BORIS HESSEN AT THE CROSSROADS OF SCIENCE AND IDEOLOGY[1] FROM INTERNATIONAL CIRCULATION TO THE SOVIET CONTEXT

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Abstract. This article is based on a joint endeavor. The first part introduces Hessen's theses and reconstructs their reception from the 1930s to the most contemporary research in Science and Technology Studies in an attempt to understand how and why Hessen's work has been recognized as a "classic" in various disciplinary fields and contexts.[2] The second part frames Hessen's ideas within the context of the early establishment of dialectical materialism, arguing for the proximity of his thought to the positions of the Russian Machists, in particular, Alexander A. Bogdanov. The reception of Hessen's theses clearly shows how his work has been at the center of symbolic negotiations and historiographical re-interpretations. His consecration as a "precursor" of both externalism and the contemporary field of STS shows how it is necessary to reinterpret Hessen's theses within the context of the Soviet debates of his day. The paper draws the conclusion that the connection between Hessen and Russian Machism is consistent with the international reception of his work as it emerges in the historiography of science studies. Furthermore, it allows for a way to approach Hessen's contribution under a new light in the present.

Keywords: Boris Hessen, Dialectical Materialism, Marxist Orthodoxy, Relativity, Science and Technology Studies, Intellectual Reception, Internalism-Externalism debate, Cultural Cold War

Introduction

In June 1931, a Soviet delegation led by Nikolai Bukharin, at the time a party leader and *Pravda* editorialist, traveled to London. The group included prominent figures in Soviet academics, such as Boris Zavadovskij, Modest Rubinstein, Nikolai Vavilov, Abram Joffe, Vladimir Mitkevich, and Ernst Kolman. The decision to host a meeting in London, where the Soviet representatives were called to share their scientific achievements with Western scholars, was the result of a growing interest among these Westerners in the relationship between science and socioeconomic development. They wondered if an analysis of the role of science in driving the

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development of society could explain the weaknesses of capitalism and if such an analysis would suggest an interpretation of the relationship between science and societal development in socialist terms. In the 1930s, a growing body of scholars advocated the idea that an appropriate analysis of the history of scientific theories should incorporate aspects that, until then, had been considered secondary, if not wholly irrelevant, namely, the social, cultural, historical, economic, and therefore political components, which appeared to them to be inextricably linked with scientific production. The project of a socialist science, which the Soviets described as the only possible plan for enabling the global and homogeneous development of society, attracted many English scientists and historians of science with a Marxist education. In particular, Hessen's presentation, which was considered to be one of the most brilliant at the London gathering, became the cornerstone for a new foundational trajectory in the historiography of science that incorporated "extrinsic" components of scientific research that were believed to constitute the material bases of its planning.[3]

The theses that Hessen proposed at the congress was a clear and fascinating, Marxist exposition of Newton's mechanics. He highlights how Newton's ideas were intrinsically rooted in the political and economic environment of 17th-century England. He further indicates that *The Principia* exhibits the needs that arose in the new industrial setting for the nascent political class, including mechanical and technical problems related to trade, navigation, and war and how they manifested in the state of the art in the natural sciences at the time. The technical problems of the 17th century as Hessen points out, not only shaped the ensuing development of physical science, but were essentially triggered by problems faced by the bourgeoisie in its effort to establish itself as a ruling class. It is no surprise that the central part of *The Principia* discusses the expansion of communication routes by land and sea, mining technologies, metallurgy, and, of course, the military industry. These concerns derived in turn from the dissolution of feudalism, the emergence of mercantile capital, and manufacture. Newton himself, according to Hessen, can be regarded as a typical representative of the rising bourgeoisie and expressed all of the traits that characterized his social class.

As is well explained by Freudenthal and McLaughlin, Hessen builds his work around three main theses: 1) the first concerns the relationship between economic and technological development in the early modern age and articulates how these two developments were related to science, especially machine technology and mechanics in the era of capitalist manufacture. 2) The second thesis draws the conclusion that in those areas of seventeenth-century knowledge where scientists could not yet rely on the study of cutting-edge technologies such as steam engines, generators, or electric motors, physicists were unable to make any significant progress in corresponding directions, such as in thermodynamics or electrodynamics. For instance, Newton did not solve the problem of energy conservation because this task had yet to find expression in the historical development of the productive forces at the time. 3) The third thesis concerns the ideological constraints and compromises that characterized English science during the Glorious Revolution (1688). Because of these compromises, Newton had to adhere entirely to a mechanistic worldview and to

reconcile his conception of matter with that of a God who sets it in motion. Thus, in the third book of the *Principia*, "The System of the World," Hessen sees Newton's attempt to unify the celestial plane with the laws of mechanics on the material plane.

The reception of Hessen's famous essay has undergone various stages or, to put it in Bourdieau's terms, labeling processes (*marcature*) through which Hessen himself has come to be regarded as a precursor figure in a wide range of debates. Readers of his work have offered a variety of interpretations of it based on their specific positions within these debates. In the following pages, we shall trace the path that led to the birth of the social studies of science and STS (Science and Technology Studies), which was often punctuated by the appearance, reappearance, and critical re-elaboration of Hessen's thought beyond Russia and the Soviet Union. The anti-deterministic character of his theses will emerge clearly from the account of scholars interested in overcoming the debate between internalism vs. externalism. The reconstruction of the international and interdisciplinary circulation of Hessen's famous essay is necessary for understanding how the evaluation of his intellectual legacy has changed over time. This reconstruction will enable, in the second part of the text, to demonstrate how important it is today to re-examine Hessen's ideas within the philosophical and historical context of his time. In this way we will be able to bring out the full scope of his thought and also reassess the nature of his methodology in light of the present.

Hessen's International and Interdisciplinary Circulation

During the aforementioned London congress and in the days following, the Hessen theses generated considerable debate. Its resonance was broadly perceived by those present at the event. At the time, there was a very active circle of scientists in the U.K. engaged in political leftism, whom Werskey called "the visible college."[4] In this group were John Desmond Bernal, John Haldane, Lancelot Hogben,[5] Hyman Levy, and Joseph Needham. These authors had a common interest in the investigation of science's role in society. Excluding Haldane,[6] everybody in this group was at the '31 congress and remained strongly influenced by the Soviet delegation's talks.

Among the members of this group, Bernal and Needham in particular were very prolific in their work to further the perspective of the Hessen theses in the history of science.[7] Arguably, Bernal still remains the main Marxist theorist in the U.K. to have studied the history of science, and was a strong supporter of the Soviet model in its promotion of a harmonious development of society and science.[8] In addition to his scientific studies about x-rays and molecular biology, Bernal authored some classic texts, such as *The Social Function of Science* (1939); *Marx and Science* (1952); *Science and Industry in the Nineteenth Century* (1953); his monumental work in three volumes, *Science in History* (1954); *Emergence of Science* (1971); and, in collaboration with Fernand Braudel, *On History* (1980). In his 1939 book especially, he tried to address the question—which was particularly important for Marxism—of "science policy." In accordance with Bukharin's presentation at the London congress, which addressed the relation between science and ideology, Bernal delineated a way of putting scientific practice at the service of society.

He declared that the interest in dialectical materialism in the U.K. clearly emerged from the congress of 1931. In fact, the Soviet delegation

> showed what a wealth of new ideas and points of view for understanding the history, the social function, and the working of science could be and were being produced by the application to science of Marxist theory."[9]

In a footnote, Bernal adds an explicit reference to the Hessen theses: "Hessen—[and his] article on Newton— […] was for England the starting point of a new evaluation of the history of science."[10] At the same time, *Science in History* served as a perfect example of how to provide a Marxist interpretation of the history of science. This masterpiece by Bernal would later become a classical point of reference within the discipline.

Also in 1931 Joseph Needham was in the midst of publishing his *Chemical Embryology* (in three volumes). During the preparation of this book he had the opportunity to meet Charles Singer, the president of the London congress. During the congress, Needham was particularly impressed by Zavadovskij's talk. Indeed, Zavadovskij reached the same conclusions as Needham, even if the former started from the axioms of dialectical materialism. Nevertheless, Hessen's contribution played the most significant role in shaping Needham's thought. In his *History of Embryology* (1934)—a revised version of his text from '31—Needham wrote that "further historical research will enable us to do for the great embryologists what has been so well done by Hessen for Isaac Newton."[11] In introducing the second edition of *Science at the Cross Roads*, he says that, "This essay [by Hessen], with all its unsophisticated bluntness, had a great influence during the subsequent forty years, an influence still perhaps not yet exhausted."[12] Also, in his later works—such as the monumental, seven-volume *Science and Civilisation in China* (published between 1954 and 2004)—Needham expresses his debt to Bukharin, Hessen, and the other Soviet delegates.

