining, as well as the significance of factors such as geopolitics, economics, ideology, and scientific organization. I will do

this by analyzing various elements of dominant discourses regarding the nature and role of science during the Cold War, which accompanied the aforementioned socio-political factors.

A Gramscian reconsideration of the role of science specifically views science as a cultural phenomenon that is politically articulated and socially and historically embedded in struggles for meaning. His theory of hegemony and many of his ideas about culture and knowledge, which he saw as contested areas in the struggle for meaning, invited the study of politics into science (Badino and Omodeo 2021: 2-3). A center draws scientists for conferences, draws students from all over the world for education, has a widespread impact, and regularly gets emulated. People migrated both temporarily and permanently from the periphery to the center, while ideas circulated primarily from the center to the periphery. The imbalance between the periphery and the center was made worse by their frequent unequal exchanges (Schott 1998).

The First Ideas and Steps in the Establishment and Development of the Yugoslav Nuclear Program

Before describing the first steps taken toward a Yugoslav nuclear program, this section briefly discusses the years preceding this program, focusing on the work of a significant Yugoslav scientific figure during that period – Pavle Savić. He was a scientist known in academic circles for his collaboration with Irene Joliot-Curie in the 1930s at the Radium Institute in Paris. According to Kragh (1999), it was "the attempt to explain the Curie-Savitch results that led Hahn and Strassmann to fission" (Kragh 1999: 259). Additionally, Savić was a professor at the University of Belgrade, a partisan, a cryptographer for the Supreme Headquarters of the People's Liberation Army and Partisan Detachments of Yugoslavia (NOVJ), as well as a council member, vice president, and commissioner for education at Anti-Fascist Council for the National Liberation of Yugoslavia (AVNOJ). He was also a soldier, quickly promoted to the rank of major, before becoming a member of the Military Mission of NOVJ and arriving in Moscow on April 2, 1944. Apparently, the main goal of the mission was to organize assistance for NOVJ from the USSR, secure credit, distribute foreign aid, and explore the possibility of international recognition for the revolutionary regime (Bondžić 2015: 91-92). However, upon arriving in Moscow, Savić quickly redirected his attention to scientific work at the Institute for Physical Problems of the Soviet Academy of Sciences.

> "A month after arriving in Moscow, Savić was granted permission by Marshal Tito and Soviet authorities to do scientific work at the Institute for Physical Problems of the USSR Academy of Sciences. He met Pyotr Leonidovich Kapitsa (1894-1984), Aleksandr Iosifovich Shalnikov (1905-1986), and other scientists, which later contributed to the development of Yugoslav science" [Bondžić 2015: 93].

Although Savić's work in physics had previously primarily focused on other field, in Moscow, he studied the behavior of liquid helium at extremely low temperatures. However, during the same year, upon Tito's orders, Savić returned to Belgrade, which was being liberated from Nazi occupation at the time. There, he became a member of the Presidency, commissioner for the reconstruction of Serbia, and later the president of the Economic Council of Serbia. He was also elected as a member of the Central Committee of the Communist Party of Serbia. In 1945, he was elected as a member of the Legislative Committee and the Constituent Assembly. After the liberation, Savić was involved in the reconstruction of the University of Belgrade and was a member of the University Reconstruction Commission (Bondžić 2015: 94). In July 1945, Savić returned to the USSR, specifically to Moscow as a member of the Yugoslav delegation, to celebrate the 220th anniversary of the Soviet Academy of Sciences. However, Savić's work in Moscow also involved securing funds, as well as material and personnel assistance for the establishment of the Institute of Physics in Yugoslavia, with the support of the Yugoslav leadership. The esteemed Soviet physicist Pyotr Leonidovich Kapitsa played a significant role in assisting Savić with the establishment of the Institute in Yugoslavia. Judging by

the construction project for the Institute in Yugoslavia, the idea was to focus on low-temperature research during the first few years and gradually expand the focus to other areas of physics. Savić himself saw the establishment of such an Institute in Yugoslavia as laying the groundwork for organizational and institutional aspects of scientific research (Bondžić 2015: 94-100).

> "It was envisioned that initially, the Institute would have auxiliary laboratories that would serve as the nucleus for future independent institutes, among which the Institute of Physics would be the center of a network of institutions that would be systematically and calculatingly developed in the near future, in accordance with available resources and capabilities, all aimed at the efficient advancement of science and technology as a whole. Savić had a broad vision, accounting for the future 'Academic City – settlement' and the establishment of a national Academy of Sciences, which would oversee the training of personnel and elevate our science and industry. He believed it was not too early to consider this, cautioning that 'nothing is more difficult than removing the creations of improvisation and accidental work'. This forthcoming, state-level Yugoslav Academy of Sciences, unique to the entire country, could not be formed by merging existing national academies, as the Soviet experience, among other things, provided many reasons to oppose it. He wrote to Tito: 'We must create a center for planned scientific research and construction work in addition to the existing institutions (Academies in Belgrade, Zagreb, and Ljubljana), new in spirit, strength, and body, and allow the healthy elements, which those institutions still contain, to find refuge in its shadow" [AJ, KMJ 836, II-6-a/2, Letter from Pavle Savić on the creation of the Physical Institute in Belgrade, March 17, 1946 according to Bondžić 2015: 100].

As already mentioned, the Academy of Sciences in the USSR represented the primary scientific institution in the hierarchy of the Soviet system, with a role defined in accordance with the principles of Marxism-Leninism, which entailed the organization of science based on the principles of centralization and the management and planning of scientific work that prevailed in the USSR. The establishment of a state-level Yugoslav Academy of Sciences, as described by Savić, never occurred. However, as already noted in this work, in 1948, prior to the split with the USSR, a body with a similar role and functioning principles was established in Yugoslavia – the Yugoslav Academic Council. Its primary task was to coordinate scientific work in the country, serve as the Advisory Body on scientific matters to the Federal Government, and represent the state in international events, with its budget allocated from the state budget (Guins 1953: 269-278; Meeting of the delegates of Yugoslav republics' academies in 1948).

It is interesting that Bondžić (2015) cites that Savić, besides the letter and mentioned project for the construction of the Institute, sent to Yugoslavia a book about atomic energy for military purposes, better known as Smyth Report, written by Princeton physicist Henry De Wolf Smyth (for this see also Miljković 2021: 62-63; CIA report 1954b). During the Second World War, Smyth served in the Uranium Section of the National Defense Research Committee and made contributions to the Manhattan Project. On August 12, 1945, the public was made aware of this study, which came out shortly after the US detonated two nuclear bombs on Japan during the Second World War. This document is an unclassified synopsis and report of the Manhattan Project, which produced the first nuclear weapons ever made in the US. The report's objectives were to enlighten US taxpayers and citizens about the Manhattan Project and to give the scientists and engineers involved a framework for what they could and could not talk about. This paper describes the administrative history and framework that shaped the Manhattan Project, as well as the physics of nuclear fission, which underlies the bomb (see Smyth 1945).

In 1946, Tito embarked on an official visit to the USSR. During his stay, he had the opportunity to visit the Institute for Physical Problems in Moscow, where Pavle Savić was working. According to Savić, during their meeting, Tito said to him: "Come back to the country, we will also build an institute" (Savić 1978: 306; Savić 1993: 10). After a few months, Savić returned to Yugoslavia for official party business. However, after the turbulent split between Yugoslavia and the USSR in 1948, he could no longer travel to the USSR (Savić 1978: 306; Savić 1993: 10). Upon returning to

Yugoslavia, Pavle Savić held various positions at the University of Belgrade and the Serbian Academy of Sciences (among other things, he served as a professor of physical chemistry at the Faculty of Philosophy in Belgrade, a professor and head of the Department of Physical Chemistry at the Faculty of Natural Sciences and Mathematics in Belgrade, as well as vice-rector of the University of Belgrade, and a corresponding member of the Serbian Academy of Sciences) (Bondžić 2015: 103). As the vice-rector of the University of Belgrade, Savić replaced the then vice-rector, philosopher Dušan Nedeljković, known for taking rigid Marxist-Leninist positions and antagonizing a large part of the academic community that was rooted in the pre-war Kingdom of Yugoslavia (Savić 1993: 10).

Yugoslavia's separation from the USSR and its initial shift toward the West in terms of geopolitical relations could clearly be observed in its role, together with NATO members Greece and Turkey, in the formation of the Balkan Pact in 1953 (Jakovina 2003: 350). In the realm of nuclear diplomacy, the result of such policy was Yugoslavia's encouragement by the West to become part of the founding group of the European Organization for Nuclear Research (CERN) in 1951, which was associated with the Western Bloc during the Cold War. CERN's political role during this period also involved promoting the goals of the Marshall Plan, which included providing scientific and technological assistance to aid the development of underdeveloped countries (Chomsky 1999; Krige 2006). However, this was not the only function of CERN in the Cold War, as the organization also served as a valuable Western platform for alliance-building, guided by the US.

> "In a world increasingly divided into two camps, CERN was also unambiguously aligned with the West. Moreover, it did not simply confirm existing alliances. By including Tito's Yugoslavia among the original twelve member states, the founders deliberately tried to drive a wedge into the Soviet bloc and lure other satellites to follow the example of the rebellious Yugoslav leader. In 1951 a group of leading academics in the Boston area prepared a special (classified) report on "political warfare" for the State Department. They recommended that Yugoslavia "be given not only emergency aid but every possible support in developing an economic and political life independent of Russia." The satellites on the other side of the iron curtain, they went on,"struggling to exist under the pitiless demands of the USSR, will observe the growing progress of Yugoslavia. No argument against the Russians could be more persuasive." CERN was not simply an instrument to promote the aims of the Marshall plan in Europe. It was also a platform on which to build a Western alliance under American leadership" [Krige 2006: 67].

As evident from the above, Yugoslavia's decision to join CERN as a member state was politically based in a segment of the broader US strategy to campaign hegemony in Europe in the fields of science and technology as well. Part of this strategy was aimed at fostering Yugoslavia's development and independence from the USSR, with the goal to extend defection from the USSR to other Eastern Bloc countries. Over time, due to this policy, the idea crystallized that this strategy was instrumental in preventing Yugoslavia from returning to the Eastern Bloc (which the CIA believed Yugoslavia would be compelled to do). In this context, the practical geopolitical significance of political support to Yugoslavia was emphasized, in the sense: Soviet penetration of Europe has been pushed back geographically; settlement of the Trieste problem; better cooperation between Yugoslavia, Turkey and Greece etc. (Krige 2006; CIA report 1962).

As previously discussed, it was in this geopolitical context that the system of socialist self-management was formed in Yugoslavia. The assistance of the US following Yugoslavia's geopolitical shift in party and state leadership, as well as the socio-economic processes that ensued and included, besides ideological elements, changes such as decentralization, "debureaucratization", and the strengthening of limited markets, all influenced scientific organization and the understanding of the nature and role of science in society in Yugoslavia (Petranović 1980: 507-532; Bošković 1981).

However, despite these influences in the field of science, there were attempts to develop the Yugoslav nuclear program along the lines of the Soviet model of organizing science even after the split with

the USSR. In this context, it is interesting to note that the initial idea regarding the Institute of Physics, prior to the split with the USSR – to serve as the foundation for scientific research in a country that would focus on the development of physics as a science in general – was sidelined. Following the breakup with the Soviets, the purpose of the institute, as perceived by the Yugoslav state and party leadership, shifted toward the development of nuclear technology, probably with the long-term aim of producing nuclear arms (for more see Bondžić 2016: 74-114).

