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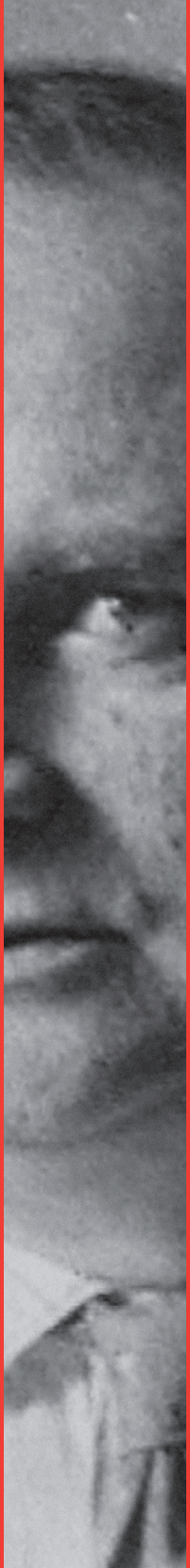

Manuscripts and Documents on the History of Physics: A Historical Materialist Textbook

Boris Hessen

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Manuscripts and Documents on the History of Physics: A Historical Materialist Textbook

Boris Hessen

Edited by Pietro Daniel Omodeo
and Sean Winkler

The International and Interdisciplinary Circulation of Boris Hessen's Theses

Gerardo Ienna

Introduction

The reception of Hessen's famous essay titled *The Social and Economic Roots of Newton's Principia* has undergone various stages or, to put it in Bourdieu'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, I will outline the various phases of the circulation of Hessen's theses from the 1930s to the present day. I will first reconstruct the immediate reception in Britain of Hessen's theses during the conference and in the years immediately following. Subsequently, I will highlight how the legacy of Hessen and the readings of him by British Marxists went beyond the national borders of Britain to arrive, firstly, in the US and, secondly, back to the USSR through a process of reverse circulation of ideas. In both cases this complex form of dissemination of Hessen's theses led to different kinds of debates. I will also consider the positions of the detractors of the theses referred to in derogatory terms as 'externalist' by showing how Hessen's intervention in 1931 has been taken as the main polemical target of this current of research. In the second part of the text, I will move towards more contemporary debates highlighting how Hessen's thought has been rehabilitated since the 1970s as the inspirational father first of the Radical Science Movements and then showing how

his theses have been taken up in the emerging debates in the field of Sociology of Scientific Knowledge and in the wider STS context. The anti-deterministic character of his theses will emerge clearly from the account of scholars interested in overcoming the debate between internalism vs. externalism. To conclude, I will trace the last phases of the international circulation of this author and the emergence of a more mature phase of canonization of his work. I will retrace the various translations that have been made of the famous 1931 speech and of other texts by Hessen that have only recently been published in languages other than Russian (and for this reason are little known at international level). 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.

The Debates in the United Kingdom Stemming from the London Congress

During the congress and in the following days, the theses supported by the Soviet delegates generated a strong debate. Its resonance was broadly perceived by those present at the event in London. At the time, there was a very active circle of scientists in the United Kingdom engaged in political leftism, whom Werskey called the 'visible college.'[1] This group included John Desmond Bernal, John Haldane, Lancelot Hogben,[2] Hyman Levy, and Joseph Needham. These authors had a common interest in the investigation of science's role

1 The concept of the visible college was coined by Werskey, echoing the expression "invisible college," which was employed by Robert Boyle to refer to a dozen natural philosophers gathered around him in 1660. Gary Werskey, *The Visible College. The Collective Biography of British Scientific Socialists in the 1930s* (New York: Holt Rinehart Winston, 1979).

2 He proposed the immediate publication of the texts of the Soviet delegation.

in society. Excluding Haldane,[3] everybody in this group was at the 1931 congress and remained strongly influenced by the talks of the Soviet delegation.