Among those attending the conference was also the scientific journalist James Gerald Crowther.[13] He was particularly active in politics and strictly linked to Hessen, with whom he even maintained correspondence from 1931 until the Russian physicist's death.[14] Crowther was a very prolific scholar who represented a cardinal point in the evolution and dissemination of Marxist methodology in the history of science. In fact, his interest in this topic predated the congress and by 1930, he had already published his book entitled *Science in Soviet Russia*. In his *The Social Relation of Science*, Crowther also declared that "The movement, of which Hessen's essay was the most brilliant expression, transformed the history of science from a minor into a major subject." In particular he declared that Hessen's perspective demonstrated how the history of science "was essential for the solution of contemporary social problems due to the unorganized growth of a technological society."[15] This broad U.K. leftist movement in science took the name of "Bernalism" in the subsequent years.[16]

In the same context in which the Hessen theses were disseminated in the U.K., one must also consider the economic historian, George Norman Clark. He declared that Hessen's work represented "the best available statement" of the relation

between the rise of modern science and the fall of the feudal economy.[17] But Clark was a detractor of Hessen's theses and in his *Science and Social Welfare in the Age of Newton* from 1937 he argues that in order to explain the success of the natural sciences in Newton's day, there were other factors to be considered in addition to those indicated by Hessen. Together with the rise of the bourgeoisie, Clark underlined for instance the role played by religion, the concern of treating the sick, the desire to win wars, artistic creation, and the pursuit of pure knowledge.[18] The third part of his book, entitled "Social and Economic Aspects of Science", is dedicated entirely to the discussion of Hessen's approach to the history of science. Various scholars have highlighted some of Clark's misunderstandings of Hessen's arguments—a topic that we will come back to later—that were reproduced in the process of canonizing the author in the following years. From this point of view, Clark made a serious mistake in assuming that the study of the determinant social factors of scientific thought should consist mainly in dissecting a scientist's personal motivation. On the contrary, Hessen and the Marxist tradition have explicitly criticized this point as an individualistic tendency in philosophy.[19] In particular, Clark argued that he would have used a "biographical"[20] and "psychological"[21] model in the history of science (i.e., exactly what the Russian authors criticized). Another very relevant aspect about Clark's work is that he knew and quoted Weber explicitly (one year before the publication of Merton's thesis). Despite this, he recognized that the German author didn't have a complete understanding of the relationship between religion, science, and technology. After having quoted *The Protestant Ethic and the Spirit of Capitalism,* he argued as follows:

> It does not appear to me that this generalization is borne out by the facts. We have seen that Spain and Portugal were homes of the studies of navigation and medicine. In the sixteenth century Italy was the most fruitful field of science and technology; in the early seventeenth in France and the Catholic Netherlands had some great names; in the late seventeenth and eighteenth England and Holland had their turn. But there was a great deal more besides religion to account for this; many other elements of economic history were tending to the same result.[22]

From the '30s to the '50s: Beyond the U.K.

At the same time, the Hessen theses crossed the Britannic borders to arrive on the other side of the Atlantic Ocean. In this context, Merton played a central role in the dissemination of Hessen's work and of a certain conception of science and technology studies. He defended his PhD thesis, *Science, Technology and Society in Seventeenth Century England*, in 1935 and published it in 1938. This work is considered the birth certificate of the sociology of science as an autonomous discipline, and it represents a cardinal moment for the *querelle* between internalism and externalism. This text is composed of two main parts: from paragraph 1 to 6, he develops what has been called the "Merton thesis."[23] In the same spirit of Weberian sociology, Merton establishes a connection between protestant ethics and the emergence of modern scientific thought in England during the seventeenth century. On the contrary, in the

second part of the essay (from paragraph 6 to 11) the role of the Hessen theses is more explicit. In fact, in a footnote, Merton admits to closely following "the technical analysis of Hessen in his provocative essay."[24] In particular, he highlights how the Russian author's paper "provides a very useful basis for determining empirically the relation between economic and scientific development."[25] In one of the appendices of his text, Merton also emphasizes his dependence on Clark's interpretation of the Hessen theses. Clark suggests that Hessen "over-simplifies the social and economic aspect of the science." In contrast, Clark "points out that at least six major classes of influence outside of science proper were operative: economic life, war, medicine, arts, religion and most important of all, the disinterested search for truth."[26]

Merton chose an eclectic methodology for which—despite indicating some distance from a strictly Marxist approach—he recognized his debt to Hessen.[27] In chapters 7, 8, and 9, he reproduces Hessen's model. First of all, Merton highlights the needs and interests at work in the productive sector and, second, its associated technical problems. Only at the end does he discuss the emergence of the scientific problems derived from these factors. It is necessary to note that Guéroult identified how some of Hessen's historiographical errors were reproduced in Merton's essay without corrections.[28] The conventional narrative has crystallized (in the wake of Weber) the idea that the "Merton thesis", as opposed to a Marxist thesis, would have given centrality to the superstructural elements, in this case, religion. As we will see, however, Hessen did not uphold a rigid deterministic relationship between structure and super-structure; in fact, quite the contrary. Therefore, Merton's debt to Hessen is even greater than has been previously thought. The idea that there is an opposition between internalism and externalism will come to be based precisely on this flawed interpretation. However, Merton's[29] and Clark's use of the Hessen theses has reinforced the canonization and dissemination of the Soviet author on a global scale. This process erected an image of Hessen as a precursor of various lines of research which, with some rectifications, have become known as "externalism". For subsequent generations, and to an ever-increasing extent, Hessen became a benchmark figure.

Another central contribution is that of Edgar Zilsel, one of the members of the Vienna Circle (later exiled to the U.S.). This author dedicated considerable attention to the sociological application of Marxist methodology to the history of science. Even if Zilsel never directly quoted Hessen's work, the theses of these two authors have frequently been juxtaposed based on the affinity of their ideas. The Viennese author's thesis tends to explain the emergence of science in the modern age in light of the resolution of social tension between, on one hand, the humanistic and university elite, and on the other, the engineers and the artisans living in more modest conditions.[30] Zilsel and Hessen share common ground in the inversion of the canonical perspective on the history of science as a history of great personalities, great inventions and discoveries. From the Viennese author's perspective the conditions of nascent capitalism and the bourgeoisie's needs made the affirmation of a new *scientific spirit* possible.[31] In this sense, the spread of capitalism necessarily required technological progress as a way of facilitating the development of the productive process. The social effects of these conditions allowed for the traversing of the social

and cultural boundaries between academics and humanists, who were exclusively involved in the intellectual and university context, and artists and engineers, who were effectively engaged in manual work, like surgeons and barbers, manufacturers of measuring instruments, those employed in construction or engineering firms, etc. For Zilsel, the birth of modern science was represented by this cross-fertilization process.

In line with this theoretical endeavor, the German sociologist Franz Borkenau, a member of the Communist Party, argued that on the contrary, the emergence of modern science was the result of the passage from manual labor to new forms of uniform production, characterized by temporally segmented and quantitatively precise tasks.[32] In other words, work underwent a mechanical transformation, as seen with the abstraction and standardization of processes and for Borkenau, this was linked with the advent of the modern concept of natural law and mechanical philosophy.

Henryk Grossmann is another author often associated with Hessen.[33] Grossmann was an economist and statistician with communist sympathies. He had Polish-Jewish origins and migrated to Germany, but after Hitler's rise to power, he emigrated to the U.S. Many scholars have erroneously argued that he only knew Hessen indirectly (i.e. through the Clark's interpretations). In 1938, Grossmann wrote a review of *Science and Social Welfare in the Age of Newton* by Clark,[34] in which he highlights how Clark only offered an interpretation of Hessen in light of the first of his three theses. Contrary to Clark's interpretation, Grossmann affords more prominence to the third thesis, in accordance with his interest in mechanical philosophy and physical movement. In this sense, Grossmann developed a kind of *technological determinism* according to which the emergence of modern science was a direct consequence of the state of then-existent technology.[35] He maintains that because the technology of the time hadn't exhibited any other kind of movement than those related to mechanics, science was then mainly dedicated to mechanical questions.