In line with this, the Institute of Physics was established as a federal institution for the study of the atomic nucleus. Specifically, in 1948, the Institute of Physics was founded as an independent institution under the Presidency of the Government of the FPRY, with Pavle Savić as its director until 1949 (Vukanović 2000: 12). In the book *Half a Century of the Vinča Institute* [*Pola veka „Instituta Vinča"*] (2000), Pavle Savić and his colleague from France, Robert Valen [43] are named as the primary conceptual and programmatic creators of the Institute. When the first facilities were built, Savić reached out to Robert Valen and invited him to Yugoslavia to run the Physics Laboratory (Savić was in charge of the Physics and Chemistry Laboratory) (Vukanović 2000; Savić 1993: 3; Jevtić 1998: 12). Slobodan Nakićenović[44] became the director of the Institute in 1949, and in 1950, the Institute was renamed the *Institute for the Study of the Structure of Matter* (Institut za ispitivanje strukture materije). Stevan Dedijer[45] was appointed as the director of the Institute in 1952, and by the decision of the Federal Executive Council in 1953, the Institute was renamed to "Boris Kidrič" (Vukanović 2000). The significance of this project for the Yugoslav state is evident in the statement: "The Boris Kidrič Institute has been controlled directly by the central government from the very beginning" (Ražem 1994: 313).

In 1948, by the decree of the Government of the Socialist Federal Republic of Yugoslavia, the Administration for the Coordination of Scientific Institutes was established as an organ within the Presidency of the Government of the FPRY. Bondžić (2016), based on a thorough analysis of the first reports on the work and tasks of this institution (from 1948 and 1949), observes that the focus of the institution was on ensuring coordination with the State Security Service. He notes that the primary goal of this institution was to fulfill the demands of the state leadership regarding advancements in nuclear energy.

The preferred model of this scientific organization was centralized, with police and party officials heavily involved in the institution's work. Accordingly, a high level of secrecy surrounded its operations (CIA report 1953; Bondžić 2016: 74-82; see also Miljković 2021: 74-85). The intertwining

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[43] Robert Valen was born in Rotterdam, the Netherlands. From the age of ten, he lived in France, where he studied to become a nuclear physicist. During his studies, he met Pavle Savića, and, being left-oriented himself, he accepted Savić's invitations to build a modern Institute in an underdeveloped country during the first post-war years. In 1954, Valen returned to France, where he was not warmly accepted by the Stalinist oriented French left, who were critical toward his Yugoslav adventures. He died at the age of 83, without a French citizenship, despite spending almost 70 years of his life in France (Vukanović 2000: 15)

[44] Slobodan Nakićenović (1916-1996) was a noted participant of the Yugoslav nuclear program. He was a prominent WWII Yugoslav partisan, and after the war, in which he was promoted to the rank of lieutenant colonel, was occupying different positions: he was political commissar at the Ministry of defense, member of the Radio-committee of FPRY, general director of the Radio-industry, head of the Office for the coordination of work of science institutes. He was head of institute in Vinča from 1949 till 1952. Later, he became State undersecretary, Secretary of SKNE until 1964 and then Director of the Division of Safeguards and Inspections of the International Atomic Energy Agency (IAEA). He was also founder and president of the Amateur Radio Union of Yugoslavia, member of the presidium of Peoples technics of Yugoslavia, member of the Council of Belgrade university etc. (see e.g, Bondžić, 2016: 60; Perović-Nešković (ed.), 2000: 16; Hall, 1987: 53).

[45] Stevan Dedijer was a Yugoslav nuclear physicist, social theorist and one of the founders of business intelligence, who was sent to the Vinča Institute in the early 1950s by the CPY leadership to work with Savić on a nuclear program, i.e. to make an atomic bomb. However, since he was not well versed in the technical features of the project, most likely he was sent there to control Savić. In 1952, Stevan Dedijer became director of the Vinča Institute, replacing Slobodan Nakićenović (See: Bondžić, 2016; Savić, 1993; Ristić, 2000).

of party and police influences in the work of this scientific institution not only underscores the project's importance for the Yugoslav leadership but also, along with centralization in the organizational model, points to a recognizable Soviet model of scientific organization (Miljković 2021: 119).

The first director of the Administration for the Coordination of Scientific Institutes was Batrić Jovanović, previously the assistant federal minister for non-ferrous metallurgy (Spasić 2013). In 1952, the Administration changed its name to the Administration for Mining Research and Mining Studies, and by the decision of the Federal Executive Council in 1953, it was renamed the Institute for Geological-Mining and Technological Research. Its director was chemist Miladin Radulović-Krcun[46], who later became the director of the Directorate for Nuclear Materials at the Federal Commission for Nuclear Energy (Spasić 2013), which will be discussed later. After several more name changes, in 1966, this institution was renamed the Institute for Nuclear and Other Mineral Raw Materials Technology (ITNMS), which it still uses today (Korolija 2019).

During this period, specifically in 1952, the Commission for Assistance in Scientific Research was established within the Presidency of the Government of the FPRY. Its primary task was to contribute to the development of scientific research, with a focus on the advancement of new scientific fields. The President of the Government of the FPRY appointed the president and members of the commission. Boris Kidrič was appointed as president of the Commission for Assistance in Scientific Research. Bondžić (2016) observes that the inclusion of a military representative in the Commission's scientific research responsibilities indicated the direction of nuclear energy research during that period (Bondžić 2016: 82-83).

> Generally speaking, "[f]rom 1948 to 1955, therefore, there were several organs in the state leadership who represented a link between science, scientific institutes, politics, the economy, the army, and the UDB [State Security Service]. Through these organs, ambitious plans of the state leadership related to scientific research, primarily the development of nuclear energy and its application, were defined and implemented. Prominent political and economic leaders, military representatives, secret police, and scientists were appointed to them. […] They were under constant surveillance by the UDB authorities..." [Bondžić 2016: 83].

In the text *The Birth and Growth of the Institute* [Rađanje i izrastanje instituta] (2000), Zdravko Dizdar, who worked as an assistant and expert collaborator at the Institute during the 1950s and later served as its director in the 1970s, rightfully emphasizes that the decision to embark on such a scientific project for a country that had just emerged from an extremely exhausting war required a lot of courage. According to him, the situation was further complicated by the fact that "even before the war, the country did not play a significant role in the world of science: few individuals had any scientific experience, and even fewer had any connections to world science" (Dizdar 2000: 20). Accordingly, he later notes in the text that when it came to resources for work, they had to start from scratch: the first equipment and books were purchased abroad, which enabled the functioning of laboratories and libraries.

> "In equipping the laboratories, both then and later, a major role was played by workshops where skilled craftsmen worked, often referred to the Institute from various work collectives across the country. In those early days of nuclear energy development, most detection, measurement, and other devices were new and commercially unavailable, requiring fabrication within the laboratories themselves. This was also the case in the early years in the Institute's workshops, where, in close collaboration with

[46] Miladin Radulović Krcun (1912–1982) was Yugoslav chemist, pre WWII communist, Yugoslav partisan and an intelligence operative, prominent communist functionier after the war and head of mining and geological reseach and noted participant in the Yugoslav nuclear program (see Bondžić & Živković 2018).

> researchers, a series of highly complex devices and instruments were designed and constructed…" [Dizdar 2000: 23].

Further in the text, Dizdar points out the significant scientific progress achieved in a short period, attributing it to the work and investments in this scientific project. He claims that this created "a solid foundation for work in some basic nuclear disciplines in the fields of physics, chemistry, and biology. This allowed research to expand in the following years to many other basic and applied nuclear disciplines" (Dizdar 2000: 25). Considering the significance of nuclear physics for this segment of work, it is worth mentioning that the book *Physics of Nuclear Reactors* [Fizika nuklearnih rekatora] (2003) mentions the group for neutron physics as an indicator of the general orientation of the Institute in the early 1950s. This group's program focused on mastering the theory of neutron slowing down and diffusion, as well as corresponding measurements. The group operated within the Physics Laboratory. "By establishing the Laboratory for Radiochemistry and acquiring radium, basic conditions were created for experimental work with neutrons, and so measurements of the spatial distribution of neutrons in water, paraffin, and concrete began as early as 1951" (Stefanović and Pešić 2003: 52). The same text emphasizes that a series of lectures on reactor and neutron physics were held at the Vinča Institute in 1952-53. Thanks to this, a foundation was laid for courses in physics and technology of nuclear reactors, which were later held at the Faculty of Electrical Engineering in Belgrade, Yugoslavia. This marked the beginning of the establishment of the Department of Physics and Nuclear Engineering, from which the Department of Technical Physics later emerged at the same faculty (Stefanović and Pešić 2003: 52-53).

It is interesting to note that the CIA report from 1954 mentions Yugoslav engineer Milorad Ristić[47] as the "head of the reaction group and also head Party man in the institute" (CIA report 1954b). In the context of Yugoslavia's shift toward the Western bloc, it is noteworthy that the CIA report notes that Ristić's report to the Central Committee of the Federation of Communists of Yugoslavia (FCY) regarding the experimental reactor, mentions Sweden, France, and Norway as options for coordination, as similar experiments were being conducted in these countries (CIA report 1954b). These countries were part of the Western Bloc (although Sweden was formally neutral) with France and Norway also being part of NATO at that time. Moreover, the CIA report mentions that the Institute employed many young researchers from the University, most of whom had attended courses at one of the foreign institutes for atomic research, as well as that they were collectively recognized as the *Atomic Battalion*. Additionally, the book *Physics of Nuclear Reactors* (2003) mentions the Norwegian Institute for Atomic Energy in Kjeller as an institution possessing a research reactor and as the first institute to host associates from the Vinča Institute in Yugoslavia for specialization in 1952. Through this collaboration, Yugoslav scientists produced significant work in the field of neutron physics. Furthermore, the CIA report from 1954 adds that "there was no secret about the method of producing atomic bombs and artillery missiles so far as Yugoslavia was concerned, since they had a copy of the Smyth report and therefore knew in detail the technique of separating U 235" (CIA report 1954b).

However, although the CIA in 1954 believed that knowledge was not a barrier to Yugoslavia's ability to develop nuclear weapons, it identified objective obstacles to the creation of bombs, primarily of a financial nature.

> "… in order to produce 10 atom bombs a year it would be necessary to purchase a huge quantity of uranium and invest about 90 billion dinars in the requisite machinery for separating it. Moreover, the electric current required for cooling the reactor producing plutonium would be about 2,000 kilowatt

[47] Milorad Ristić (1917-2002) was director of the Vinča institute from 1961 till 1965. After that, for four years, he was working at the IAEA in Vienna as an expert on nuclear power plants. Upon his return to Yugoslavia, he started his academic career as a full professor at the Faculty of Mechanical Engineering of Belgrade University (Perović-Nešković (ed.) 2000: 30; Bondžić 2016: 423).

> hours equivalent to the present total production in Yugoslavia. Under especially ideal conditions, therefore, the production of 10 atom bombs a year would cost 25 percent of the national yearly income or about the same as the total defense budget. It was therefore clearly not worthwhile" [CIA report 1954b].

In this context, it is interesting to highlight that in his autobiography, Stevan Dedijer (2000) claims that when he was in Belgrade in January 1950, Edward Kardelj explicitly told him that Yugoslavia must have an atomic bomb, so that Yugoslavia could "talk with both the East and the West on an equal footing" (Dedijer, 2000: 333). This is supported by the words of the, at the time, still respected party official Milovan Đilas: "I am for the words of Lenin: Among the wolves, I howl. While surrounded by wolves, one must defend oneself and have the most powerful weapons" (Đilas according to Bondžić 2016: 105; Đilas according to Miljković 2021: 117-118). However, in addition to the significance that the atomic bomb would play in military security and geopolitical terms, it would also, as Bondžić (2016) notes, have a significant role in maintaining the power of the Yugoslav party and state leadership at the time. Moreover, possessing an atomic bomb, especially then, would carry prestige on the international stage (Korolija 2019: 717). Here, on the example of the atomic bomb, it is clearly seen that prestige, that is, social reputation, according to sociologist Max Weber, represents power that is connected to economic and political power (Pavlović 2009: 21).