The intervention of the Soviet delegation was meant as a cultural-political operation and, for this reason, it was decided that the Soviet communications should be published in English in a volume titled *Science at the Crossroads*. During the course of the conference, a group of translators and proofreaders at the Russian Embassy worked hard to prepare the volume for print. On the morning of July 4, during the actual speech of the Soviet delegation, a first unbound version of the Soviet papers was distributed. The complete collection of the Soviet delegates' papers was published by the Russian Foreign-Language Press about ten days after the end of the conference. Despite numerous typographical errors and inaccurate linguistic revision of the translation, copies of the book quickly sold out[4]. An expanded version (with revisions) introduced by Paul Gary Werskey and including a preface by Joseph Needham appeared in 1971.[5]

The Marxist approach proposed by these delegates clearly separated them from the positivist and Comtian approach to understanding the history of science.[6] For a long time, this discipline had, in fact, been practiced as a secondary activity by professional scientists who

3 Haldane was the only one absent at the congress. He would only turn to Marxism after the Spanish Civil War in 1936.

4 Gideon Freudenthal and Peter McLaughlin, "Classical Marxist Historiography of Science: The Hessen-Grossmann-Thesis," in *The Social and Economic Roots of the Scientific Revolution*, ed. Gideon Freudenthal and Peter McLaughlin, (Dordrecht: Springer, 2009), 1-40.

5 Bukharin, *Science at the Cross Roads.* Only Hessen's text has been reprinted in a stand-alone edition in Sydney 1946. For an analysis of the various editions of the text cf. Gerardo Ienna and Giulia Rispoli "Boris Hessen al bivio fra scienza e ideologia," in *Le radici sociali ed economiche della meccanica di Newton* by Boris Hessen*,* ed. Gerardo Ienna (Rome: Castelvecchi, 2017), 39-41.

6 Jean François Braunstein, *L'histoire des sciences* (Paris: Vrin, 2008); Jerôme Lamy and Arnaud Saint-Martin, "La sociologie historique des sciences et des techniques. Essai de généalogie conceptuelle et d'histoire configurationnelle," *Revue D'histoire des sciences* 68, no. 1 (2015): 175-214.

had often not deeply reflected on the theoretical-historical model implicit in their construction of historical narratives. During the very early stages of institutionalization, the history of science thus crystallized around the celebration of great personalities, such as Galileo Galilei, Johannes Kepler, and Isaac Newton, who were often presented as intellectual figures capable of bringing a radical transformation to the sphere of human knowledge through their genial contribution. However, this approach underestimated the role played by certain forms of knowledge and certain types of actors (therefore marginalized in standard narratives) in enabling the social emergence of scientific activity. For the first time in the history of the historiography of science, the interventions of Bukharin, Hessen, Rubinstein, and others emphasized the role of technicians in the development of science, the impact of cultural-religious convictions on scientific practices, and particularly the determinations coming from the economic-social structure on the sphere of intellectual production.[7] All these elements mutually concur to form a system in equilibrium, as

7 In the same period in France the historiographic current of Annales founded by Marc Bloch and Lucien Febvre emerged. This tradition has had relevant intersections with the debates in the history and philosophy of science, especially in the context of the French *épistémologie historique* [cf. Enrico Castelli Gattinara, *Les inquiétudes de la raison: épistémologie et histoire en France dans l'entre-deux-guerres* (Paris: Vrin 1988)]. As pointed out by Maria Paula Diogo,"The Perfect Pair" authors gathered around the journal *Annales* have contributed in various ways to the history of science and techniques. These authors have proposed an approach based on the rejection of an event-based narrative (*histoire_ événementielle*). Their goal was rather to propose a historiographical model based on the concepts of *total history, history-as-problem (histoire totale*, and *histoire-problème)* aimed at proposing a long-term (*longue durée*) historical perspective on social and cultural phenomena. In analogy to what Hessen proposed in his speech in London, authors such as Braudel and Febvre devoted attention to the analysis of the material conditions of the emergence of technological forms as much as its effects on culture and society. This communion of purpose is also evident from the collaboration between the Bernalist authors Needham and Julian Huxley with Febvre in the context of the UNESCO project for the writing of the *History of Scientific and Cultural Development of Mankind* cf. Maria Paula Diogo, "The Perfect Pair." See also Elena Aronova, *Scientific History. Experiments in History and Politics from the Bolshevik Revolution to the End of the Cold War* (Chicago: University of Chicago Press, 2021), 87-131.

we outlined above, where science, technology, and society reinforce each other.