Interlude: Internalism and Liberalism in Science during the Post-War Period.

As we have seen in the previous paragraphs, Hessen's intervention in '31 gave way to two intellectual programs: "Bernalism" and "externalism." In the post-war period, two counter-movements emerged against the Hessen theses. The first type of detractors represented—from a methodological point of view—the internalist tendency in the history of science. The second type of detractors was a kind of political opposition to Bernalism represented by the liberal wave in science.

For internalism, science is an intellectual activity essentially isolated from its social, political, and economic context. From this point of view, the interpretive effort focuses on the intellectual aspects of the setting and the solutions to problems. The most influential thinker in this type of approach at the global level is Alexandre Koyré. His development of the internalist line of thinking started in *Études Galiléennes* (published in 1938) and continued with *La revolution astronomique* (1961), which further deepened his elaboration of the topic. However, *From the Closed World to the Infinitive Universe* of 1957 is considered to be his masterpiece. Koyré's formulation of the concept of the *astronomic* or *scientific revolution* is mandatory knowledge for anyone that

is engaged in the history of science (and has been totally absorbed into common sense). In his *Newtonian Studies* (published posthumously in 1965), one might read the following as a rejection of the Hessen theses and of the externalist program as a whole[36]:

> The new science, we are told sometimes, is the science of the craftsman and the engineer, of the working, enterprising, and calculating tradesman, in fact, the science of the rising bourgeois classes of modern society.
> There is certainly some truth in these descriptions and explanations: it is clear that the growth of modern science presupposes that of the cities, it is obvious that the development of firearms, especially of artillery, drew attention to problems of ballistics; that navigation, especially that to America and India, furthered the building of clocks, and so forth—yet I must confess that I am not satisfied with them. I do not see what the *scientia activa* has ever had to do with the development of the calculus, nor the rise of the bourgeoisie with that of the Copernican, or the Keplerian, astronomy.[37]

From *Études Galiléennes* to his posthumous works, Koyré argued for the hypothesis that the experiments never played a significant role in the emergence of the scientific revolution. On the contrary, they were often an obstacle to it, and in their place, Koyré highlights the importance of mental experiments instead. Koyré's internalist thesis was received by an entire generation of historians of science, which included such prominent figures as Bernard Cohen at Harvard, Alfred Rupert Hall in London, Herbert Butterfield at Cambridge, Alistair Crombie at Oxford, Charles Gillispie at Princeton, etc.[38] In this period, as Werskey confirms: "the history of science emerged as a distinct academic discipline under the guidance of scholars supremely conscious of the Marxists' neglect of science as a body of ideas."[39] Marxist accounts of science provided the basis for internalists' treatment of science as simply a corpus of ideas.

In 1949, Butterfield published *The Origins of Modern Science,* one of the most important contributions to the internalist intellectual wave. He was well known for having introduced into the history of science a strong critique to the *Whig* interpretation of history, which was understood as the tendency to prize past revolutions as long as they were victorious. In this sense, a teleological principle was surreptitiously inserted into the historical dimension of science, and thus the existence of progress was presupposed in science. Butterfield's approach was continued by his disciple Alfred Rupert Hall in his *Ballistic in the Seventeenth Century*, in which Hall inverted Hessen's perspective. In this book, Hall argues that scientists' engagement with ballistics between the sixteenth and seventeenth centuries naturally emerged from their interests in the study of movement (which was, at the time, the most fruitful field of inquiry). In his article entitled "Merton Revisited", he identifies Hessen's intervention of '31 as a "collector's piece,"[40] and defines it as the first contribution to the externalist approach.

At the same time, opposition to the Hessen theses began to assume a political dimension. This opposition not only took the form of an internal question to the methodology of the history of science, but also of an antagonism toward so-called Bernalism (i.e., a socialist political model of science). After the end of WWII, liberal scientists were mainly concerned with the danger of giving up the freedom of science (e.g., *Lysenkoism*), as they believed that it would cause the end of "pure science." From this point of view, it is important to consider the foundation laid by Michel Polanyi and John Baker in the *Society for Freedom in Science*. The latter had the explicit aim of opposing the very tradition which Hessen had initiated. As Baker writes,

> The movement against pure science and against freedom in science was first brought to Great Britain by the Soviet delegation to the International Congress on the History of Science held in London in 1931. […] Owing to the world-wide economic depression, attention in 1931 was naturally focused on economic matters, and this preoccupation lent impetus to the specifically Marxist doctrine, then brought to England from Russia, that scientific progress was really determined by economic causes and that all scientific work should be consciously and directly devoted, under central control, to the material service of the State.[41]

This interlude shows how the canonization process and the global circulation[42] of the Hessen theses were determined by the fact that the theses were understood in a polemical fashion by a whole intellectual current. This characterization, however, was based not so much on a genuine hermeneutic effort to understand Hessen's work, but on an extremely reductionist reading of it.

To Become a "Precursor": The Dissemination of Hessen's Work between the '60s and '80s

As mentioned above, in the Anglo-Saxon context, the history of science became an institution and obtained disciplinary autonomy thanks to internalist scholars. On the other side of the Atlantic, the sociology of science and so-called externalism attained the status of a discipline, especially with Merton and the work of the Mertonians. Between the '60s and the '80s —after the institutionalization phase of the discipline—there arose a clear need for interdisciplinary dialogue between philosophy, history, and sociology in science studies.

In order to understand this process, it is necessary to mention Kuhn, whose work is a cornerstone of all disciplinary studies of science. In his *Copernican Revolution* (1957)—a text which was strongly influenced by Koyré—he extended the internalist approach, while trying to integrate it with the externalist approach. In 1972, Kuhn mentioned the Hessen theses in a presentation at a conference[43] in which he tried to overcome the classical opposition between internalism/externalism, shifting the problem onto the debate about the unity or disunity of science.[44] In 1962, he published *The Structure of Scientific Revolutions,* a work universally recognized as one of the most influential in many disciplinary fields (thanks to the intrinsic functionality of

concepts such as *paradigm, normal science*, and *anomaly*). From this point of view, *The Structure* opened a new vision of the social dimension of science during the '70s, even if he refused some sociological interpretations of his work as supporting a relativistic viewpoint.

It is important to focus our attention on the emergent interest in the interdisciplinary studies of science (i.e. STS). In 1964, David Edge founded the *Science Studies Unit* in Edinburgh, recruiting young lecturers like Barry Barnes, David Bloor, Steven Shapin, and Werskey, whom we already mentioned. In this context, the basis of the "strong programme" in the sociology of scientific knowledge (from here on SSK) was developed. Through a careful commingling of the sociology of knowledge (Durkheim and Mannheim), the philosophy of Ludwig Wittgenstein, and the Kuhnian thesis, SSK proposed a new interdisciplinary program in the study of science (rhetorically conceived as an anti-Mertonian program).[45] The first aim of this new program was to establish a fruitful dialogue between history, philosophy, and the sociology of science.

The U.K. academic context in which SSK emerged was characterized on one hand by a broad dissemination of Bernalism,[46] and on the other hand by the debate between internalist and externalist positions. As highlighted above, both Bernalism and externalism were recognized as a direct effect of Hessen's intervention in London. Among other references (like Durkheim, Mannheim, Wittgenstein, etc.), SSK recognized the Hessen theses as a precursor of their program.