Dedijer (2000) further claims that quickly upon arriving in Vinča, he realized that the idea of creating a nuclear bomb was "pure fantasy." He claims to have realized this as soon as they began producing graphite, which was necessary for atomic reactors. At that moment, he understood that they could not even make "a mixture for making pencils," let alone produce graphite of "extremely high quality and purity" (Dedijer 2000: 333).

Funding for running the institute was provided by the Presidency of the Government of the Socialist Federal Republic of Yugoslavia and the Federal Planning Commission, highlighting the project's national significance. Accordingly, some physicists at the institute also served as party informants, tasked with overseeing the institute's work. Interestingly, it was these informants who noticed and reported that the level of party loyalty in the institutes was unsatisfactory (Bondžić 2016: 68). As for the idea of party science itself, it can be assumed from the text that it quickly lost its significance in practice, if it ever had a systematic basis in the daily work of scientists. However, despite this, the party's importance in the Vinča Institute during this period could not be denied. Consequently, despite the turbulent split with the USSR and a certain ideological deviation from Soviet ideology in science, the project was subject to direct and clearly hierarchical supervision by the Yugoslav state.

The book *Physics of Nuclear Reactors* (2003) states that during 1954-1955, there was further elaboration of the idea of developing nuclear technology at the Vinča Institute. This was based on "the assumption of autonomous development of the application of nuclear energy in the country, primarily the development of nuclear energy" (Stefanović and Pašić 2003: 53). According to Ražem (1994), regarding the first International Conference on the Peaceful Uses of Atomic Energy in Geneva in 1955, its establishment was conditioned by the context of the disclosure of nuclear knowledge. The USSR also participated in the conference (Stalin died in 1953). Yugoslavia, which in this period began to build its independence through the policy of non-alignment with the Third World countries, presented its results and collected experiences and information about the current situation in the world. "The conference presented the results of studies which were made public for the first time after many years of secrecy" (Ražem 1994: 314). In *Physics of Nuclear Reactors* (2003), it is argued that the aforementioned UN conference on the peaceful use of nuclear energy provided significant encouragement for furthering the idea of developing nuclear technology in Yugoslavia. The scientific results presented at this conference helped "to realistically assess possible paths of nuclear technology development" (Stefanović and Pašić 2003: 53).

It is worth noting that Savić (1993), recollecting the United Nations Conference in Geneva in 1955 and the positive reactions to the report of Yugoslav scientists about the catalyst for obtaining heavy water, pointed out that Yugoslavia did not intend to produce weapons. "We had no intention of producing a bomb, so we had no reason to hide such results. Those who had such results (the great powers) declassified the details as soon as they could so as not to lose ground. It turned out that they used the same material as us" (Savić 1993: 17). According to Bondžić (2016), it seems that, it can be concluded that although Savić somewhat avoided confrontation with the Yugoslav leadership and sometimes even supported their ideas regarding nuclear weapons, considering everything, he never seriously dedicated himself to and engaged in the process of developing nuclear weapons.

Although this section of the work primarily focuses on the Institute in Vinča and later the SKNE, it is important to note that after the establishment of the Vinča Institute, institutes for physics were also created in other Yugoslav republics: the "Ruđer Bošković" Institute in Zagreb, Croatia, and the "Jožef Stefan" Institute in Ljubljana, Slovenia. According to the final views from a CIA report in 1958 regarding the progress and operation of the Yugoslav atomic energy project, prepared by *the Office of Scientific Intelligence*, it was indicated that during the first half of the fifties nuclear research institutes had been established in Yugoslavia. Additionally, it notes that a "number of scientists had been trained both abroad and within Yugoslav institutes, and deposits of low-grade uranium had been located" (CIA report 1958: 2).

It should be noted that one of the requirements for developing nuclear weapons was the discovery of nuclear raw materials, specifically uranium ore. Bondžić (2016) reports that uranium fever began in Yugoslavia during this time period. The search for uranium, a secret strategic raw resource, required constant and intense surveillance by the UDB and was veiled in secrecy. "The secrecy was inviolable, and no one dared defy it, as the most important state secret. The UDB maintained everything under its watchful eye and oversight. Wherever uranium-related activities were taking place (fields and institutes), everything was pervaded and subjected to UDB" (Bondžić 2016: 94). Even though, during this period, the UDB was in charge of monitoring and checking everything and everyone who had any connection to uranium, this jurisdiction was later transferred to the army, most certainly the military security service; nonetheless, the relationship with uranium stayed the same up until the 1960s, when this relationship changed (Bondžić 2016: 94). The involvement of the security services with such projects was also characteristic of the Manhattan Project, that is, of projects of this type in the US as well. Nuclear programs by definition represented a security priority and therefore it was considered that any unforeseen and unauthorized sharing of secret information could threaten the security of the country developing it.

Moreover, in 1955, as noted, the Federal Commission for Nuclear Energy (SKNE) was established. This commission, which will be discussed further in the text, marked a qualitative leap in the development of the Yugoslav nuclear program.

Development of Nuclear Technology in Yugoslavia During the Period of the SKNE

Yugoslavia's nuclear policy was strengthened in 1955, which was accompanied by the development of new organizational forms, methods, goals, and tasks. The goals were primarily focused on the application of nuclear energy in the industrial field and were related to peacetime efforts, but "also to the further hidden, secretive, under the strict control of the state and the UDB, production of atomic weapons" (Bondžić 2016: 114). The Federal Commission for Nuclear Energy (SKNE) is regarded as a key component in the development of Yugoslavia's nuclear program. The SKNE was established in 1955 as the organ of the Federal Executive Council (SIV). The primary mission of the SKNE was to coordinate, aid, and steer the advancement of nuclear sciences, nuclear energy, and their applications. From its inception in 1955 until the end of 1961, the SKNE was the

agency responsible for financing nuclear institutes from the federal budget and allocating funds to the institutes (for more see Bondžić 2016: 117-137). According to Miljković: "[b]ehind the strength of its formal position, the SKNE actually enjoyed much more power than an average ministry, which in fact made it a state within a state" (Miljković 2021: 236).

The significance of the SKNE in nuclear research and its structural role in nuclear scientific activities becomes apparent from the Decision adopted by the Commission under Article 6 of the Regulation establishing the Federal Commission for Nuclear Energy/Official Gazette no. 12/55. The Decision clearly stated that the "Boris Kidrič" Institute in Vinča, Serbia (at that time still called only "Institute in Vinča"), would be placed under the supervision of the SKNE, along with the "Ruđer Bošković" Institute in Zagreb, Croatia, and the "Jožef Štefan" Institute in Ljubljana, Slovenia. Furthermore, the Decision specified that these institutes would execute all tasks assigned to them by the SKNE (AJ 177-14-40; see also Bondžić 2016: 117-120). The book *Display of Nuclear Energy in Yugoslavia* [*Izložba nuklearne energije u Jugoslaviji*] (1960) noted that:

> "The Commission supervises activity in the field of nuclear energy, takes steps to research certain key issues in the field of nuclear energy outside of the Commission's jurisdiction, and to that end, delegates authority to relevant institutions and organizations. The Commission, with the approval of the Federal Executive Council, decides on the Commission's involvement in international organizations and their activity" [*Izložba nuklearne energije u Jugoslaviji* 1960:7].

The manner in which the SKNE performed its tasks was something that even the CIA turned its attention to in 1958. According to the CIA report, in order to carry out the tasks assigned to it, the Commission established a number of organizational units to investigate issues related to its work, implement its acts, oversee the establishments that carry out its tasks, and render decisions on matters falling under the purview of the Commission. The Division for Contacts with Foreign Countries, the Division for Protection from Radiation, the Section for Production and Application of Atomic Energy, the Section for Scientific Research, the Directorate of Nuclear Raw Materials, and various administrative divisions are some of these organizational units (CIA report 1958: 3-4).

In this context, it is worth reiterating that until the late 1950s, science in Yugoslavia was directly funded by federal and republic budgets (Blagojević 1982: 316). Similarly, in the USSR, as previously indicated, the state was responsible for financing and organizing institutes, which were independent of the University (Kojevnikov 2004: 23). The significance of the SKNE is evidenced by the fact that Aleksandar Ranković was appointed as its head – a figure who founded the State Security Service (UDB) and served as its leader, in addition to being Deputy Prime Minister, known as the second most important figure after Tito (Đorđević 1989; Dimitrijević 2020: 117-120, 189-191, 216-227). The UDB was established after the Second World War through the reorganization of the Department for People's Protection (OZNA). The organization aimed to emulate the Soviet model of organization. In addition to Ranković's appointment and direct state funding, which underscored the importance of the entire project for the state, strong hierarchies and high centralization marked the year 1955 in terms of the organizational structure of the SKNE and nuclear technology development in Yugoslavia.

In the already-mentioned CIA report from 1958 about the Yugoslav nuclear program, the creation of the SKNE is seen as the beginning of the second phase in the program's development, with the following goals and tasks:

> "Under this Commission, the Yugoslav program was to concentrate on the further training of physicists and workers; equipping institutes with advanced equipment; increasing cooperation with foreign nuclear science institutes and organizations; performing basic research in atomic energy; and producing isotopes for use in agriculture, industry, and medicine. Currently, these objectives are being accomplished and the Yugoslavs are beginning to investigate the production of nuclear materials" [CIA report 1958: 2].

The 1950s saw a partial declassification of nuclear knowledge at the global level, with the emphasis shifting toward technological cooperation and the exchange of scientific information among scientists worldwide. However, this situation seemed to have been most advantageous to the United States, considering that it held an advantage in nuclear technologies and knowledge compared to other countries. This can be seen as an important reason for the United States' decision to share confidential and closely guarded information with allied states. Of course, the United States remained cautious and sought to ensure that this sharing did not compromise its national security or economic advantage. However, the United States stood to benefit from this distribution of scientific knowledge and, generally speaking, its socio-economic power in the Western Bloc. Through scientific partnerships with countries less favorably positioned on these issues, the United States was able to gain new information, control the direction in which the nuclear program develops in them, and shape these countries' scientific communities. As a result of this strategy, research priorities were redefined, institutional structures for knowledge production were established, and nuclear programs in other countries were directed in a manner that suited the United States, not least because it potentially created new market footholds (Krige 2016: 7-10). The main goal of this political strategy was to prevent the spread of "communism" and the proliferation of nuclear weapons in other countries. During the Cold War, science and technology were accorded the function of "soft power" by those who held greater power (Krige 2016: 9; Krige 2006).

> "The asymmetry that derived from US scientific and technological pre-eminence provided American administrations with a "powerful political force" (Hornig) with which they hoped to shape both Europe's research priorities and the institutional forms in which knowledge was produced. This fusion of technological leadership with political leverage should not be taken for granted [...] The United States, by contrast, sought to use its technological advantage in collaborative projects to learn what it could from others, to get a foothold in potential markets, and to shape the research priorities of its allies. Confident of its ability to exploit any new idea more rapidly than its competitors, and of the entrepreneurial dynamism of its industry, the US didn't balk at collaboration but rather embraced it to achieve scientific, commercial, and political objectives" [Krige 2016: 9-10].

A good example of the tendency to shape European nuclear programs in line with US national interests is found in the text by historian of science Simone Turchetti (2014). In Italy, a national research committee was established in 1952 to investigate the peaceful uses of atomic energy, particularly with regard to the construction of nuclear reactors. Making Italy less dependent on foreign energy sources was one of the committee's objectives in using nuclear power. However, Turchetti (2014) showed that Italy's dependence on overseas assistance increased as a consequence of the atomic energy initiative.

> "I explain the reasons for this outcome by looking at the unfolding of US–Italy relations and the offers of collaboration in the atomic energy field put forth by the U.S. State Department and the U.S. Atomic Energy Commission. I argue that these offers undermined plans to shape the nuclear program as its Italian architects had envisioned, caused them to reconsider the goal of self-sufficiency in energy provisioning, and reconfigured the project to be amenable to the security and economic priorities of the U.S. administration. In this way, I conclude, the path for the Italian project to ''de-develop'' was set" [Turchetti 2014: 470-471].