The rhetoric of the scientific genius sent by God or appearing from nowhere is therefore deconstructed through the adoption of sociological tools of analysis capable of bringing to light a hidden side of the dynamics of scientific production and highlighting the communitarian structure of scientific activity.

It should also be emphasized that this historiographical model is not unrelated to a certain way of understanding the organization of scientific activity in contemporary times. The issues at stake in the science-at-the-crossroads debate therefore imply the discussion of two intimately connected aspects: on the one hand, the opposition between capitalist science and socialist science, and on the other hand, the opposition between internalist historiographic methodology and what has been called (not without discredit) externalist methodology.[8] The approach proposed by the Soviet delegates inaugurated a method of inquiry that allows us to see both the effect of science on societal transformation and the impact of society on the production of scientific practices. The entanglement of these two aspects still represents a fundamental theoretical background that Marxism has provided in order to understand the most urgent problems of our contemporaneity.

Among the members of this visible college, Bernal and Needham were particularly prolific in their work to further the perspective of the Hessen theses in the history of science.[9] Bernal was a strong supporter of the Soviet model in its promotion of a harmonious development of

8 Wolf Schäfer, "Boris Hessen and the Politics of the Sociology of Science," *Thesis Eleven*, 21, no. 1 (1988): 103-116, on 104.

9 Steven Shapin, "Hessen Thesis," in *Dictionary of the History of Science,* ed. William F. Bynum, (London: Macmillan, 1982), 185-186.

society and science.[10] In addition to his scientific studies about X-rays and molecular biology, Bernal authored several now classic texts, such as *Engels and Science* (1935); *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); and *Emergence of Science* (1971). Especially in his 1939 book, he tried to address the question—particularly important for Marxism—of science policy. In accordance with Bukharin's presentation at the London congress that focused on the relation between science and ideology, and theory and praxis, Bernal delineated a way to put scientific practice at the service of society.

In this regard, he clearly stated that the interest in dialectical materialism in the United Kingdom 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."[11] In a footnote, he also added an explicit reference to the Hessen theses: "Hessen—article on Newton— [...] was for England the starting point of a new evaluation of the history of science."[12] In this context *Science in History* served as a perfect example of how to provide a Marxist interpretation of the history of science. This text by Bernal would later become a classical point of reference within this discipline and considered by many a masterpiece.[13]

10 Serge Guérout, "Présentation," in *Les racines sociales et économiques des Principia des Newton*, Boris Hessen, (Paris : Vuibert, 2006), 1-67.

11 John D. Bernal, *The Social Function of Science* (London: Rutledge, 1946), 393.

12 Ibid., 406.

13 In fact, in 1981, on the occasion of the fiftieth anniversary of the London congress, the journal *Isis* dedicated a special part of its third issue to the theme of Marxism and history of science in which Jerome Ravetz and Richard Westfall contrasted precisely in attributing a different meaning to Bernal's science in history for the history of the discipline, cf. Jerome Ravetz and Richard S. Westfall, "Marxism and the History of Science," *Isis* 72, no. 3 (1981): 393-

At the same time, Joseph Needham was publishing his *Chemical Embryology* (in three volumes) in 1931. During the preparation of this book, he also had the possibility to meet Charles Singer, the president of the London congress. During the congress, Needham was particularly impressed by Boris Zavadovskij's talk. Indeed, Zavadovskij reached the same conclusions of Needham, even if the former was starting 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 1931—Needham wrote, "further historical research will enable us to do for the great embryologists what has been so well done by Hessen for Isaac Newton."[14] In introducing the second edition of *Science at the Cross Roads*, he said, "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."[15] Also, in his later works—like the monumental seven-volume *Science and Civilisation in China* (published between 1954 and 2004)—Needham expressed his debt to the stimuli received by Bukharin, Hessen, and the other Soviet delegates.