Werskey was the most engaged with the Marxist tradition among scholars in STS, dedicating a great number of articles to this topic as well as his *The Visible College* (1979), which was mentioned above. Among other contributions, he published a paper in 1971 entitled "British Scientists and 'Outsider' Politics, 1931-1945" in the first issue of the field's "flag journal," *Science Studies*[47] (today known as *Social Studies of Science*). This text ends with the following reference to the '31 congress's collected interventions: "British science once again finds itself 'at the crossroads.'"[48] In a footnote, Werskey more explicitly recognizes the importance of this text, which he defines as an "invaluable document" that had "a profound impact on the thinking of Radical scientists."[49] At the same time, a new edition of *Science at the Crossroads* was reprinted in 1971 on the occasion of the fortieth anniversary of the London congress. A new *Introduction* by Werskey and a *Foreword* by Needham (one of the few still alive among the congress's participants and in a position to provide testimony) were added to this publication. The anniversary edition was made in the middle of the Cold War, when the relationship between science, technology, politics, and the economy was a pressing topic. Technological and scientific development seemed to impose transformative changes upon the world, the military balance of power, political relations among nations, and even everyday life. During the postwar period and throughout the Cold War era, science became a new issue for public policy and a source of economic and military growth. In this context, a strong interest in the debates from the '30s and '50s began to resurface. Hessen's work was broadly considered one of the most striking examples among the interpretative proposals of that period. Needham expressed that Hessen's influence was "not yet exhausted,"[50] while also underlining that "The trumpet-blast of Hessen may therefore still have

great value in orienting the minds of younger scholars towards a direction fruitful for historical analyses still to come."[51]

For his part, Barnes had contended that Marxism in science "found its most single-minded application" in the Hessen theses.[52] To this he added,

> When it was published in 1931 few were able to set aside their political commitments and evaluate it objectively, but it provided an influential theoretical model, and one may wonder how many of the empirical studies now used to illustrate its weakness would have existed in its absence. (p. 17-18)[53]

Along the same Kuhnian line of thinking, SSK also aimed to overcome the opposition between externalism/internalism. In doing so, authors like Bloor, Michael Mulkay, and Shapin deconstructed the inherited image of Hessen as an advocate of crude externalism. From this point of view, Bloor stressed that Hessen's work "is certainly crude, although by no means so crude as the parodies of it found in internalist criticisms would imply."[54] Mulkay clearly reverses the kind of superficial interpretations of the Hessen theses that were made by internalists, as he, after having synthesized the main aspects of Hessen's work, writes that

> Although the economic factor is fundamental to the materialist conception of history, this does not mean in Hessen's view that it is the sole determining influence upon any particular set of ideas. Accordingly, he attempts to complete his analysis of Newton's work by showing how Newton drew selectively upon the cultural resources available to a member of his class, for example, in the form of political, juridical, philosophical and religious beliefs, and by showing how these ideological elements influenced and limited Newton's thought.[55]

Contrary to previous interpretations, Mulkay maintains that the Hessen theses allow one to open the "black box" of science and provide its sociological explanation (i.e. the first aim of SSK). In this sense, Hessen's work is used by the author as a good example of the potential of a Marxist approach in SSK:

> It [Hessen's work] merely serves here to illustrate that Marx can be interpreted in a strong sense, that is, as implying that the content of established scientific knowledge should be treated to a considerable extent as the outcome of specifiable social processes.[56]

From 1972 until 1989, Shapin—among those affiliated with the *Science Studies Unit*—was a professor at Edinburgh. For his course on the social history of science, he proposed various readings, including Hessen, Bernal, Needham, Zilsel, Ravetz, R. M. Young, etc.[57] In 1981, he authored three entries for the *Dictionary of the History of Science*: "Needham thesis," "Hessen thesis," and "Zilsel thesis." Moreover, in subsequent years, Shapin adopted a skeptical perspective on the opposition between

internalism/externalism. In his historical treatment of this topic,[58] he referred to Hessen's work as a pivotal point from which various disciplinary debates in science studies have followed. Shapin remarked that the internalist interpretation of the Russian author was a parodistic version of the real text:

> While Hessen's materialism informed his attack on the supposed absolute autonomy of ideas, neither he nor the historical materialist tradition from which he came ever proposed to reduce science totally to its economic foundation [….] From Marx and Engels onwards, materialists have always acknowledged that material influences proceed through culture and that cultural practices may come to have relative autonomy.[59]

On the same line, also in his bibliographical essay for *Scientific Reason*, he mentions Hessen and Zilsel's works among the classics of the history of science.[60]

In 1984, another protagonist of STS, Simon Schaffer, published an article entirely dedicated to Hessen entitled "Newton at the Crossroads" in the journal *Radical Philosophy*.[61] This text reconstructs Hessen's argument and addresses its uses by authors like Clark, Merton, Needham, Bernal, Hall, etc. Schaffer highlights two issues in particular. On one hand, he emphasizes Hessen's deconstruction of the notion of the scientific genius. The concept of the scientific genius starts to look erroneous and useless in light of any adequate contextualization of scientific, cultural, economic, and political practices. Even if naively, Hessen took into serious consideration the power structures underlying scientific knowledge to challenge this notion. On the other hand, Schaffer emphasizes Hessen's account of the social construction of science. In the same spirit as many others in STS who had appropriated Hessen's work, Schaffer tried to retrace an intellectual genealogy in order to legitimate STS as an intellectual field. Moreover, in the introduction to the second edition of *Leviathan and the Air-Pump*, both Shapin and Schaffer recognize their debt to Marxist methodology by arguing that

> For many British historians, Marxism was a lingua franca, not necessarily providing a theoretical foundation for political projects but certainly constituting a loosely connected set of concepts and methodological sensibilities with which many historians felt they should engage even while their political affiliations diverged.[62]

The primary aim of *Leviathan and the Air-Pump* was to ascertain the implicit, though tangible, political significance of scientific development. In some way, this book is part of the materialistic line of research in the history of science.[63]

As in previous years, the Hessen theses were once again recognized during this period as an influential and innovative contribution to the description of the relation between science and technology. In *The Social Construction of Facts and Artefacts*, Trevor Pinch and Wiebe Bijker refer to Hessen's work as a "locus classicus" in

technology studies, because he "argued that pure science is indebted to developments in technology."[64]

How should Hessen being labeled the progenitor of these various debates about scientific knowledge be interpreted? From a methodological point of view, Koyré had strongly criticized the idea of the "precursor" in the history of science: "Rien n'a eu une influence plus néfaste sur l'histoire que la notion de 'précurseur.' Envisager quelqu'un comme 'précurseur' de quelqu'un d'autre, c'est, très certainement, s'interdire à le comprendre."[65] Nevertheless, it is very interesting to observe the process by which the figure of an authoritative "precursor" is constructed by an emergent field or debate that tries to legitimize itself. According to what Bourdieu called the social condition of international (but also interdisciplinary) circulation of ideas,[66] Hessen's work passed through various marked phases.

The history and sociology of science has attributed to the Russian author the merit/demerit of having been among the first to open a new wave of studies, which were later labeled externalism. Nevertheless, it should be emphasized that Merton was the one who introduced terms such as internalism and externalism into debates about science. Moreover, the choice to line up on one side or the other, internalist or externalist, depends also on different disciplinary revindications that conditioned the process and the form of the institutionalization of specific disciplinary fields (we especially focused our attention on Anglo-American debates[67]). Also, Hessen's work had an extraordinary impact on the context of science *policy,* by laying the foundation of what came to be known as "Bernalism." This posture had a broad political impact on science studies, not only in the U.K. but also in the USSR and in Poland. Bernal's works had, in those cases, an impact as great as that of Hessen at the London congress in 1931,[68] and stimulated the renaissance of *naukovedenie*.[69] There was, therefore, a sort of bidirectional circulation of research paradigms between the two sides of the iron curtain. At the same time, some authors emphasized the importance of Hessen's work for the analysis of the relation between science and technology. Finally, Hessen's work had been perceived from the perspective of SSK as a theoretical source for unlocking the so-called "black box" of the social content of scientific knowledge. As we have seen, in this sense, the Hessen theses played a peculiar role in the closure of the debate between internalism/externalism. For a long time the scope of Hessen's work has been exclusively interpreted in light of debates that developed in the Western world. Nowadays, it is necessary to revisit the Soviet physicist's work in order to revive the critical spirit in which he interpreted the sciences, with the effort not only of trying to understand his underlying political values, but to historically and sociologically reconsider our own epistemologies as well. To do this, however, it is necessary to engage in a critical re-reading of Hessen's work from the point of view of Soviet intellectual debates at the time.