As for Yugoslavia in this period, it is interesting to turn to a CIA report on considering foreign training in nuclear science, which notes that regardless of Yugoslavia being more open to the USSR than before, it still preferred training in the West.

> "The Yugoslavs prefer training in the West rather than in the USSR for several reasons. Yugoslav oflicials have stated that in the West much more information was available to the students; the USSR, they say, has withheld information as classified that would be completely open in the West. An 'additional factor is the frequent change in the political relationship between the USSR and

> Yugoslavia. Several times in the past, a Yugoslav has gone to the USSR during a period of good relations and then been forced to remain idle or return home when political relations cooled" [CIA report 1958: 7].

According to a 1958 CIA report about providing the research reactor to the Institute at Vinča, it is noted that the USSR agreed to supply heavy water, natural and enriched uranium for both the reactor and the critical assembly that the Yugoslavs built themselves, as well as that the goal of the Yugoslav purchases was to limit the number of "strings" linked to the Soviet agreement. Initially, the report notes that Yugoslavs tried to acquire a research reactor from the US, but they ended up turning to the USSR due to the US's requirement that any bilateral deal include "safeguard" terms, which guarantee only peaceful applications. Moreover, the CIA (1958) remarked that despite Yugoslavia's refusal to accept the conditions of a bilateral agreement with the US, the country persisted in sending students to the West (e.g., the US AEC (Atomic Energy Commission) atomic training facilities at Argonne and Oak Ridge). Besides this, the CIA (1958) added that Yugoslavia showed interest in learning more about uranium treatment and in purchasing power and experimental reactors from the US.

Moreover, in the context of the role of scientific internationalism, as described above, it is important to note Yugoslavia's cooperation as part of the so-called Atoms for Peace program[48], launched in 1953 after the speech of the same name made to the UN by US President Eisenhower

> "In 1953 Eisenhower announced his Atoms for Peace program to rapturous applause at the United Nations. It was implemented by the AEC using bilateral agreements with friendly governments that included safeguards to keep nuclear knowledge, materials, and technology from being diverted from reactors into national weapons programs [...] Heartened by these initiatives, Europeans, eager to enter first the Atomic Age and then the Space Age, actively sought what the US could give so as to learn from the leader, to avoid duplicating what had been done elsewhere already, and above all to save time and money. The US was willing to cooperate so long as its national security and economic advantage were not jeopardized by the sharing of sensitive information and technology" [Krige 2016: 7-8].

As already noted in the text, Yugoslavia was of major geopolitical and strategic significance to the Western Bloc. Owing to this, the country was able to obtain significant nuclear and technical support, as well as the opportunity to participate in the exchange of scientific knowledge thanks to the Atoms for Peace program. However, the support and opportunities that Yugoslavia enjoyed during this period came with a cost. The other side of the Atoms for Peace program, according to Hymans (2012), was that it slowed the development of the Yugoslav nuclear program. According to him, it is also important to note that the program affected Yugoslav scientists in that it influenced their views on the Yugoslav nuclear program. As a result, this negatively affected its advancement, which was favored by the Yugoslav state leadership. Because of this influence, Yugoslav scientists began to increasingly lean toward non-proliferation. Several notable scientists even abandoned the work on the Yugoslav nuclear program, and some even left the country (Hymans 2012: 174-182).

Based on the aforementioned CIA report from 1958, which primarily addressed the goals of the Yugoslav project and the potential for achieving it, one can observe the attitude toward foreign aid to Yugoslavia, particularly after Stalin died in 1953 and an easing of strained relations with the USSR. According to this report, to progress its atomic energy program, Yugoslavia needed outside assistance, which it received from the USSR and Western countries. Even though Yugoslavia was expected to continue to solicit the cooperation of different countries, the report notes that relying solely on one state for aid is unlikely to harm its program. While getting training and isotopes from

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[48] The "Atoms for Peace" program aimed at providing conditions for nuclear research to countries that previously did not possess nuclear technology, with a focus on preventing nuclear weapon proliferation and containing the USSR. The IAEA was established in 1957 as the global entity promoting the principles of "Atoms for Peace" (for more see Leszczynska 2002; Tomić-Petrović 2022).

the West, Yugoslavia obtained most of the hardware for its nuclear energy project from the USSR. Nevertheless, the Soviets offered to train Yugoslav personnel, while the US offered to sign a bilateral research agreement that would facilitate hardware sales (CIA report 1958).

The same report also mentions that Yugoslavia lacks the plants necessary to produce weapons-grade nuclear material (CIA report 1958).

> "Although provisions have been made for production of a plutonium separation plant at Vinca, no progress has been made in attempts to obtain technical information and equipment from the Soviet Union for full-scale plutonium processing. Until such plant is in operation, the irradiated fuel from the research reactor will probably be returned to the USSR, which will undoubtedly retain the plutonium" [CIA report 1958: 2].

In connection with production at the nuclear institutes, and in the context of the Yugoslav nuclear program, it is significant that the institute's workers, prior to importing instruments, were tasked with manufacturing them. Accordingly, it was estimated that each institute had a well-equipped workshop for the production of equipment.

> "In the years when the various institutes were being established and equipped, it was virtually impossible to import Western instruments and equipment due to foreign exchange limitations and trade restriction. As a result, the workers of the institutes had to 'produce much of their own equipment. Each institute has a well-equipped workshop where nearly all equipment is produced. At the Rudjer Boskovic Institute, for instance, Geiger-Mueller tubes are produced for all three institutes and many of the parts for the cyclotron were made. At the Boris Kidric Institute, the scientists and technicians constructed their own mass spectrograph, 120 channel analyzer, and Cockroft-Walton generator" [CIA report 1958: 7].

In connection with the "Boris Kidrič" Institute during this period, the report also mentions that Western scientists visited this institute on numerous occasions and were allowed to examine the whole facility, except for the warehouses housing Soviet reactor components and equipment (CIA report 1958: 5). In another CIA report from 1964, again in connection to the "Boris Kidrič" Institute, it is noted that the total workforce of the institute during that period was 1200; and that a great deal of attention was given to the "technical instruction of specialized personnel in the applications of results achieved in the fields of medicine, agriculture, industry, and electronics" (CIA report 1964: 1); as well as that, at the time, there were "under study or in preparation nuclear propellants from uranium extracted from the mines at Kalna. These propellants are to be employed in the first nuclear-electric central, construction of which is scheduled to start in 1970" (CIA report 1964: 1).

In connection with the Yugoslav nuclear program, the 1958 CIA report states that newer reports suggest that security has been tightened and that the training of scientists in the nuclear sciences was conducted through the operation of these nuclear physics institutes. Nonetheless, despite greater security measures in place, the CIA concluded that the Yugoslav nuclear program could be described as "a small atomic energy program which currently consists almost entirely of basic nuclear research" (CIA report 1958: 1). In this context, it was noted again that Yugoslavia, although previously interested in nuclear electric power, came to the realization "that the application of nuclear electric power is not economically feasible in Yugoslavia, which has large amounts of untapped hydro-electric power resources" (CIA report 1958: 1).

In the context of the Yugoslav nuclear program during the Cold War, it is important to mention the establishment of the Non-Aligned Movement, officially formed in 1961, of which Yugoslavia was one of the founding members. Starting in the 1950s, when the Movement was in the process of formation, and formally from 1961, achieving world peace was a significant ideal of the Movement. In line with this ideal and its perceived importance, the Non-Aligned Movement advocated for the

limitation of nuclear arms, which can be seen through the positions the Movement actively took in various debates on the topic (Lüthi 2020: 287-307).[49] Already at the founding conference in 1961 in Belgrade, the issue of nuclear arms emerged as important. This topic was notably marked by the USSR's decision to end its three-year moratorium on nuclear testing. Considering that the moratorium involved the participation of the US and the UK, the USSR's decision was seen as a step leading to the deterioration of the international situation. However, in 1963, an agreement on the partial prohibition of nuclear testing was reached internationally between the US, the USSR, and the UK. The Non-Aligned Movement supported this agreement (Lüthi 2020: 297; CIA report 1963: 25). In accordance with this, the CIA report (1963) regarding Yugoslavia's reaction states the following:

> "A Yugoslav Foreign Ministry statement 'warmly welcomes' the initialing of a partial test ban agreement 'as an event of the greatest international significance'. The statement, summarized by TANYUG, maintains that the accord reached 'convincingly confirms the correctness of negotiating and the need for mutual confidence, serves as evidence of the practical value of the policy of peaceful coexistence, and opens up considerable prospects for further negotiations'. A POLITIKA article, TANYUG reports, 'emphasizes the great merits of the three signatory powers', but points out that with this credit goes 'responsibility for the future development of everything relating to this agreement and all that may violate it'" [CIA report 1963: 31].

Thus, it appears that in the 1960s, Yugoslavia abandoned the idea of creating an atomic bomb (Konta 2019: 436), at least until the next attempt, which is beyond the scope of this work. In this context, it is also worth mentioning that, it was considered that the Yugoslav nuclear military program never progressed significantly, despite the government's nuclear research program in the 1950s aimed at developing the capacity to construct an atomic bomb (Potter et al. 2000). Andrew Koch (1997) argued that there was no substantial evidence of a significant nuclear weapons program in Yugoslavia. In Slobodan Nakićenović's book on the development of nuclear energy in Yugoslavia, published in the early 60s, only the peacetime application of nuclear energy is mentioned (see Nakićenović 1961), which was the official state line at the time. Bondžić (2016) suggests that, in the early 1960s, the Yugoslav state and military leadership still had ambitions regarding nuclear weapons production, which they kept secret. Bondžić mentions a meeting held in May 1961 in the office of the President of the Federal Executive Council, Aleksandar Ranković. At this meeting, they discussed the "Information on the possibility of producing nuclear weapons in small quantities," in which the "most detailed and explicit ambitions for military use of nuclear research" thus far were expressed (Bondžić 2016: 268). Moreover, according to Bondžić (2016), the nuclear ambitions did not disappear with the fall of Aleksandar Ranković, the weakening of the UDB, or the decline in nuclear investments during this period, nor did they disappear with the dissolution of the SKNE in 1971 in the context of the decentralization and "deetatization" process. What happened during this period could perhaps be characterized as a "retreat" of politicians. This retreat, however, according to Bondžić (2016) was short-lived, and state leadership planning of civil and military research was only briefly interrupted. He writes that according to some authors, the project was interrupted in the 1960s under the influence of internal weakening and the disappearance of the external threat from the USSR, but primarily "by order from the highest level," that is, from Tito, who "put his aspirations for nuclear weapons on hold" (Bondžić 2016: 319). According to him in the mid-70s, aspirations for nuclear armament were revived in Yugoslavia, despite its stated commitment to disarmament and ratification of the Treaty on the Prohibition of Nuclear Weapons. However, further discussion on this topic is not within the scope of the current paper.

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[49] Indian President Nehru, along with Tito from Yugoslavia and Nasser from Egypt, founded the Non-Aligned Movement. During the 1950s, he advocated for the rejection of the proliferation of nuclear weapons. However, upon Nehru's passing in 1964, India departed from this stance and proceeded to develop an atomic bomb in 1974. (Lüthi 2020: 287-307).

It is worth noting that in 1957, after the adoption of the federal Law on the Organization of Scientific Work and the establishment of Federal, Republic, and Provincial Funds for Scientific Work, Yugoslavia started establishing more direct links between scientific activities and the users of its services (Blagojević 1982: 316). Certainly, this did not mean that science was no longer budget-funded, as this remained the main form of financing scientific institutions. However, it is important to note the implementation of this law, because it marked the inception of a new type of funding, "through special social funds or direct contracting with the economy and other users" (Blagojević 1982). In line with these broader changes in Yugoslav science during this period, discussions began on changing the organization of SKNE. In accordance with this, in 1958, at a meeting of the Presidency of SKNE, the subject was the "onerous," "slow," and "difficult" work of certain sectors of the SKNE. They thought it imperative to improve the work of SKNE in order to "enhance efficiency," and it was suggested that, for this purpose, the organization needed to be simplified and expedited, with possible models that the Yugoslav nuclear program could emulate being programs in countries such as the US, Sweden, UK, and France (Bondžić 2016: 123-124).