Among those attending the conference was also the scientific journalist James Gerald Crowther.[16] He was particularly active in

405. Consider also that the Society for Social Studies of Science, one of the major institutions in the field of STS, has awarded the J. D. Bernal Prize every year since 1981 to a scholar who has distinguished himself or herself by making a significant contribution to the study of the social dimension of science. Among the winners of this prize are: Robert K. Merton, Thomas Kuhn, Joseph Needham, Joseph Ben-David, Bruno Latour, David Edge, David Bloor, Harry Collins, Barry Barnes, Donna Haraway, Steven Shapin, Michel Callon, Sheila Jasanoff, Donald MacKenzie, Steve Woolgar, and Karin Knorr Cetina.

14 Gary Werskey, "Introduction," in *Science at the Cross Roads,* ed. N. Bukharin, (London: Frank Cass & Co. Ltd., 1971), XXII.

15 Joseph Needham, "Foreword," in *Science at the Cross Roads,* ed. N. Bukharin (London: Frank Cass & Co. Ltd., 1971), VIII.

16 Crowther was a correspondent for the *Manchester Guardian* and a secret member of the communist party. It was Crowther himself who revealed the real composition of the Russian delegation at least four weeks before the beginning of the conference.

politics and closely associated with Hessen, with whom he maintained correspondence from 1931 until the death of the Russian physicist.[17] Crowther was a very prolific scholar who represented a cardinal point in the evolution and dissemination of Marxist methodology in the history of science. By 1930, he had already published *Science in Soviet Russia* (his interest in this topic predated the congress). In *The Social Relation of Science*, Crowther also declared, "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."[18] As will be explained in the next paragraph, this broad UK leftist movement in science took the name of Bernalism in the following years (from the name of Bernal, its major authoritative scholar).

In the same context in which the Hessen theses were disseminated in the United Kingdom, one must also consider the economic historian, George Norman Clark.[19] Despite being a detractor of Hessen's theses, he clearly declared that Hessen's work represented "the best available statement" of the relation between the rise of modern

17 Christopher A. J. Chilvers, "The Dilemmas of Seditious Men: The Crowther-Hessen Correspondence in the 1930s," *The British Journal for the History of Science*, 36, no. 4 (2003): 417-35.

18 James Gerald Crowther, *The Social Relations of Science* (New York, The Macmillan Company, 1941), 617.

19 Clark, who was the opening speaker of the first session of the London conference, was harshly criticized by the Soviet delegation. See Freudenthal and McLaughlin, "Classical Marxist Historiography of Science," 30. For the Russians, in fact, Clark's proposals (but also Hill's), went toward a new form of "the cult of heroes" of the history of science. From a Marxist point of view, it was considered necessary to break with individualistic and/or bourgeois philosophies of history, privileging instead studies that highlighted how the great scientists of the past had been influenced by the social and economic forces of their time. See Werskey, "Introduction," XXII.

science and the fall of the feudal economy.[20] But Clark's reception of Hessen's work was not without criticism. In *Science and Social Welfare in the Age of Newton* from 1937, he specified that in order to explain the success of natural sciences in those centuries, there were other factors to be considered in addition to those indicated by Hessen. Together with the rise of the bourgeoisie, Clark underlined at least six other factors: the role played by religion, the concern for treating the sick, the desire to win wars, artistic creation, and the pursuit of pure knowledge.[21] The third part of his book, titled *Social and Economic Aspects of Science,* is entirely dedicated 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 (we will come back to this topic later) that were reproduced in the process of canonizing the author in the following years. Various scholars highlighted some of Clark's misunderstandings of Hessen's arguments—a topic that I 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.[22] In particular, Clark argued that he would have used a "biographical"[23] and "psychological"[24] model in the history of science (i.e., precisely what the Russian authors criticized).