The Emergence of the Hessen Theses

Boris Hessen was born in 1893 in Elisavetgrad, now Kropyvnytsky, in Ukraine, into a Jewish family. His father was a bank employee. During high school, he took part in local political movements, at the same time showing a particular interest in science, mostly mathematics, which led him, along with Igor E. Tamm (future

Nobel Prize winner in 1958 for the discovery of the Cherenkov Effect) to study physics at the University of Edinburgh in 1913-14. Here Hessen worked under the direction of Edmund T. Whittaker, an English mathematician and physicist working on celestial mechanics and numerical analysis. From his teachings Hessen acquired an interest in the history of physics, as Whittaker was known in the academic environment not only as a scientist but also as a historian of science. In 1914, Hessen returned to Petrograd where he continued his studies in physics, mathematics, and statistics at the Polytechnic Institute under the supervision of Aleksandr A. Chuprov. When the Russian civil war ended, he began to work on natural sciences at the Institute of "Red Professors" of the Central Committee of the Communist Party. In 1928, Hessen asked permission to carry out research in Berlin. He wished to collaborate with Richard von Mises, a German scientist and mathematician with whom he shared, among the other things, an interest in philosophy.[70] It is important to note that von Mises was a great supporter of Mach and thus close to the Vienna circle. From this moment on, Hessen's career went through a series of major turning points. In 1930, he was appointed Director of the Institute of History of Physics at Moscow State University and the following year he became a professor of physics. Also involved in philosophical discussions, he was elected to be a Corresponding Member of the USSR Academy of Sciences for the philosophy section of the Department of Social Sciences in 1933. His reputation worsened when he obtained these positions, however, and only two years later, he fell victim to the Stalinist purges. In 1934, the Communist party accused him of conspiracy, an allegation received only three years after his talk in London.[71]

The accusations made against Hessen occurred during a time of exceptional political tension in the Soviet Union. The organs of the Soviet administration of justice conducted severe inspections in search of subversive elements to be judged by the special *troika*: a commission that could issue sentences to people without a fair trial, even in their absence. In the context of this fight against infidelity to orthodox Marxism, a number of scientists, philosophers, and intellectuals were subject to a campaign of terror, as they were labelled and condemned as saboteurs, spies, or terrorists. In the field of physics, these convictions achieved full effectiveness by turning into dynamite resolutions. One of the most dreadful examples was the tragic fate of Matvei P. Bronstein, who was part of the circle of Soviet physicists close to Lev D. Landau, and who had made the struggle for the autonomy of science in general, and theoretical physics in particular, his life's mission. He also worked in favour of the modernization of the Soviet academic structure. Bronstein was sentenced to death on 18 February 1938. Hessen had the same destiny two years earlier for reasons that are in part similar. Both he and Bronstein were often accused of advocating a form of scientific cosmopolitanism which, as it was internationalist in character, was interpreted as carrying anti-Soviet connotations.[72] Both defended the theory of general relativity and quantum mechanics from the contempt of Soviet ideologues, who accused these endeavors as reactionary expressions of bourgeois science and thus antithetical to the principles of Marxism. The reasons that led to Hessen's condemnation were thus rooted in the split between truth and heresy, or

orthodoxy and revisionism, out of which dialectical materialism arose in the early years of the 20th century.

Hessen's support of Einstein's positions, which, according to his view, represented a fruitful opportunity for Soviet physicists to settle their problems in a way that did not anchor and limit philosophical and epistemological discussions to pure dogmatism, reopened unhealed wounds among scientists that supported orthodox Marxism. In particular, Hessen revived the deep aversion to those idealists disguised as materialists who championed the epistemology of Mach. The Russian Machists, above all Alexandr A. Bogdanov and Vladimir A. Bazarov, perhaps the sharpest intellectuals within this faction, believed that Mach's theory of the physical elements, and his empiricism in general, did not contradict a materialist interpretation of nature, but rather the opposite: they saw it as being fully compatible with Marx and Engels's teachings. Russian Machists appreciated the anti-transcendentalist imprint of Mach's physics which rejected the metaphysical aspects that characterized Western philosophy, for example the absolutization of concepts such as substance and matter. For Mach, these were rather abstract and unnecessary from a scientific point of view. He claimed instead that knowledge derives from experience. In turn, experience has its foundation in sensations. Therefore, if Mach's empiricism could take root in some wings of Marxist intellectualism, despite the devaluation of matter, it was mainly because his approach was still characterized by a certain refusal of idealism, and leaned towards a materialist interpretation of cognitive processes. Cognition has indeed, according to Mach, a psychophysical, biological and evolutionary matrix. In other words, he thought that the active relationship between any constituent part of our environment and the organism (or the individual), provides the necessary preconditions for experience. In this regard, Russian Machists believed that Mach and Marx were not to be found on two opposite sides, but that Machism was totally compatible with materialism[73].

Russian Bolshevists who defended an integration of Marx and Mach became the primary target of Lenin's accusations, which began around 1905 and reached a new peak of intensity a few years later in his *Materialism and Empirio-criticism*[74]. In this book Lenin presented the theory of reflection as the only possible explanation of knowledge production. The idea that the external world is reflected and copied in our cognitive processes and sensations allowed Lenin to account for the existence of matter in objective and absolute terms. He thus undertook an ideological crusade against the detractors of orthodox Marxism and condemned those like Bogdanov who, having followed in the footsteps of the immaterialist empiricist tradition of George Berkeley, had then agreed with Mach in denying the external world by making it dependent on our mutable sensory perceptions.[75] Lenin finds in Mach and thus in the Russian Machists a complete reversal of the materialistic perspective which, according to the natural sciences, regards matter as a primary base, and consciousness, thought and sensation as secondary data. According to Lenin, accepting the position of the Machists would mean reducing the cognitive value of scientific theories and of history in its progressive development. He concluded that knowledge is a true and objective representation (sometimes also defined as eternal) of the external world that

is not exhaustive and complete; rather it proceeds by gradual approximations that become more and more adequate in their grasp of reality.

Reflex, mirror, photograph, etc., are among the verbs used by Lenin as metaphors to understand the cognitive processes which appear to be directed toward a static nature although Lenin does not forget to remind us of the dynamic character of history. Indeed, the objectivity of historical development is understood as the dialectical evolution of structural factors in nature.

The theory of reflection appears to be significantly in line with a conception of the cognitive process as a linear replacement of old acquisitions with new ones. In this way, Lenin is unable to successfully defend his philosophical system from the accusation of determinism. Once matter is established as the objective fundament, science must develop in such a way that legitimizes and strengthens it. Mach would have replied that science must be historical in the sense that it does not need to search for eternal validity; on the contrary it needs to be constantly challenged and discussed. Along the same lines, Bogdanov thought that placing oneself in direct continuity with Marx's work does not mean precluding the possibility of developing, updating, deepening and, if necessary, revising his theory in the light of new social needs and theoretical acquisitions.

As is well known, Einstein was a close friend to Mach and recognized his achievements as pioneering in the development of his own physics. By challenging the Newtonian notions of time and space, Mach was considered by Einstein a predecessor of the general theory of relativity. But supporting Einstein's physics meant supporting, albeit indirectly, Russian Machism and a heterodox interpretation of Marxism according to which reality is not merely reflected in the process of knowledge; in the Machist view, rather, reality emerges as a result of the active organizational correlation between the subject and the object in their coupled historical development.

According to Lenin, both Mach and Einstein were responsible for having annulled the objectivity of matter. Mach did so because it turned matter it into a projection of our sensory organs, as he affirmed that knowledge production is possible only through our sensations. Furthermore, in postulating a continuum between time and space, and most importantly, the equivalence of energy and matter, he ended up denying any ascription of autonomy or determination to the latter.[76]

Lenin engaged in a spirited debate with Bogdanov after the publication of *Empiriomonism*, wherein Bogdanov discussed the theory of psycho-energetics as the study of "cognitive parallelism between life, as a complex of experiences, and its reflection in a socially organized experience."[77] Bogdanov believed that "the task of cognition consists in expediently organising experience" which is made of elements that are not merely data given to us as ready-made, but come from active practice and that are closely related to culture and labour. Similarly, Hessen believed that science is a form of social practice in a material context[78].

Hessen and Bogdanov

The proposed association between Bogdanov and Hessen, which has never been considered in recent literature on Hessen, is suggested by the fact that both had a Machist background in the philosophy of science, and this approach emerges despite

the fact that Hessen labeled himself a dialectical materialist. One of Hessen's most influential mentors was von Mises, who, following Mach, rejected any form of dualism between subject and object in the process of knowledge, and believed that the contents of experience do not have an objective meaning. In this sense, he formulated a theory similar to that of "substitution" as put forward by Bogdanov, according to which coordinated elements of experience turn into entities that with time "replace" that combination of elements with metaphysical concepts. This correlation becomes a model for the organisation of facts: some phenomena are substituted for others so that the first are as if transformed into "symbols" of the second[79]. As pointed out by Arran Gare, Bogdanov's theory of substitution anticipated the ideas of Marxists historians of science such as Zilsel, Needham, Bourkenau and Young. Indeed, according to Bogdanov, the development of science is driven by a combination of both internal and external factors, that is to say that any change is society, labour and organization is a precondition to any advancement of science[80].