After the Second World War, the United States did not "simply" transfer "pure" scientific knowledge to the devastated European countries, although this narrative was dominant during the Cold War. The knowledge "imported" into Europe from the United States was imbued with anti-Soviet tendencies and characterized by the introduction of decentralization processes in scientific organization, as well as the promotion of so-called scientific internationalism, along with elements of the official dominant model of US science (Krige 2006; Krige 2016).

This contributed to the superiority of the vision of free, "apolitical" science, which was associated with the liberal-democratic political system. This served as a contrast to Soviet science, which was portrayed in the context of the "totalitarian" Soviet system. Some US scientists contributed to this by working to promote US science not only in the United States but also worldwide, through a nominally apolitical stance imbued with the principles of professionalism rather than politics. The promotion of US science as a discipline primarily characterized by the freedom of scientific inquiry served the interests of the US government (Krige 2006; Krige 2016; Wolfe 2018).

The same can be said of the principle of scientific internationalism, which was used during the Cold War as a weapon against the USSR, serving the interests of US foreign policy, with the goal of attaining intelligence of strategic value, while it was still a major asset in the struggle for ideological hegemony in the United States and other countries (Manzione 2000: 21-55; Krige 2006: 161-181). National scientific leadership was promoted by the role of scientists and their appeal to scientific internationalism. "[O]penness and security, sharing knowledge or technology and implementing regimes of surveillance, were two sides of the same coin" (Krige 2006: 161). In contrast to the ecumenical declarations made in 1945 about world order and a strong, international scientific fraternity living beyond politics, scientists had a professional obligation to support Western countries in effectively opposing the Soviet Union, in order to protect science and international cooperation. According to this position "false," controlled, Soviet science competed with "true," autonomous, more cooperative science (see Manzione 2000: 52).

On the other hand, contrary to US politics, in the USSR, the party strategy before Stalin's death favored scientific isolationism; even though there were, certainly, scientific internationalists among Soviet scientists as well (Ichikawa 2019: 36-61). In connection with this, it is noteworthy that during the preparatory meetings for the All Union Physics Conference by the Arrangement Committee for Physics in the USSR, it so happened that "those physicists who engaged in the forefront modern physics" were criticized for "idealism" and "cosmopolitanism" by the mentioned philosopher Maksimov, who was seen as a "philosophical conservative," as well as by other philosophers and "patriotic and materialistic physicists" (Ichikawa 2019: 46). It is also interesting that during the first meeting, a speech was read "on the outline of the conference, full of intimidation upon the modern

physicists by reconfirming the philosophical position stated in Lenin's *Materialism and Empirio-Criticism*, criticizing idealism and cosmopolitanism..." (Ichikawa 2019: 45-46).

Due to its specific geopolitical situation, which was also significant for the USSR after Stalin's death, Yugoslavia managed, through nuclear diplomacy, to use the competition between both blocs during the Cold War to secure significant nuclear technology, such as nuclear reactors[50] (Konta 2019: 417-440; CIA Report 1958: 8-9; CIA Report 1973: 9). However, considering that the personnel relevant to the development of the Yugoslav nuclear program did not return from studies/training abroad largely due to the policy of scientific internationalism (Ražem 1994; Hymans 2012: 174-186), resulting in geopolitical power asymmetry for Yugoslavia. Moreover, this also points to the lack of partisanship among Yugoslav scientists, that is, their commitment to the further development of socialist relations in Yugoslavia, as Kardelj ([1960]1981) formulated it without using the term partisanship. This is a crucial aspect to consider, given that the leadership assessed this field as exceptionally important for the overall development of Yugoslav socialist society.

The beginning of significant changes in the Yugoslav nuclear program started with changes in financing. In 1962, one of the most important changes in the financing of nuclear institutes was implemented. This had a profound impact on the SKNE because "[s]ince its establishment in 1955 until the end of 1961, scientific institutes were financed from the federal budget through the SKNE, which allocated funds to the institutes" (Bondžić 2016: 131). However, from 1962 onwards, the SKNE started allocating funds to institutes based on research contracts containing descriptions of research projects, indicators of the monetary value of the task, as well as the number and duration of researchers involved. The funding system was still based on federal budget funds, but it was redesigned in a way believed to allow for greater investment efficiency and the public spending of money, as well as the responsibility for the performance of the paid tasks undertaken.

> "It was believed that introducing a system of task contracting between the SKNE and nuclear institutes and other users would ensure a more complete direction of allocated funds and their more rational and efficient use. This system was also thought to encourage greater accountability and discipline regarding the purpose and expenditure of contracted funds" [Bondžić 2016: 133].

This led to the involvement of the Yugoslav Investment Bank in the financing process. It was believed that the Yugoslav Investment Bank would handle specific financing tasks with more expertise and greater cost-effectiveness compared to the SKNE (Bondžić 2016: 132-133).

In early 1965, as scientific institutions dealing with nuclear energy in Yugoslavia gained more autonomy, discussions also started revolving around the financing of the nuclear program (Bondžić 2016: 134-136). The focus shifted from budgetary financing to funding through a dedicated fund for the development and research in the field of nuclear energy, involving republican bodies, the industry, universities, and others. Essentially, this aimed at "limiting and reducing state investments and decreasing the then-existing human and material capacities in the field of nuclear energy" (Bondžić 2016: 136). The goal was to restrict government investments in nuclear physics, which ultimately led to the closure of the SKNE in 1971. The effect of this was the slowing down of the Yugoslav program (Bondžić 2016: 134-136). This path of the Yugoslav nuclear program was marked by a diminishing role of the federation and decentralization processes inherent in the development of Yugoslav society. Constitutional changes (in 1967, 1968, and 1971) and the introduction of confederal elements, in line with the organizational concept of Kardelj's Yugoslavia, marked the beginning of a profound

[50] For example, through this nuclear diplomacy, Yugoslavia acquired RA, a heterogeneous heavy water reactor, with a nominal power of 6.5 MW and a maximum power of 10 MW from the USSR in 1956, installed at the Institute in Vinča, Belgrade, Serbia. Additionally, Yugoslavia obtained the 250 MW Triga-Mark reactor for the Jožef Stefan Institute in Slovenia from the US in 1961.

weakening of the federal state in its legal and formal aspects (Gončin 1971; Kardelj 1977; Bakić 2011: 66, 306;).

The jurisdiction of the Council of Republics, as well as provinces, was significantly expanded first by the amendments of 1967. and 1968. godine. In this way, the Council of Republics became the most important legislative body in Yugoslavia. These changes were further deepened by the amendments of 1971. Such tendencies represented an even greater departure from the principles of centralized decision-making, which in ideological terms characterized Marxist-Leninist ideology. The process of "deetatization," which was the official goal of Yugoslav reforms in the 1960s, essentially referred to the weakening of sovereignty of the federal government, while the sovereignty of the republics was strengthened.

> "If we were to take the concept of state dying out literally, then every state in Yugoslavia, both federal and member republics, would have died out. This did not happen because, thanks to the constitutional amendments from the period of 1967-1971 and the Constitution of 1974, the federal units significantly strengthened in contrast to the weakened federal state. Valerie Bunce, moreover, observed that Yugoslavia gradually lost its state characteristics in the 1970s, while the republics acquired them during the same period (Bunce, 1997: 349)" [Bakić 2011: 306].

Thus, the process of "deetatization" was not implemented at all levels, which resulted in stronger ties between local and republican political elites, managers and companies, and a weaker federal level of government. The very decision-making process in the federal center depended on the agreements between the republic and provinces that had veto power (Bakić 2011: 63-64).

The mentioned processes in Yugoslavia were confirmed by the CIA report on the Yugoslav economy from 1967. According to the report, these changes were sociologically and politically significant. In this regard, it is possible to gain insight into the process of decentralization and, accordingly, the relaxation of some administrative constraints, greater liberalization of imports, encouragement of foreign capital imports, and so on, in the Yugoslav economy. The aim of these processes, which included "international commitment to free trade and to a market economy" (CIA report 1967: 46) was, among other things, "to get the Government (and party) out of business" (CIA report 1967: 46).

When considering scientific activity in Yugoslavia, of which a significant segment constituted the Yugoslav nuclear program, in relation to the aforementioned constitutional changes in Yugoslavia, it is interesting to reflect on the 1973 CIA report. The report highlights the connection between the processes of decentralization and self-management in all segments of society and scientific changes. In this context, the process of confederalization stands out as significant for scientific policy, as it was associated also with the reduction in funding for scientific research. Certainly, this does not entail a complete abandonment of the principle of centralization in science but rather another step toward weakening the federal state and its role in science, which nonetheless remained a relevant factor in the Yugoslav scientific community.

> "The organization for science has undergone various changes as a result of 1971 constitutional reforms affecting the organization of the federal administration. A move to decentralize the government structure is at the heart of the reforms. Since the early 1950's there has been a strong trend toward decentralization with emphasis on self-management at all levels. Recent moves have increased authority in the republics to make scientific and technical policy, while reducing financing of research" [CIA report 1973: 2].

The effect of these reforms was greater authority for the republics in creating scientific policy. However, the consequence of these reforms was the reduction of state funding for scientific activities. "The waning investments and state interest in nuclear energy affairs, decentralization of the state, and diminishing authorities of federal bodies, transferring competencies to the republics, led to … the

eventual closing of the SKNE" (Bondžić 2016: 240). A brief description of these processes, which highlights the significance of the organizational changes related to nuclear energy in Yugoslavia following the closing of the SKNE, is summarized in the 1973 CIA report as follows:

> "The Federal Commission for Nuclear Energy was abolished during 1971, and responsibility for the nuclear energy effort was dispersed among the republics. Federal funding of the nuclear energy program has ceased. The three nuclear research institutes were transferred some years ago to the supervision of the nuclear energy committees of the republics. The three nuclear research institutes were transferred some years ago to the supervision of the nuclear energy committees of the republic governments where they are located. [...] Federal support for certain federal institutes has also ceased, although some federal institutes continue to receive federal funds" [CIA report 1973: 3].

After the closing of the SKNE on October 1, 1971, the importance of nuclear research in Yugoslavia declined. Simultaneously, federal funding for the Yugoslav nuclear program ceased. Matters concerning nuclear institutes fell under the jurisdiction of the republics. According to the CIA report, scientific policy since the 1960s had been moving toward reduced state funding and increased contributions from users. It was believed that this approach would lead scientific research institutions to become more financially independent (CIA report 1973: 3-6). The proclaimed principle of self-management implied the necessity of dealing with "statism" in scientific activities. It was believed that addressing elements like "statism" in science would contribute to greater alignment of science in Yugoslavia with the idea of self-management.

During the period when changes toward decentralization of the Soviet model of organization were already present, Aleksandar Ranković, a member of the Yugoslav leadership advocating for a preservation of the established level of centralisation, fell from power, accused of abusing the State Security Service in a power struggle (Dimitrijević 2020). Considering Ranković's role as the head of the State Security Service (UDB) and that in the 1960s, i.e. before the fall from power in 1966, he left the head of the nuclear program, coupled with the fact that no one of similar importance to the state was appointed to that position afterwards, speaks to the diminishing importance of the nuclear program in the perception of the Yugoslav state leadership in that period (see Bondžić 2016). Until this wave of changes, the SKNE aimed to utilize the federal state budget of Yugoslavia to the fullest extent possible for the nuclear program. This tendency persisted despite the emergence of elements in the organization of science that were once opposed to the Soviet model of scientific organization. However, with the wave of changes that followed, even this tendency disappeared (see Ražem 1994). The key organizational changes in Yugoslav science, including the dissolution of SKNE, which were in line with the processes of decentralization and the so-called deetatization, or the transfer of statism to the republican level in almost all spheres of society, are summarized in a CIA report from 1973.