Although Clark's reading of Hessen's text is strongly critical and at times even a caricature, in our opinion it is necessary to consider

20 George Norman Clark, *Science and Social Welfare in Age of Newton* (Oxford, Oxford University Press, 1937), 63.
21 Guérout, "Présentation," 37; Clark, *Science and Social Welfare*, 89.
22 Freudenthal and McLaughlin, "Classical Marxist Historiography of Science," 30.
23 Clark, *Science and Social Welfare*, 86.
24 Ibid., 87.

that the English historian's objective is largely to overcome the 'crude' approach of the Soviets by means of a series of additions that allow him to go beyond the strictly economic interpretation of Newton's work. Clark also knew Max Weber, whom he quotes explicitly in his text (a year before the publication of Merton's theses.[25] Despite this, he recognized that the German author did not 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:

> **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.**[26]

Throughout the 1930s, the Marxist approach to science was developed even beyond the British borders. Authoritative authors coming from very heterogeneous intellectual backgrounds had, in fact, already worked in this direction, so that a strong historiographic tradition began to consolidate in the West.[27]

25 Robert K. Merton "Science, Technology and Society in Seventeenth Century England," *Osiris* 4 (1938): 360-632. See also Steven Shapin, "Understanding the Merton Thesis." *Isis 79*, no. 4 (1988): 594-605.

26 Ibid, 85-6.

27 From the context of the Vienna Circle and Austro-Marxism, Edgar Zilsel developed an original interpretation of the birth of modern science as the resolution of a class conflict. Edgar

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 American 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 theses."[28] 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

Zilsel, *The Social Origins of Modern Sience* (Dordrecht, Springer, 2013). Henryk Grossmann and Franz Borkenau, an economist and sociologist, respectively, were both affiliated with the Institut für Sozialforschung (Institute for Social Research) in Frankfurt under Carl Grünberg's direction. These authors thus related in various ways to the nascent Frankfurt critical theory. Cf. Rick Kuhn, "Henryk Grossman and Critical Theory," *History of the Human Sciences* 29, no. 2 (2016): 42-59; Gideon Freudenthal and Peter McLaughlin, eds., *The Social and Economic Roots of the Scientific Revolution: Texts by Boris Hessen and Henryk Grossmann* (Dordrecht, Springer, 2009); Valeria E. Russo, "Henryk Grossmann and Franz Borkenau A Bio-Bibliography," *Science in Context* 1, no. 1 (1987): 181-91; Rick Kuhn, "Introduction to Henryk Grossman's Critique of Franz Borkenau and Max Weber," *Journal of Classical Sociology* 6, no. 2 (2006): 57–100. Within this special issue and other articles, Peter D. Omodeo has instead analyzed the perspective elaborated by Gramsci. Pietro D. Omodeo, "La via gramsciana alla scienza," *Historia Magistra* 4 (2010): 53-68; Pietro D. Omodeo, "Egemonia e scienza: Temi gramsciani in epistemologia e storia della scienza," *Gramsciana: Rivista internazionale di studi su Antonio Gramsci* 2 (2016): 59-86; Massimiliano Badino and Pietro D. Omodeo, *Cultural hegemony in a scientific world: Gramscian concepts for the history of science* (Leiden, Brill, 2020); Pietro D. Omodeo, "The Struggle for Objectivity: Gramsci's Historical-Political Vistas on Science against the Background of Lenin's Epistemology" *HoST-Journal of History of Science and Technology* 14, no. 2 (2020): 13-49. For a general perspective on these issues, cf. Ienna and Rispoli, "Boris Hessen At The Crossroads of Science And Ideology".

28 At the time, Merton had already used Hessen's work for an article dedicated to the analysis of the relation between science and military technique. R. K. Merton, "Science and Military Technique," *The Scientific Monthly* 41/6 (1935): 542-545.

(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."[29] 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."[30] 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."[31]

Merton chose an eclectic methodology for which—despite indicating some distance from a strictly Marxist approach—he recognized his debt to Hessen.[32] 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.[33] The conventional narrative has crystallized (in the wake of Weber) the idea that the "Merton theses", as opposed to a Marxist theses, would have

29 R. K. Merton, "Science, Technology and Society in Seventeenth Century England", *Osiris* 4 (1938): 501-502.

30 Ibid.

31 Ibid., 565.

32 "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." Ibid.