Von Mises also defended the notion of "connectibility", which closely resembles Mach's theory of knowledge as a process of connecting different coordinated complexes. This theory was also advocated by Bogdanov in his *Empiriomonism*. From von Mises, Hessen acquired the aversion to a deterministic methodology in physics. Hessen believed that scientific theories should not be rejected only because they do not conform to a dialectical materialist viewpoint. Contrary to von Mises, however, he did not abandon the importance of objectivity in science, as he tried to use it to justify his support of new ideas in physics. Diplomatically speaking, Hessen defended objectivity to legitimize the importance of probability and contingency in quantum mechanics[81]. In other words, he protected the new physics from dogmatic accusations[82]. However, an objective interpretation of probability does not mean that Hessen believed, with the objectivists, that probability is independent form the observer as part of the historical process. Objectivists dismiss the subjectivist characterization of probability because it might lead to idealism, but Hessen criticised the idea that reality can be independent and objective[83]. Even when he asserts the objectivity of matter, his arguments seem to contradict this assumption[84].

A common background between Hessen and Bogdanov can then be justified by their common adherence to Einstein's physics. Bogdanov had discussed and praised relativity and its philosophical interpretation in a co-edited Russian publication. The book was published in 1923 and included the translation of a condensed version of Moritz Schlick's *Space and Time in Contemporary Physics* followed by three essays by Bogdanov, Bazarov, and Pavel S. Jushkevich.[85] As Daniela Steila points out, Bogdanov even considered relativity to be a confirmation of his *empiriomonistic* thoughts. Einstein's relativity was for him a further development of Mach's point of view while it also remained compatible with Wilhelm Ostwald's energetic epistemology, which Marxist ideologues particularly castigated because of its defense of a perspective that paradoxically exalted energy and dematerialized matter.[86] For Bogdanov, there was no place for any dualism between the subject and the object, and the theory of relativity helped him assert his idea of the correlation of bodies: "The theory of relativity works on the premise that here there is *one* fact, not two. It is

the correlation of two sides that changes; depending on the position of the knowing subject, this might be expressed in one way, or another."[87]

Like Bogdanov, Hessen was too erudite to overlook the shaky presuppositions underlying the arguments made against Einstein. As Graham shows in his pioneering article, Hessen defended both a Marxist view of science, expressed in the association between scientific theories and their material and economic substratum, as well as modern physics in its more "internal" theoretical aspects.[88] He did so in the 1930s, at a time when the main Marxist intellectuals had declared the irreconcilability of the two dimensions and opted for reductionist materialism. As has already been pointed out above, Hessen did not defend socio-economic determinism. His ideas about the relationship between structure and superstructure are more akin to Bogdanov's theory of equilibrium which in turn inspired Nikolay Bukharin's account of the complementary relationship between theory and praxis[89].

Hessen believed, like Bogdanov, that Marxism and relativity were complementary aspects of different visions of the world—the one prioritizing economic aspects of human society and the other physical and cosmic ones. Marx would have agreed with Mach as well as Einstein that the subject shapes the object of knowledge in a unified social process rather than reflecting it in a deterministic act. With his physics, Einstein expressed a monistic point of view.[90]

Hessen's situation took a turn for the worst after 1929. The rift that emerged in the late '20s between two schools that contended for primacy in the interpretation of Marxism had not been so profound when Lenin was still alive. These two divergent currents aimed to clarify the relationship between materialism, dialectics, and science, as well as the question of which method was the most effective at harmonizing dialectics with recent scientific acquisitions in physics, chemistry, and biology. On one hand, there were the Deborinites, followers of the philosopher Abram M. Deborin, who claimed that materialism should avail itself of the study of the Hegelian dialectic, to which Marxism was linked both historically and conceptually. They also argued that it was necessary to engage in a dialogue with the most recent developments in the natural sciences, since in many cases, these studies showed a certain consistency with the principles of materialism and could easily be adjusted to fit with the perspective of dialectics. The other faction was that of the Mechanists. They were more radical and negationist, and found in the Marxist writer Ivan I. Skvorkov-Stepanov one of their main mentors. They postulated a clear detachment of Soviet science from Western thought and saw materialism as absolutely antithetical to all previous philosophy. The exponents of this current held a rather positivist view of science and were unwilling to accept the theory of relativity—on the contrary, they pushed for an even more drastic schism between bourgeois science and Soviet science.

Hessen belonged to the Deborinite faction, whose philosophical assumptions and epistemological attitude would have allowed him to cleverly combine two apparently conflicting aspects: faith in Marxism and the defense of a constantly evolving idea of science. He was also convinced of the need to look at scientific theories in a way that allowed one to critically evaluate the intellectual and cognitive contents of a theory regardless of the social context in which it had matured or the interpretation it had undergone. Although his report in London was centered on a

Marxist reading of Newton's mechanics, and therefore not at all based on the distinction between "content" and "context," the accusations that Hessen received had to do with the heterodox roots of his philosophical vision, which at a time of worrisome consolidation of the Stalinist *diamat* aimed to inscribe the progress of physics within the coordinates of dialectical materialism.[91] In fact, Hessen was convinced that Marx's ideas showed a certain coherence with the theory of relativity and that dialectical materialism would undoubtedly have benefited from a greater intellectual openness towards the philosophy of science and all of its ramifications.[92]

Hessen believed that the development of science follows a dialectical evolution through different ontological steps, which means that new ideas in physics such as time, space, and movement have overcome the Newtonian paradigm based on a static, abstract, and formal interpretation of matter. Even though Hessen admitted that relativity theory was compatible with dialectical materialism, we agree with Olga Stoliarova that Hessen had a different interpretation of dialectical materialism. The meaning of the dialectic for Hessen included the integration of both materialist and idealistic aspects.

More serious accusations were not late in coming. Defined as a Machist, idealist, mystic, and, of course, a deviationist, Hessen was accused of misinterpreting Lenin's thoughts, of having confused theory and practice, and of having given rise to a subjective interpretation of knowledge, following von Mises's physics. The latter accusation had a very weak, if not arbitrary, correspondence to Hessen's claims. As the following quote suggests, according to Hessen,

> The subject and the object acquire a true reality, a vital reality only in the process of mutual interaction. The object is not in opposition to the subject as if it were a *thing-in-itself*. No, it is exposed to the subject through a reciprocal relationship. It is knowable, and this cognitive act is a historical process of mutual interaction.[93]

Hessen seems to defend an *empiriomonistic* view of knowledge production that saw cognition as a historical process in Bogdanovite terms[94]. Indeed, the theoretical synergy between Hessen and Bogdanov can be found at many different levels of inquiry, for example, concerning their interpretation of knowledge evolution and the organization of scientific experience in historical perspective. In *Fundamental Elements of a Historical Concept of Nature*, published in 1899, as well as *Knowledge from a Historical Point of View,* Bogdanov announces a series of epistemological errors in the science and philosophy of the past—that of having looked at nature from "a static point of view."[95] This led to the attribution of characteristics that have gradually become scientific objectification.

> The history of the development of the human mind is an uninterrupted process of metamorphoses and transformations of old ideas into new ones, and there is no doubt that at every stage of understanding any new "truth" sooner or later will turn wrong. But this does not characterize only history. Actually, even current ideas represent a

> struggle between "old truths" and the "new ones" (…). Static epistemology has not sufficiently emphasized that the movement and change of reality can be rightly understood only if a historical point of view is adopted.[96]

Hessen would adopt a similar point of view in the preface to his collection of early modern historical sources, where he highlights the importance of a historical study of science and how this role is considerably neglected in current physics.