> "Pivotal organizations for federal authority in science and technology have been the Federal Council for the Coordination of Scientific Activities and its subordinate Federal Fund for the Financing of Scientific Activities. The Federal Fund was abolished by a Coordinating Committee for Science Activities. The new organization is made up of representatives of the republics (three each from the six republics, two each from the autonomous provinces, and one representative of the army). The Coordinating Committee, a nonfederal organization, is expected to involve scientific workers and interested self-managing agencies in developing science policy. The FEC has a voice in the committee's discussions" [CIA report 1973: 2].

It is noteworthy that, according to Miljković (2021), one of the internal factors leading to the abandonment of Yugoslavia's nuclear program was the phenomenon of "Yugoslav-specific inter-republican competition" (Miljković 2021: 499). This competition, he argues, was intertwined with the rivalry between two competing ideological and structural processes within Yugoslavia, personified in Ranković and Kardelj: one favoring the preservation of the established level of centralisation (Ranković) versus the other advocating for greater decentralization and market-oriented reforms (Miljković 2021: 499-500).

In the context of this scientific reorganization and the closing of the SKNE, the Yugoslav nuclear program, exposed to processes of decentralization, "deetatization," and confederalization, was assessed in the CIA report from 1973 similar to the evaluation in the 1958 report. It was considered modest, focusing on basic research, without the potential for weapon development, and so on. The only difference was that this time, the report also highlights the existence of a tendency toward the economic uses of nuclear energy.

> "Yugoslavia has established a modest nuclear energy program confined to basic research, the use of radioisotopes, and the development of the economic uses of nuclear energy, particularly for the production of electric power. The country does not have the capability to develop nuclear weapons and has no plans to expend any effort in this field. The nuclear energy program has been carried out with the assistance of other countries and probably will continue to be dependent on foreign aid" [CIA report 1973: 9].

In addition to this, it is interesting to note an observation by the CIA, that due to the significantly altered organizational structure of the state and scientific activity, and thus the Yugoslav nuclear program, Yugoslavia's long-standing efforts to build nuclear power stations, now that "the Federal government has lessened its control in favor of greater autonomy for the republics and provinces," became as a result "the responsibility of the various republics" (CIA report 1973: 9).

Discussion

The relationship between the US's economic demands and the shift in Yugoslavia's rhetoric regarding the nature and function of science relates to the Cold War struggle for ideological hegemony, i.e. the soul of Yugoslav socialist science. In this instance the process, brought about by the geopolitical shift towards the West, points towards an attempt to "limit" socialism in science. This highlights the crucial role of the ideal-typical Cold War representation of Western science when a semi-peripheral state like Yugoslavia is involved. The Yugoslav system's continued adherence to socialist ideology, however, not only slowed down this process but also made these changes—as much as possible—consistent with some elements of Marxist postulates, understood much wider than in the USSR, primarily due to the control of the Party and its officials. It is necessary to look into what this development reveals about the process of establishing the ideological framework of Yugoslav science, keeping in mind Savelli's (2018) analytical categories of ideology "by design," which refers to situation "where professional knowledge was theoretically guided by ideological considerations" (Savelli 2018: 2), and ideology "by default," which refers to "events and knowledge" shaped "by the fact that they unfolded" in a certain ideological context, "but were not necessarily guided by that ideology" (Savelli 2018: 2). Along with its socialist science, Yugoslavia found itself in an ideologically hostile bloc with Western countries during a geopolitical transition, forcing it to confront their socioeconomic demands. In this framework, it is possible to consider the shifts in Yugoslav's perspectives on nature and the role of science as partly influenced by liberal-democratic ideology "by default." However, in light of these developments in science, the Yugoslav Communist Party, acting as a conductor of the process and enforcing internal control and a socialist articulation of the discourse, imposed socialism "by design" (Korolija 2023).

The debate over the place and function of Yugoslav science within the framework of the relationship between science and the state validates Forman's (1987) and Kevles' (1990) observations that the changes in the nature of science-state relations during the Cold War were also political. In reality, science did not exist in its ideal-type form in either of the two blocs that declared its science "autonomous" or "partisan." However, Yugoslav reality was shaped by socioeconomic pressures and demands aimed at ensuring the dominance of bloc ideologies. Thus, the uniqueness of Yugoslav scientific ideology was largely a product of the Cold War era state formation and adjustment, its impact on politics and society, and the state's desire for greater independence, framed by a particular socialist ideology (Korolija 2023).

This work suggests that various depictions of science's role and nature in society served to propagate the declared ideological principles of political blocs. To examine ideology within the framework of the Cold War struggle for hegemony, I used a combination of a critical approach to ideology and a theoretical-ideological approach (Rehmann 2015). One can also observe the tension between the Cold War scientific views on science through considerations of "autonomous" and "partisan" ideological scientific perspectives, as well as their mutual interaction, in the context of Yugoslav geopolitical and socioeconomic dynamics. In the Yugoslav case, this tension was resolved through certain deviations from Soviet ideas of science. The case of science in Yugoslavia highlights some real, or practical, differences that are primarily expressed at the level of science financing and organization but are also articulated within official discourse about the nature and role of science in society. The differences between scientific practices during the Cold War were undeniably overemphasized, especially when one considers the obvious bloc deviations from discursive principles in practice. This work examines the Cold War ideology of science in Yugoslavia and concludes that the main distinctions between Soviet and Western conceptions of science are essentially related to different economic dynamics, specifically the Soviet conception of a planned, centralized economy as opposed to the concept of a market economy. Given the (in)compatibility of these two perspectives on science within the framework of a single society, it appears that addressing socioeconomic dynamics within specific

social contexts should be the starting point. In other words, science in Yugoslavia, explored in this work, shows that we need to consider, to a larger degree, that socioeconomic processes were involved in the interactions between the two major scientific perspectives in addition to philosophical ones (Korolija 2023). As Woodward claimed, "[t]he political system and politics of Yugoslav society did mirror its economy, in the way seen in capitalist market economies" (Woodward 1995: 16). This study emphasizes the need to investigate this assertion using the example of the interaction between socioeconomic circumstances and science in Yugoslavia.

It is also vital to ask what, specifically, the nature and function of science in this ideological framework generally tells us about the connection between science and the state, using the example of science in (semi-)peripheral Yugoslavia during the Cold War. The example of socialist Yugoslav science confirms that Cold War science was heavily influenced by the state system. However, in order to understand its uniqueness with respect to bloc science, one must first consider its ideological divergence from the USSR, as well as the ruling Yugoslav party's and state structures' geopolitical shift toward the Western Bloc, particularly in the early years. Even when it meant supporting greater autonomy for science in socialist Yugoslavia, the fact that changes in the ideological framework of science's nature and role in the country were instigated by Party officials and essentially implemented "top-down," informed Yugoslav science's ideological framework. This is not to say that scientists had no freedom to do their work; rather, it means that scientific freedom – as well as scientific partisanship – was shaped and constrained by party-state initiatives and requirements pertaining to the nature and function of science in a concrete society. These requirements and projects were formed in the context of the Cold War, much like science itself (Korolija 2023).

The ideological framework of science during the Cold War, as well as its "autonomy" and "partisanship," were ultimately established by the states, not by the society or scientists themselves. As a result, attempts to examine and define what Forman (1987) would call the "true path" of science must be made more thoroughly and interdisciplinary through the focus on the activities of the ruling elite. It is also worth noting historical dynamics pertaining to the changes in the nature and role of science in society (Kevles 1990). These changes, in the case of Yugoslavia, stem from the socioeconomic and ideological effects of a geopolitical shift toward the West. Here, the issue is distinguishing between the components of the system and the concrete structure that ultimately restricts the independence and social involvement of science (usually due to its own interests). In light of this, it is imperative to examine the causes of (dis)agreement and the (im)possibility of placing the concepts of "autonomous" and "partisan" science into practice in accordance with their core precepts. Additionally, these concepts must be derived from a more comprehensive and clearly distinguished historical, philosophical, and sociological analysis of the interactions between the state, science, and society during the Cold War (Korolija 2023).

Specifically, when it comes to science in Yugoslavia and what we can discover through its example related to science in the Cold War, it is important to try to deal with the concept of the nature and role of science in the context of all the structural, socioeconomic, and ideological processes that ensued after its break with the USSR and turn to the West. Taking into account the Marxist-Leninist understanding of the partisanship of science and its direct reliance on the Party when articulating the interests of the working class, in whose service science should be according to this perspective, it seems that Yugoslavia, at least nominally, by advocating for greater autonomy of science and scientists, made a certain deviation from partisanship defined in this way. At the same time, it seems to have moved closer than before to the ideological perspective of free science, which is also addressed by Dušan Bošković in his work *Standpoints in Dispute* [*Stanovišta u sporu*]. However, when applying these ideological scientific concepts to the concrete political and socioeconomic reality of Yugoslav society during the Cold War, it is clear that certain scientific examples from Yugoslavia point to obstacles to the existence of this conception of science within the practical and ideological framework of the system. Furthermore, when considering political discourse on science,

one should be aware of the possibility of rhetorical-political manipulation in order to appease powerful foreign political partners, the population, or specific segments of the population (such as cultural workers). In other words, this could explain why concrete practice differs from public proclamations.

Using the example of the introduction of a "freer," decentralized science in the context of reducing administrative roles in the economy in Yugoslavia, one can observe a tendency for scientific "freedom" to intersect with market needs in its infancy, which often resulted in the deteriorating of the financial status of specific scientific institutions. An example is the fate of the journal *Science and Nature* [*Nauka i priroda*]. This leads us to a Marxist critique of "free science," as a science fundamentally subservient to the market and the ruling class in capitalist society. However, the Party still sought to dictate the course of science, but primarily when it deemed it relevant for the state and its own position, such as the nuclear program (at certain times). When this changed, the state would sometimes "liberate" it more (in the market) or, as Duančić (2020) successfully demonstrated in the case of Lysenkoism in Yugoslav biology, it would be quite disinterested in certain scientific and ideological questions. Furthermore, using the Yugoslav nuclear program as an example, one can see that it was only after different reasons led to a loss of state ambitions for it (in that period) that it became increasingly infused with processes of decentralization and de-bureaucratization, adding to its weakening. Therefore, it seems that science in Yugoslavia remained party - and state - shaped in this context as well. Considering that in the US during the Cold War, science was associated with the ideal of "freedom," and that this "freedom" was also, as Wolfe (2018) points out, politically constructed and thus limited by the American system, it can be concluded that during this period there existed only ideologically colored science, or party-affiliated, rather than science exclusively tied to the general interest of society, or the broader population – the working class. Although in ideological terms this was an idea associated with the Soviet view of the nature and role of science in society, in practice, as certain critics observe, despite the benefits that science brought to Soviet society and humanity, its potential was far from fully realized (e.g., Graham 1993; Graham 1996).

As certain left-wing critics argue, the reason for this lies in substitutionism, which contributed to the replacement of the workers' interest in the Soviet Union with the party's interest. Such criticism, in other more radical left perspectives, has been expanded to point out the very existence of hierarchy as a consequence of the state structure, which generates social inequality by creating, in the context of socialist societies, a managerial layer that controls the means of production (see e.g., Bakunjin 1979; Lazić 1987), as well as science and technology, seen as important resources of socialist, but also generally contemporary society, deeply rooted in its everyday life. Therefore, according to this perspective, science, just like in liberal-democratic, capitalist systems, eventually also begins to be tied to particular, rather than general interest, regardless of socialist ideology, whose nominal aim is to link science to the interest of the working class, i.e., the universal interest. It seems certain that "[e]tatist bureaucratic and production relations" represented a hindrance in the further development of production forces and the development of science and technology (Kuljić 2002: 270). However, one should also consider global factors – the full realization of a socioeconomic system opposed to a capitalist system while maneuvering within the framework of a global capitalist system seems utopian. One can conclude that such a situation greatly contributed to the impossibility of realizing the proclaimed social ideals (Volerstin according to Kuljić 2002).