33 These errors had been broadly recognized by many scholars (for example, cfr. Needham, J., "Introduction," 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, "Présentation," 47.

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[34] 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.[35] Zilsel

34 The success of Mertonian sociology in the U.S. has made possible the institutionalization of sociology of science as an autonomous discipline: R. K. Merton, "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).

35 J. Lamy; A. Saint- Martin, "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.

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.[36] 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.[37] 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.[38] Grossmann was an economist and statistician with communist sympathies. He had Polish-Jewish origins and migrated to Germany,

36 Zilsel, *The Social Origins of Modern Science*, 10.

37 Guérout, "Présentation," 42.

38 This connection had great success, especially for the edition that collects the texts of both authors under the direction of Freudenthal and McLaughlin.

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 Clark's interpretations). In 1938, Grossmann wrote a review of *Science and Social Welfare in the Age of Newton* by Clark,[39] 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.[40] 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.

Back in URSS: A reverse circulation of ideas

In the years following the London congress, the debates certainly did not end. During the 1930s, the so-called visible college was transformed into a progressively larger cultural phenomenon known as Bernalism.[41] This name was motivated by the wide influence generated by *The Social Function of Science* in the British and intellectual field, which allowed it to establish itself as a reference manifesto

39 H. Grossman, "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. Gideon Freudenthal and Peter McLaughlin (Dordrecht/Boston: Springer, 2009), 235.

40 H. Grossmann, "The Social Foundations of the Mechanistic Philosophy and Manufacture," in *The Social and Economic Roots of the Scientific Revolution*, eds. Gideon Freudenthal and Peter McLaughlin (Dordrecht/Boston: Springer, 2009).

41 For Bernalism's dissemination, cf. Ravetz and Westfall, "Marxism and the History of Science"; Maurice Goldsmith and Alan Mackey, eds., *The Science of Science* (London: Pelican Books, 1966); Gary Werskey, "The Marxist Critique of Capitalist Science: A History in Three Movements?," *Science as Culture* 16, no. 4 (2007): 397-461; Aronova, *Scientific History*, 132-139.

for Marxism in scientific debates.[42] The sphere of intellectual debates of the 1930s that sprang from the 1931 London conference also had a *longue durée* effect over the following decades and fostered the Soviet reception of a wider range of intellectual debates.

Shortly before the London Congress, a new interdisciplinary field of research emerged in the Soviet Union. *Naukovedenie* (the science of science) stood at the crossroads of history, sociology, and epistemology. Russia's electrification plan, for example, was among the first objectives of *naukovedenie,* which became known as the study of the inherent nature of science and a general theory of scientific cognition. In 1926, Ivan A. Borichevsky described it as a study of the social purpose of science and its relations with other types of social creativity. According to Borichevsky, this area of knowledge did not yet exist, but it must. It was required by the very dignity of its object—the revolutionary power of exact knowledge.[43] With this early description, *naukovedenie* can even be considered as a sociology of science ante litteram.

The main goal of the *naukovedenie* was to analyze science and technology as institutions, combining what we would now call organization and management of science and social studies of science. In Soviet Marxist terms, science is thus interpreted as a strategic productive force for the progress of society. This branch of research had a twofold task: on the one hand, to improve the performance of scientific researchers, and on the other, to understand the cognitive dimension of science using all relevant human and social sciences. *Naukovedenie* was thus configured as a field at the intersection of the two cultures, that is, between the humanities and social sciences

42 Goldsmith and Mackay, *The Science of Science*, 9.

43 Ivan A. Borichevsky, "Naukovedenie kak tochnaya nauka," *Vestink Znanija* 12 (1926): 786; Yakov M. Rabkin, "'Naukovedenie': The Study of Scientific Research in the Soviet Union," *Minerva* 14 (1976): 61–78.