> At present, not only does historical analysis of (scientific) problems disappear from the work of leading physicists, but even trends and schools that fundamentally deny the usefulness and necessity of a historical study of science are founded. (…)
> No matter how new and unaccustomed theories of modern physics are, no matter how radically they differ from the views of classical physics, the modern stage of the development of physics is still a historical stage in its general development. Therefore, knowledge on the history of the emergence and development of physical theories not only facilitates an understanding of their current state, but also helps to establish their historical roots and thereby clears the way for new research.
> The modern development of physics puts forward a whole range of basic categories—causality, statistical and dynamic regularity, the problem of measurement —that require deep analysis. The role of historical research for understanding these categories is undeniable. Getting acquainted with the history of the development of physics, we see that many questions have already been fundamentally posed, and in some cases the correct path to their solution has been outlined. History is not "a list of human delusions, but a pantheon of great ideas." How little more we draw from this treasury! What we know about the thoughts of the great founders of modern natural science, what is often described in our textbooks and books on the history of science, often doesn't even resemble the richness of the original thoughts. With very rare exceptions, we almost never find the images of that tense struggle that was conducted between various directions in physics and in the course of which the basic principles and laws were forged.[97]

The importance of history for the understanding of scientific development as an open process in which material and ideal elements are interwoven dissociates Hessen's view from dialectical materialism and places it next to *empiriomonism.* According to Bogdanov, with time, "matter" has become a consolidated idea similar to a metaphysical abstraction if not a faith. As Stoliarova reminds us

> in the large-scale panorama of science development drawn by Hessen, a change in the world's image results from the expansion of experience

> of a collective subject in the process of practical activities transforming reality[98].

As we saw earlier, Bogdanov comes to a similar conclusion when he discusses knowledge from the point of view of *Empiriomonism*. He claims that experience is never subjective, but always collective; that is, experience is "socio-organized". History is fundamental because it provides an explanation of knowledge creation not in individualistic terms but as social adaptation, concerning, above all, a common genesis of cognitive experience.

At the crossroads between loyalty to Marxism and fidelity to scientific thought in its unchained historical development, Hessen defended a hybrid approach that is traceable to revisionism. His talk at the 1931 conference might have been an opportunity to make up for his mistakes, but it was not enough to dispel doubts about his proximity to right-thinking Marxist positions.[99] In the minds of Soviet authorities, the idea of mutual interaction between subject and object in the cognitive process risked subjectivizing matter while at the same time weakening the scientific and epistemic apparatus on which Marxism had to be founded.

Arrested on August 22, 1936, and sentenced in the same year for his involvement in anti-revolutionary activities, Hessen was judged by the Supreme Court in a secret session presided over by the statesman Vasily V. Ulrich. On December 20, it was reported that both Hessen and the physicist Arkadij O. Apirin (who was arrested in June of the same year) were members of an anti-Soviet terrorist organization that was held responsible for the assassination of Sergei M. Kirov in collaboration with the Gestapo. Hessen and Apirin were killed on the same day, December 20, 1936. Hessen died in prison. The date of his death was falsified: for many years he was believed to have disappeared in 1938. His body was cremated and the ashes buried in the Donskoy cemetery. His official rehabilitation was not conferred until 1956.[100]

Conclusion

We have argued that although Hessen claimed in his famous essay that he would apply the methods of dialectical materialism to an analysis of the genesis and development of Newton's work, his theses seem to suggest a less dogmatic interpretation of the relationship between the economic structure and political superstructure of society. Hessen argued that society develops as an organic whole where the methods of production condition the social, political and intellectual process of the life of society. We have shown that it would be misleading to interpret this relationship as a deterministic one as Hessen never sustained a sharp, univocal correspondence between the material and the intellectual dimensions of society, either in any of his previous works or in his famous text from '31. Instead, he promoted the importance of an historical analysis in the study of science for which Newton's activity and theories could be rightly understood only when historically contextualised. If we strip the rhetorical tone of Hessen's presentation at the London congress, in which he was evidently called to present to Western scholars the sound advancements of Soviet science, what is left is a synthetic, but dense, appraisal of Newton's mechanics in

relation to its societal, economic, political and religious aspects. In this respect, we have argued with Graham that this rhetorical tone, loaded with ideological components, was more of an obligation than a choice for the Soviet physicist. We then presented the hypothesis that Hessen's views were closer to an understanding of materialism and scientific development that were rooted in Russian Machism rather than in dialectical materialism. It is true that Hessen was accused of being a Machist as were most people executed in those years. However, the presence of Ernst Mach's legacy, which was particularly vivid in the work of scientists and philosophers like Bogdanov, can also be felt in Hessen's arguments and we have substantiated that claim with the support of textual evidence. Hessen's interpretation of subject-object interaction in the process of knowledge creation is more in line with an empiriomonistic epistemological framework rather than with dialectical materialism. Based on this assumption, we have offered a new synthesis in which a Machist interpretation of Hessen's work is in harmony with the ways in which his theses have been received, interpreted and re-elaborated in modern science studies in an international context.

Acknowledgements

In 2017, we published a new Italian translation of Boris Hessen's *The Social and Economic Roots of Newton's Mechanics* as *Le radici sociali ed economiche della meccanica di Newton*),[101] which first appeared in Italy in 1977 in the Italian edition of *Science at the Cross Roads*.[102] Working on this publication has been an opportunity for us to fill in the gaps in our understanding of a still neglected chapter in the historical analysis of the social studies of science. We dove into Hessen's biography, his writings and a study of his socio-political context, and cleared any misunderstandings associated with the first English translation that have been perpetuated for many years. We not only compared the Italian version of the Russian text published by Hessen in 1933, but also consulted translations that appeared later on in several languages and provided a thorough introduction to Hessen's biography and intellectual legacy.[103] The present article is based on this joint endeavor, which we are presenting here in an updated fashion.

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[1] This text is the result of collaborative work; however, Ienna is the author of the first part of the paper (pp. 39-49) and Rispoli of the second (pp. 49-58).

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[6] Haldane was the only one absent at the congress. He would only turn to Marxism after the Spanish Civil War in '36.
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[21] Clark, G. N., (1937), 87.
[22] Clark, G. N., (1937),. 85-6.
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[24] Merton, R. K., "Science, Technology and Society in Seventeenth Century England", *Osiris* 4 (1938): 501-502.
[25] Merton, R. K., (1938): 501-502.
[26] Merton, R. K., (1938): 565
[27] "We have already indicated that the preceding three chapters of the present study, despite certain differences of interpretation, are heavily indebted to Hessen's work" [Merton, R.K,. (1938): 565].
[28] These errors had been broadly recognized by many scholars (for example, cfr. Needham, J. (1971): VIII). For his part, Merton reproduced some of these errors like writing "Herique" instead of "Von Guericke" (p. 507) or "the arsenal of Florence" instead of "the arsenal Venice" [Guérout, S., (2006): 47].

[29] The success of Mertonian sociology in the U.S. has made possible the institutionalization of sociology of science as an autonomous discipline: Merton, R. K., "The Sociology of Science: An Episodic Memoir," in *The Sociology of Science in Europe*, eds. R.K. Merton; J. Gaston (London-Amsterdam: Feffer&Simons, 1977); Ben-David, J. "Emergence of National Traditions in the Sociology of Science. The United States and Great Britain," in *Sociology of Science. Problems, Approaches and Research*, ed. J. Gaston (San Francisco-Washington-London: Jossey-Bass Publishers, 1978).
[30] Lamy, J.; Saint- Martin, A., "La sociologie historique des sciences et des techniques. Essai de généalogie conceptuelle et d'histoire configurationnelle," *Revue D'histoire des sciences* 68/1 (2015): 175-214.
[31] Zilsel, E., *The Social Origins of Modern Science* (Dordrecht/Boston: Springer, 2003): 10.
[32] Guérout, S., (2006): 42.
[33] This connection had great success, especially for the edition that collects the texts of both authors under the direction of Freudenthal and McLaughlin.
[34] Grossman, H., "Review of G.N. Clark, Science and Social Welfare in the Age of Newton" in *The Social and Economic Roots of the Scientific Revolution*, eds. B. Hessen, and H. Grossmann (Dordrecht/Boston: Springer, 2009): 235.
[35] Grossmann, H., "The Social Foundations of the Mechanistic Philosophy and Manufacture," in B. Hessen, and H. Grossmann, (2009).
[36] In a footnote he mentioned Hessen, Clark, Grossmann, and Borkenau: cfr. Koyré, A., *Newtonian Studies* (London: Chapman & Hall, 1965): 6.
[37] Koyré, A., (1965),5-6.
[38] Braunstein, J.-F., *L'histoire des sciences* (Paris: Vrin, 2008), 92.
[39] Werskey, G., (1971a): XXIII
[40] Hall, A. R., "Merton Revisited, or Science and Society in the Seventeenth Century", *History of Science* 2 (1963): 2
[41] Baker J. R.; Tansley A. G., "The Course of the Controversy on Freedom of Science," *Nature* 158, (1946): 574.
[42] Bourdieu, P., (2002)
[43] Kuhn participated at the congress in honor of George Sarton with an intervention entitled "Mathematical versus Experimental Traditions in the Development of Physical Science" cfr. Kuhn, T., *The Essential Tension* (Chicago: The University of Chicago Press, 1977).
[44] I Kuhn, T., (1977),vi, 32
[45] For the advocates of SSK, Mertonian sociology would have studied science only from the external point of view without raising the problem of the social conditioning of the internal content of scientific knowledge. For the vulgate of SSK the science is treated by Mertonians as a "black-box."
[46] For example, the *Rede lecture* of 1959 entitled *The Two Cultures* by Charles Percy Snow gave a broad public, political and academic resonance to Bernalism. This lecture has had also the effect of stimulating the birth of many interdisciplinary programs or research's units in U.K. Universities like that of Edinburgh. Furthermore, since 1981 the *Society for Social Studies of Science* has given out the *J. D. Bernal Prize* (the most important recognition in the field of STS) explicitly dedicated to the memory of this author.
[47] It is remarkable that in the first issue of the most prominent journal in the field there was a clear reference to this tradition. *Science Studies* was founded in 1971 by Edge and Roy MacLeod with a clear interdisciplinary aim. D. Edge and R. MacLeod, "Editorial," *Science Studies* 1/1 (1971): 1-2.
[48] Werskey, G., "British Scientists and "Outsider" Politics, 1931-1945", *Science Studies*, 1/1 (1971): 83.