However, unrelated to structural critiques of both socioeconomic systems, the factor of the Cold War and the need for both blocs, as well as the rest of the world, to adapt to this situation, contributed to the ideological principles of "free" science or, in the USSR, "class-conditioned" science, to be officially "strengthened" while also deviating from them and abandoning them if they were perceived as unhelpful in a specific situation of the bloc power struggle, competition, hegemony, and so forth. The same applies to the case of (semi-)peripheral socialist Yugoslavia and its aspirations for independence and social development in this geopolitical context.

The relationship between the center and the periphery in the context of the Cold War is significant for analyzing science in Yugoslavia. In this dissertation, we attempted to illustrate this through the example of the attempt to develop the big science phenomenon in Yugoslavia, specifically through the Yugoslav nuclear program. Considering the prestige and importance of nuclear technology during that period for a society striving for development and independence on an international scale, the motives for the big science project in Yugoslavia are clear. On the other hand, considering the power asymmetry and the advantage of the US in the development of nuclear technologies, as well as the geostrategic significance of Yugoslavia as a socialist state leaning toward the Western Bloc, Yugoslavia's choice of scientific cooperation and assistance projects pertaining to nuclear development is also evident. In other words, due to Yugoslavia's need for societal development and independence in the context of the Cold War, it found itself agreeing to the Cold War game. Through the example of nuclear cooperation and assistance promoted by the US to strengthen its own ideological hegemony and push communism out of Europe, it is possible to see how much political significance the US attributed to "free" science, as well as scientific internationalism, seeing them as instruments of utmost importance in this struggle.

The trend of "pure" science interweaving with technology, the important role of the state and bureaucracy, the security oversight of science (which was believed to have strategic significance), the fusion between science and engineering, militarization, etc., all point to this similarity. As Forman observes, physicists in the US who believed they were apolitical, and "just" doing science, were often subjects to the "illusion of autonomy" in the Cold War context (Forman 1987: 229). In the words of philosopher Louis Althusser, they were interpellated[51] in the ideology of scientific autonomy. In other words, despite highlighting and exaggerating the contrast between "free" and partisan (or Soviet) science, the big science phenomenon was present and dominant in both blocs during the Cold War, and its organization entailed a state as an important factor to maintain and develop this phenomenon (Kojevnikov 2004: 22-23). The necessary structural reasons for the development of a complex and expensive nuclear project, as well as to protect its security and political interests, require the financial and organizational involvement of the state. Thus, it is easy to observe the role of ideology in depicting particular interests like general ones.

The period addressed in this work concerning the nuclear program in Yugoslavia, as well as science and Yugoslav society in general, is characterized by intensified processes of decentralization, "deetatization," debureaucratization, more independent funding, the emergence of a discourse on "free" science, and so on. Specifically regarding the nuclear program, these processes in this period coincide, in a later phase, with a weakening focus of the state leadership on this project. However, at the beginning of this period, following the break with the USSR and the initial shift toward the West, accompanied by the emergence of the mentioned processes (Korolija 2023), the Federal Commission for Nuclear Energy (SKNE) was established in 1955. Although it emerged in a context where processes of decentralization and debureaucratization in society were gaining momentum, the principles according to which SKNE was founded implied centralization, state planning, high involvement of party officials, the UDB, and the like. In this segment, the primacy of structural interest over proclaimed, ideological principle is obvious, which was often the situation characteristic for science in the West as well. The Cold-War competition in developing nuclear programs represented a significant context that helps to explain the similarity between scientific models of the Eastern and Western Bloc, and the practical deviation from these proclaimed principles. Only after the official establishment of the Non-Aligned Movement, which presented new potential for building

[51] In short, according to Althusser, existing structures shape individuals into conscious subjects in society. He claimed that people adopt various identities through different institutions. These institutions maintain order in the system by assigning various social roles to individuals, who internalize them. In this way through the concept of interpellation, Althusser explains how structures in society mold individuals' identities, beliefs etc. (see Altiser 2015).

Yugoslav independence during the 1960s, did the anti-nuclear movement in the world started to grow, which in turn affected Yugoslav policy in this domain.

The CIA report from 1962 focuses on the politics of the US as well as assistance programs for Yugoslavia. One part of the report states that it was the US policy toward Yugoslavia that resulted in "increased integration of Yugoslavia into Western economy" (CIA report 1962: 1), which also contributed "to a substantial modification of the Communist system in Yugoslavia in the direction of decentralization…" (CIA report 1962: 1). Yugoslavia's development of "its own national system in the direction of decentralization and in increasingly closer relation to the West" (CIA report 1962: 1-2), according to the report, led the country to open up to Western ideas and institutions.

> "These changes in Yugoslavia's internal system and in its relations with the free world have become institutionalized so that there appears to be no road back to the block provided that Western policies toward Yugoslavia continue and no radical change overtakes the international situation" [CIA report 1962: 2].

Based on a careful reading of this report in the context of the Yugoslav socioeconomic system in the period, it seems that great attention was given to decentralization in economic decision-making, i.e. transferring key decisions to companies. This and the general intensification of institutional decentralization at the federal level were assessed as positive from the US standpoint in the Cold War struggle.

In this analysis, it has been shown that since the 1950s, there has been an intertwining of the described socioeconomic changes with science, which with further development led to a more visible reflection of these socioeconomic processes in society. The dissertation emphasizes the importance of decentralization, particularly concerning Yugoslav science. This process continued to evolve during the subsequent years of establishing socialist self-management. The CIA, regarding the organization of science in Yugoslavia, noticed that decentralization was so pronounced that it characterized not only institutes but also separate laboratories within institutes. Institutional research was now often conducted through contracts with specific industrial firms, and institutes competed not only within the country but also abroad.

> "Decentralization extends not only to the institutes but even to the separate laboratories within institutes. Each laboratory is governed by a small, elected council that is in charge of establishing salaries and financing. A large portion of the research conducted by the institutes depends on contracts with industrial firm, and the institutes find out that they have to compete with various organizations both within the country and abroad. It is not unusual to find that some of the institutes are better known abroad than they are domestically" [CIA report 1973: 2].

However, it was necessary to emphasize in the dissertation the significance of internal factors for the mentioned processes and their importance for Yugoslav science, especially the Yugoslav nuclear program, during the period from 1948 to 1971. Specifically, the analysis of this period also encompasses the processes of Yugoslavia's confederalization. In this sense, it is important to bear in mind that, regardless of the party and other official ideological proclamations in favor of the ideology of autonomous science, the analysis of the nuclear program in this period points to the significance of the state's confederalization from 1967. These changes were ideologically articulated as a struggle against statism (implemented up to the federal republic level, not beyond) and for increasing the processes of democratization, decentralization, as well as the expansion of self-management (Bakić 2011).

It should also be emphasized that these processes in science (such as decentralization), although supported by the anti-communist West, aligned with certain aspects of the idea of socialist self-management (Supek 1971; Kardelj 1977). However, it is important to remember that, fundamentally,

the nuclear program implied a centralized organization. Regardless of the proclaimed ideology, Yugoslav practice, and hence the practice of Yugoslav science, followed the needs of the party-state leadership. In line with the changes and interests of the party-state leadership, a gradual weakening of the Yugoslav nuclear program took place during this period. Control by the UDB, secrecy, military influences, etc., were all important factors for this project, which were stronger before the start of confederalization than after its commencement, although they were certainly present afterwards too. As for scientific practice, it is possible to observe a discrepancy in the Yugoslav nuclear program between the proclaimed, official level and practice on the ground. The same contradiction is evident in the case of Western "free" science. This is supported by the fact that some American physicists believed that physics in the United States would become, or was close to becoming, one of the branches of the military (Kragh 1999). Proclaimed ideological principles during the Cold War often served to promote and establish concrete cultural hegemonies and maintain the image of a bloc-based contrast. In the case of the Yugoslav nuclear program, one can also see how ideological principles were used by the Yugoslav state-party leadership to advance their own interests, hence in the context of a (semi-)peripheral state such as Yugoslavia too, while also showing the deviations from these same principles.

Yugoslav leadership established the Yugoslav nuclear program on a predominantly Soviet organizational model. This was an important feature of the nuclear program while it was believed that it could contribute to state prestige, modernization, independence, national security, etc. One might ask why in this work this type of scientific organization in Yugoslavia is labeled as the Soviet organizational model when it emphasizes that there were no significant differences in practical terms between such projects in the West and the East. The initial reason for such labeling is the fact that scientific organization in Yugoslavia was indeed initially built on the model of the Soviet Union, and that this structure was largely retained even for a period of time after the split. Moreover, this approach refers to the attempt through the text to point out the existence, during that period, of forced declarative, nominal differences between the Western and Eastern Blocs, i.e., free, "pure" decentralized science and party-controlled, centralized, applied science. In this way, it highlights the significance and power of Cold War ideology or the dominance of the black-and-white, polarized perception of blocs, which was reflected in dominant scientific representations and their opposed positioning in the global discourse. However, in the context of Cold War politics, the Non-Aligned Movement, international scientific cooperation, lack of resources, and confederalization of the state, the Yugoslav nuclear program started to weaken. This example shows that science funded by the state leadership, because it saw it as a significant investment, is also science organized according to the principles of Soviet science.

Therefore, the Yugoslav nuclear program is a good example of how big science implies substantial governmental engagement rather than the independence of scientists from the system. Based on the examination of its evolution, the question emerges as to whether it is "little science," or "free" science, which refers to science deemed of no vital importance to the state, or big science, or in this case, the Soviet model of science, which is science deemed by the state and party leadership as a politically and socially significant resource? In this sense, the Yugoslav nuclear program, in a way, shows that it is actually the little science phenomenon, rather that big science, that involves processes compatible with the idea of a "free" science. It is also important to consider the structural changes that occurred in Yugoslavia as a result of the shift from a federative to a confederate state model. These developments coincided with the nuclear project's decline.

Moreover, it is worth noting that Ranković's departure in the 1960s was an important factor. He was part of the political group that supported the preservation of the established level of centralization in Yugoslavia, unlike some other members of the Yugoslav leadership. In this context, the 1962 CIA report on Yugoslav criticism of Western politics connected to "all questions reflecting the issues of colonialism or neocolonialism" (CIA report 1962: 1-2) is also interesting. CIA analysts emphasized

that these policies were not always a part of Yugoslav practice but rather reflected the beliefs of the older generation of Yugoslav communists that was leaving the scene (CIA report 1962: 2). The report further notes that: "… as time goes on power in Belgrade will inevitably gravitate into the hands of people who have less commitment to old fashioned Communism, more understanding for Western civilization and greater appreciation of the value of relations with the West" (CIA report 1962: 2).

Conclusion

The concluding segment of this dissertation will attempt to briefly outline the basic hypotheses, defined in the Proposal as "theses for testing," as well as provide a summary of the insights that certain chapters of this work have provided.

The first segments of this work present how the shaping of science took place and several assumptions about its role in society based on politics and the practical needs of a certain regime. Both blocs considered science during the Cold War crucial not "just" for social development but also for state security. This particularly applied to nuclear physics. Between the Soviet model of science and big science, prevalent in the West, there were no major differences, particularly in terms of state control and, despite the scientific ideology in the West, structural aspirations toward centralization. Accordingly, the work shows that, despite ideologically and philosophically opposed scientific principles, the position and role of science in both Cold War blocs were similar, and in both cases, there were deviations from proclaimed principles in practice. While certain real differences were often exaggerated and emphasized in dominant scientific discourses, the similarities were ignored in order to create a black-and-white Cold War picture of two completely opposed ideological blocs: Eastern and Western. By describing the Cold War logic of bloc exclusivity, this work, on the one hand, presents the perspective connected to the Western Bloc, which championed the relative independence of science and its value-neutral nature as a desirable feature that guaranteed its validity. On the other hand, the work emphasizes the perspective of the partisan, class-oriented, ideologically colored science connected to the Eastern Bloc, which held that the full potential of science is achieved by serving the working class in the struggle for a classless society.