(providing the method) and the natural sciences (representing the object).[44] Apart from Borichevsky, the pioneering figures of *naukovedenie* in the 1920s include Bukharin and Vladimir Vernadsky. In 1916, the latter had already recognized the need to address the problem of the organization of research and scientific work in Russia and the importance of creating a network of research institutes across the country and even at a global level. He argued that science is a global phenomenon, thus in order to solve problems that pertain to contemporary society, a concerted effort at the transnational level is required. Moreover, organization is fundamental when it comes to obtaining scientific achievements in a quick and 'economic' way.[45]

Vernadsky worked to establish an institutional commission for the study of the history of knowledge at the Soviet Academy of Sciences.[46] One of the objectives of the commission was to study nature in relation to the evolution of society, a project Bukharin mentioned in his presentation in London. The commission addressed the importance of developing the field of the humanities, paying exceptional attention to the history and philosophy of science and sociology. Vernadsky believed that scientific work could only be clarified in a historical context because only then is it possible to understand emergent phenomena. Moreover, he argued that the study of history had revealed the need for a reconstruction of science as transdisciplinary

44 Elena Aronova, "The Politics and Contexts of Soviet Science Studies (*Naukovedenie*): Soviet Philosophy of Science at the Crossroads," *Studies in East European Thought* 63, no. 3 (2011): 175–202.

45 Vladimir I. Vernadsky, "Izbrannie nauchnye trudy akademika V.I. Vernadskovo," in *Trudy po istorii, filosofii y organizazii nauki, Tom. 8* (Fenics, 2012).

46 The first chair of the "History of Modern Scientific Thought," which discussed both the contributions of Soviet scientists and great classics such as Newton, was established in those years, and in 1927, the Institute of History of Science, as a part of the Natural Science Section of the Academy of Sciences, was taken over by Bukharin. The institute covered broad areas addressing the relationship between science, the arts, technology, scientific research methodology, and more.

knowledge and as a global phenomenon.[47] In this way, Vernadsky pointed out the problem of the rationalization of science that was at the base of scientific and economic planning in the 1920s and 1930s.

In the 1910s and 1920s, an interdisciplinary intellectual field emerged in Poland as well, called *naukoznawstwo* (also translated as the science of science or logology). The main authors of the *naukoznawstwo* were Stanislaw Michalski and some representatives of the philosophical school of Lvov and Warsaw, such as Kazimierz Twardowski, Maria Ossowska, Stanislaw Ossowski, Taddeusz Kotarbinski, Kazimierz Ajdukiewicz, and Florian Znaniecki.[48]

Although the genesis of Polish and Soviet science of science studies were relatively independent from one another, their disciplinary histories intertwined as they developed. During the Stalin era in the Soviet Union, the whole scientific field of science suffered various forms of censorship and purges, abetted by Lysenkoism[49]. Beside the most famous case, the Lysenko affair, in relation to which the geneticist Vavilov (one of the speakers at the '31 conference) was sentenced to death, many of the authors who participated in the London Congress were publicly discredited or, in the worst cases, purged.[50] The same fate impacted the institutionalization process of the *naukovedenie* and *naukoznawstwo* whose development came to an abrupt halt in the 1930s.[51]

47 Vladimir I. Vernadsky, "O Zadacach Komissii po izucheniu estestvennych proisvoditel'nich sil v dele organizazii spetzializirovannich issledovatel'nich istitutov," *Voprosiy istorii estestvoznaniya y techniki*, no 1 (1999 [1917]): 161-167.

48 Michał Kokowski, "The Science of Science (naukoznawstwo) in Poland: Defending and Removing the Past in the Cold War," in *Science Studies during the Cold War and Beyond*, eds. Simone Turchetti and Elena Aronova (New York, Palgrave MacMillan, 2016), 150.