[49] Werskey, G., (1971): 83
[50] Needham, J., (1971), VIII.
[51] Needham, J., (1971), IX.
[52] Barnes, B., (ed), *Sociology of Science* (Harmondsworth: Penguin; 1972), 18.
[53]Barnes, B., (1972).
[54] Barnes, B., *Scientific Knowledge and Sociological Theory* (London: Routledge 1974), 106.
[55] Mulkay, M., *Science and the Sociology of Knowledge* (London-Boston: Allen&Unwin, 1979), 7-8.
[56] Mulkay, M., (1979), 7-8.
[57] Shapin, S., "A Course in the Social History of Science," *Social Studies of Science* 10/2 (1980): 231-258.
[58] Shapin, S., "Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism-Internalism Debate", *History of Science* 30 (1992): 333-369.
[59] Shapin, S., (1992): 362.
[60] Shapin, S., *The Scientific Revolution* (Chicago: The University of Chicago Press, 1996).
[61] Shaffer, S., "Newton at the Crossroads", *Radical Philosophy* 37 (1984): 23-28.
[62] Shaffer, S.; Shapin, S., *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life, 2nd Ed.* (Princeton-Oxford: Princeton University Press, 2001): XXIV.
[63] Lamy, J.; Saint Martin, A., "Marx, un spectre qui ne hante plus les sciences studies? Première partie: Marx, des campus aux machines," *Cahiers d'histoire. Revue d'histoire critique* 124 (2014): 161-182.
[64] Pinch, T.; Bijker, W. E., "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other", in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. W. Bijker; T.P. Hughes; T.J. Pinch (Cambridge-Mass: MIT press, 1987), 19.
[65] Koyré, A., "Introduction," in N. Copernic, *Des révolutions des orbes célestes. (Du livre I, chapitres 1-11)* (Paris: Librairie Félix Alcan, 1543; 1934), 4.
[66] Bourdieu, P., (2002).
[67] In other national cases, such as French or USSR debates, the institutionalization of disciplinary studies of science followed different trajectories.
[68] Mirsky, E. M., "Science Studies in the USSR (History, Problems, Prospects)," *Science Studies* 2/3 (1972): 281-294; Rabkin, Y. M., "Naukovedenie: The Study of Scientific Research in the Soviet Union", *Minerva* 14/1 (1976): 61-78
[69] *Nukovedenie* (translated as *Science Studies*) is an interdisciplinary field of inquiry about science developed in the URSS since mid-20s [Graham, L. *Science in Russia and the Soviet Union: A Short History* (Cambridge, Cambridge University Press, 1993): 151]. In the same period in Poland there also emerged an interdisciplinary field of studies of science named *Naukoznawstwo* (translated as *Science of Science* or *Logology*) [Kokowski, M. "The Science of Science (naukoznawstwo) in Poland", in *Science Studies during the Cold War and Beyond* eds. S., Turchetti; E. Aronova (New York: Palgrave MacMillan 2016): 150; Krauze, T.; Kowalewski, Z.; Podgórecki, A. "The Sociology of Science in Poland", in *The Sociology of Science in Europe*, eds. R. K., Merton; J. Gaston (London-Amsterdam, Feffer&Simons, 1977)]. During WWII these research programs both progressively disappeared because of the Nazi occupation of Polish territory on the one hand, and the Stalinists' aversion to this field on the other [Mirsky, E.M., (1972): 282; Graham L., (1993): 152; Lubrano, L., *Soviet Sociology of Science* (Columbus-Ohio: AAASS, 1976), 4-5] Around the mid-'60s, during the post-Stalinist administration, the international dissemination of Bernal and De Solla Price's works also encouraged a new wave in this two fields in Eastern Europe (and relative intersection between *Nukovedenie* and *Naukoznawstwo*) (Dobrov, G. M. "The Sociology of Science in the URSS", in R.K., Merton; J. Gaston, (1977)].

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[71] Graham, L. "The Socio-Political Roots of Boris Hessen: Soviet Marxism and the History of Science", *Social Studies of Science* 15/ 4 (1985): 705–722.
[72] Gorelik, G., Bouis, A.V., *The World of Andrei Sakharov: A Russian Physicist's Path to Freedom* (Oxford: Oxford University Press, 2005).
[73] Adler F. „Der 'Machismus' und die materialistische Geschichtsauffassung", *Die Neue Zeit* 28 (1909):10?????.
[74] Lenin, V.I., *Materialism i Empiriocrititsism* (Moskva: Zveno, 1909).
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[76] Vucinich, A., *Einstein and Soviet Ideology* (Stanford: Stanford University Press, 2001), 17.
[77] Bogdanov, A.A., *Empiriomonizm: Stati po filosofii* (Moskva: Respublica, 2003), 80.
[78] Bogdanov, A.A., *Philosophy of Living Experience*, ed. D.J. Rowley (Amsterdam: Brill, 2015) 207. See also, White J.D., *Marx in Russia* (London: Bloomsbury, 2019). Stoliarova, O., "Idei B.M. Gessena y otechesvennaya filosofiya", *Filosofskij zhurnal*,, 10/3 (2017): 112-132.
[79] Bogdanov, A.A., (2015).
[80] Gare, A. "Alexander Bogdanov's History, Sociology and Philosophy of Science" *Studies in History and Philosophy of Science Part A* 31/2: (2000): 231-248.
[81] See for instance Hessen B. M., "Predisloviye k stat'yam A. Eynshteyn i Dzh. Tomsona," *Pod Znamenem marxisma* 4 (1927): 152-165.
[82] Gorelik G.E., Frenkel V.Ya. *Matvei Petrovich Bronstein: and Soviet Theoretical Physics in the Thirties* (Switzerland: Birkhäuser, 2010).
[83] Hessen, B. M., *Osnovnye idei teorii otnositel'nosti* (Moscow-Leningrad, 1928).
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[87] Bogdanov cited in Steila, D., (2014) 8.
[88] Graham, L., (1985).
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[91] Joravsky, D., "Soviet Views on the History of Science," *ISIS* 46/143 (1955): 3-22.
[92] Vucinich, A., *Einstein and Soviet Ideology,* 2011.
[93] Hessen cited in Josephson, P., (1991), 244.
[94] Josephson, P., (1991), 244.
[95] Bogdanov, A. A. *Osnovnye Elementy Istoricheskogo vzgliada na prirodu* (St. Petersburg, 1899), 10. See also, *Poznanie s istoricheskie tochky zreinja* (St. Petersburg, 1901).
[96] Bogdanov, A.A., (1899) 10-19.
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[98] Stoliarova, O. (2017): 124.
[99] Graham, L., (1985).
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Geschichte der Physik' (Druckfahnen, 1936 ca. 700 Seiten, russ.)," *Sitzungsberichte der Leibniz-Sozietdt der Wissenschaften* 92/2007: 133-152.

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[102] *Scienza al bivio. Interventi dei delegati sovietici al II Congresso Internazionale di Storia della Scienza e della Tecnologia* (Bari: Di Donato 1977).

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