That is, in short, the framework in which the socialist Yugoslav system was formed after the Second World War, initially leaning toward the Soviet socioeconomic and ideological system in everything, even science, as this work has shown. The work broadly outlines the geopolitical, socioeconomic, and ideological changes that occurred in Yugoslavia after the break with the USSR in 1948, which were reflected in certain segments of science. However, later in the work, using the example of the Yugoslav nuclear program, it was also emphasized that after the break with the USSR and the initial shift toward the West, accompanied by specific ideological and structural changes in science, the nuclear program in Yugoslavia was established in line with the principles of strict state security control, state funding system, and high centralization. These were elements that Yugoslav officials criticized in Soviet science during that period, and they were elements that were not primarily associated with Western science, although it too was far from being devoid of state, political, and military control and influence in practice. Furthermore, the work demonstrates that the processes of debureaucratization and decentralization, officially connected with the concept of Western "free" science, occurred only after the nuclear program's value to the Yugoslav state diminished due to a variety of reasons in that period. By showing and comparing the desired model of scientific organization, system of financing, and dominant scientific discourse in Yugoslavia before and after the break with the Soviet system, while exploring the development of the Yugoslav nuclear program in this context, the following hypotheses were articulated and addressed.

The first hypothesis is as follows:

1. By discontinuing its cooperation with the USSR, Yugoslavia, which up until then relied on the Soviet system based on Marxism-Leninism, began to reshape its structure along the lines of decentralization and introduced a limited market in the economy. In terms of the ruling socialist ideology, this resulted in a new ideological paradigm – socialist self-management. The specificity of the ideology of self-managed socialism was reflected in science as well, where one can also observe

decentralization processes and the effects of the introduction of a limited market in the Yugoslavia, along with the introduction of the concept of autonomous science.

The work considers the first hypotheses partially confirmed. The work presented, on the one hand, the shaping of Yugoslav scientific organization, discourse and system of financing in accordance with the Soviet model and idea of science prior to the break, all within the context of the attempt to build and shape Yugoslav society after the Second World War in alignment with Soviet principles. On the other hand, the work presents the social, economic, and ideological change in Yugoslav society after the break with the USSR, which contributed to the creation of the socialist self-management system and the corresponding changes to Yugoslav science. However, the development of the Yugoslav nuclear program seems to have followed a different logic. Its establishment, even after the break with the USSR, was based on the principles of centralization, state control, connections with the party and the police, with the idea of its application to the development of society, and similar. This later changed, but for this thesis, it is important to mention this initial aspect of its development, because it points to deviations in this scientific segment compared to new official proclamations, which were more aligned with the concept of autonomous science. I started with the assumption that novel social processes that characterized the system of socialist self-management, such as increased decentralization and a stronger introduction of (a limited and controlled) market, contributed to changes in the, until then, dominant discourse. The discourse changed from belief in the need for a class-based science, or state-planned science, that is also state-financed and centralized and serves society, toward the implementation of processes such as decentralization and "debureaucratization", a discourse marked by elements of scientific freedom, and a somewhat more independent financing and greater independence (in the market). In relation to this hypothesis, it is important to emphasize that the mentioned changes, in accordance with the initial Yugoslav turn to the West, were in certain elements aligned with the dominant "Western" scientific discourse. However, the development of the Yugoslav nuclear program significantly deviated from these ideological assumptions, until its slowing down due to numerous factors.

2. Examples of the nuclear program (nuclear physics) in Yugoslavia, the US, and the USSR show us that the role of science, even in systems that are – in an ideological sense – dominantly confronted, is in practical terms very similar due to the strategic importance of science for social development, and particularly of nuclear physics for ensuring the relative security of the state. Thus, the state forms of organizing scientific work are similar too. Despite this fact, or precisely because of it, it seems that science is not essentially independent from political ideology.

The work shows that, despite the proclaimed opposed ideological positions, the role of Yugoslav science, specifically the Yugoslav nuclear program, was similar to the role of science in opposed blocs, and thus it was considered in relation to its role in social development and securing the state's relative security and independence, as well as increasing its esteem in international relations. It is important to reiterate that when depicting the development of the nuclear program during the Cold War, as well as Yugoslav science in general, the state in question, and therefore science, had a (semi-)peripheral position in the broader context of the world capitalist system. Thanks to its, as highlighted multiple times in this work, significance for the Western Bloc, Yugoslavia also utilized this position in the domain of science for its own scientific and technological development and the development of society in general, as demonstrated by Carla Konta (2019). However, the asymmetry of power, not "just" in the sphere of science and technology, which was rooted precisely in the country's peripheral position in the global capitalist system compared to the center, significantly influenced the Yugoslav party and state leadership and the country's political decisions, which were in turn reflected in the sphere of Yugoslav science. Certainly, it is necessary to add to this that Yugoslavia was a devastated and impoverished country after the Second World War, and the US, besides being the capitalist center, was also in a much better position to the Soviet Union and other countries affected by the war on their own territory.

Moreover, the work shows that despite ideological differences state approaches to organizing scientific work, big science projects such as the nuclear program all have similar characteristics and involve a great involvement of state structures, state planning and financing, centralization, and so forth. Accordingly, it seems that the practical significance of a nuclear project for a given state, or state leadership, represents the deciding factor for its development and application. Even in the case of its weakening, political and state decisions and a certain Cold War context proved to have been very significant. When it comes to the relationship between science and ideology, one gets the impression that ideology was often also in the service of the interests of state structures, just like science. Ideological deviations in practice, as well as practices aligned with certain ideological principles, depended primarily on the state and party and the broader geopolitical context at the given moment. These were precisely the key factors that influenced the alignment of certain segments of science with ideology, as well as specific deviations in science from proclaimed ideological principles. In line with this, this hypothesis is considered confirmed.

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Generally speaking, in the example of Yugoslavia and science in general during the Cold War, it appears that knowledge is always dependent of its historical, socioeconomic, and political context. Because of this, as Gramsci emphasized, every knowledge, even scientific knowledge, must be considered within its wider sociopolitical and cultural context. Through Gramsci's concept of cultural hegemony, science can be understood in the context of the dynamics of political power, which represents an important aspect of shaping scientific knowledge. Scientific knowledge, as this work has shown, should be viewed in the Cold War era as an instrument for establishing, spreading, and maintaining hegemony. In addition to this, following the "ideology-critique" approach, which approaches ideology as "false consciousness," this work has also demonstrated certain deviations from proclaimed ideological principles in situations where it was not deemed to be in the interest of ruling state and party structures. The Cold War context is undoubtedly reflected in the science of Yugoslavia. As indicated, Yugoslavia was a poor, less developed socialist country with a (semi-)peripheral position in the global capitalist system, aspiring for modernization and a more independent position in the bloc-divided world. The Non-Aligned Movement, of which Yugoslavia was a founding member and an important participant, sought to achieve non-aligned independence, but was still part of the dynamics of the global capitalist system. Considering this, throughout the work, the importance of power asymmetry is highlighted, as well as economic, political, social, cultural, and scientific dependency within the center-periphery framework for the development of science and technology. Because of this, one can say that in the background of promoting universal scientific principles closely linked to scientific validity under the banner of scientific internationalism (such as "Atoms for Peace"), there was a need for control, shaping, and dominance of center countries over (semi-)periphery countries and their science.

Overall, Yugoslavia was a socialist (semi-)peripheral state in the global capitalist system, which, after breaking ties with the Soviet Union, was forced to make certain concessions to the Western Bloc. Its significance in international relations during that period increased as it was seen as a wedge in the Eastern Bloc and a barrier to Soviet influence. All of these factors that influenced Yugoslav social organization and ideology were also reflected in science. Ideological changes, as well as deviations from proclaimed principles in science, need to be understood precisely in the context of this geopolitical situation and Yugoslav state-party interests and positioning in the Cold War.

However, it seems that my work's contribution is not limited to insights relating to history, sociology, philosophy of science, politics of science and technology and nuclear physics, but also in that it creates space for further explorations of certain philosophical-sociological assumptions necessary to lay the groundwork for truly free science. In other words, science that would serve society under the

democratic control of the broadest social strata, rather than being dictated by the interests of imperialist and hegemonic powers and their states. It seems that the basic condition to achieve such a science would be to abolish monopoly over property and a class division of society, laying the foundations for a different system that would escape the dynamics dictated by capitalist interpersonal relations. Although this work cannot offer precise and definite answers regarding these assumptions, its contribution may lie in helping to raise and explore such questions.

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Dynamics of the Relationship Between Science and Ideology and the Origins of the Nuclear Program in the Context of the Socioeconomic Transformation of the FPRY

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• резултат сопственог истраживачког рада;
• да дисертација у целини ни у деловима није била предложена за стицање друге дипломе према студијским програмима других високошколских установа;
• да су резултати коректно наведени и
• да нисам кршио/ла ауторска права и користио/ла интелектуалну својину других лица.

Потпис аутора

_____

У Београду, _____

образац изјаве о истоветности штампане и електронске верзије докторског рада

Изјава о истоветности штампане и електронске верзије докторског рада

Име и презиме аутора _____Маја Королија_____

Број индекса _____52/2016_____

Студијски програм _____Историја и филозофија природних наука и технологије

Наслов рада_Dynamics of the Relationship Between Science and Ideology and the Origins of the Nuclear Program in the Context of the Socioeconomic Transformation of the FPRY (Динамика односа између науке и идеологије и зачеци нуклеарног програма у контексту друштвено-економске трансформације ФНРЈ) _____

Ментор _____Проф. др Јово Бакић и др Игор Челиковић_____

Изјављујем да је штампана верзија мог докторског рада истоветна електронској верзији коју сам предао/ла ради похрањивања у **Дигиталном репозиторијуму Универзитета у Београду.**

Дозвољавам да се објаве моји лични подаци везани за добијање академског назива доктора наука, као што су име и презиме, година и место рођења и датум одбране рада.

Ови лични подаци могу се објавити на мрежним страницама дигиталне библиотеке, у електронском каталогу и у публикацијама Универзитета у Београду.

Потпис аутора

_____

У Београду, _____

образац изјаве о коришћењу

Изјава о коришћењу

Овлашћујем Универзитетску библиотеку „Светозар Марковић“ да у Дигитални репозиторијум Универзитета у Београду унесе моју докторску дисертацију под насловом:
која је моје ауторско дело.

Дисертацију са свим прилозима предао/ла сам у електронском формату погодном за трајно архивирање.

Моју докторску дисертацију похрањену у Дигиталном репозиторијуму Универзитета у Београду и доступну у отвореном приступу могу да користе сви који поштују одредбе садржане у одабраном типу лиценце Креативне заједнице (Creative Commons) за коју сам се одлучио/ла.

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Кратак опис лиценци је саставни део ове изјаве).

Потпис аутора

_____

У Београду, _____

1. **Ауторство**. Дозвољавате умножавање, дистрибуцију и јавно саопштавање дела, и прераде, ако се наведе име аутора на начин одређен од стране аутора или даваоца лиценце, чак и у комерцијалне сврхе. Ово је најслободнија од свих лиценци.

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6. **Ауторство – делити под истим условима**. Дозвољавате умножавање, дистрибуцију и јавно саопштавање дела, и прераде, ако се наведе име аутора на начин одређен од стране аутора или даваоца лиценце и ако се прерада дистрибуира под истом или сличном лиценцом. Ова лиценца дозвољава комерцијалну употребу дела и прерада. Слична је софтверским лиценцама, односно лиценцама отвореног кода.