49 Dominique Lecourt, *Lyssenko* (Paris: Maspero, 1976)

50 Needham, "Foreword," IX-X.

51 In Poland, this type of study had suffered a major setback due to the double invasion of Nazi Germany and the USSR and the subsequent closure of many universities, foundations, and scientific associations. Cf. Kokowski, "The Science of Science (naukoznawstwo) in Poland," 151; Tadeusz Krauze, Zdislaw Kowalewski and Adam Podgórecki, "The Sociology of Science in

For many years, the ideas of Bukharin, Hessen, Vavilov, and many others were banned in Soviet intellectual debates. Nevertheless, the kind of approach proposed by these authors and the *naukovedenie* and *naukoznawstwo* had already begun to circulate in Western countries. Because of these vicissitudes, Bernalism became, perhaps paradoxically so, the only survivor of the theories proposed by the Soviet delegates of London, which shortly in turn became a western version of the science of science.[52]

It was not until Stalin's death in 1953 and with the more moderate policies of his successor, Nikita Khrushchev and especially those of Leonid Brezhnev beginning in the 1960s, that this type of study began to attract new attention in the Soviet Union. For this reason, it is only at the end of the 1950s and the beginning of the 1960s that there was a real institutionalization of the *naukovedenie* label, which hybridized both Polish *naukoznawstwo* and Western science policy.[53] In fact, in 1965, the *International Congress on the History of Science* was held between Krakow and Warsaw with the participation of Soviet and Polish delegates, as well as scholars from the Western Bloc. The conference was opened by Bernal and Mackay's plenary lecture

Poland," in *The Sociology of Science in Europe*, eds. Robert K. Merton and Jerry Gaston, 193-223 (London-Amsterdam, Feffer & Simons, 1977), 204; Loren R. Graham, *Science in Russia and the Soviet Union: A Short History* (Cambridge, Cambridge University Press, 1993), 152.

52 Cf. Goldsmith and Mackey, *The Science of Science*; Derek De Solla Price, *Little Science, Big Science* (New York: Columbia University Press). Also, the classical article by Polish scholars Ossowska and Ossowski was translated and broadly disseminated in English by the journal Minerva: María Ossowska and Stanislaw Ossowski, "The Science of Science," *Minerva* 3, no. 1 (1964): 72-82.

53 It should be remembered that after the end of the war, Poland was completely annexed to the countries under Soviet influence, which led to massive control by the USSR over academic posts in the nation's universities. In those years, for example, the texts of Marx, Engels, Lenin and Stalin were translated into Polish, as were the most important contributions of scientists from the Soviet regime such as Zhdanov, Lysenko, Vladimir Alexandrovic, etc. As for the science of science, the previous generation of scholars had largely been relieved of their institutional positions, leading to a forced alignment in this field of research with Soviet orthodoxy (cf. Kokowski, "The Science of Science (*naukoznawstwo*) in Poland," 152-55).

entitled *On the Roads to a Science of Science*. This talk seems to have had an impact on the Soviets similar to that which Hessen's talk at the 1931 London conference had on the field of Anglophone scientific studies.[54] Bernal and Mackey's text was quickly translated and published shortly thereafter in a popular Russian journal [*Voprosy istorii estestvoznaniia i tekhniki*].

The Russian reaction was immediate and, as early as 1966, S. R. Mikulinsky[55] and N. I. Rodny published an article titled "Science as a Subject of Specialized Society" in which they defended a new stage of development and institutionalization of *naukovedenie*.[56] In this text, the *naukovedenie* are described as having two components: one stemming from the history of science, the other aiming at the study of social and economic conditions and the psychological dimension of scientific thought. This is a justification for the turn of the Institute of the History of Science, founded by Vernadsky, toward the new field of the *naukovedenie*.[57]

Bernal's texts, which were translated, thus established themselves in the Soviet Union as a central reference in this academic field. More than 100 people attended the same conference, including Derek J. De Solla Price (USA), Gennady M. Dobrov (USSR), Michajlowicz Kedrov (USSR) René Taton (France), and Ignacy Malecki (Poland).[58] In particular, it is to the fortunate meeting between Dobrov himself (author of *Science of Science: Introduction to General Science Policy Studies*) and De Solla Price that part of the expansion of Soviet

54 Cf. E. M. Mirsky, "Science Studies in the USSR (History, Problems, Prospects)," *Science Studies* 2, no. 3 (1972): 281-94; cf. Rabkin, "'*Naukovedenie*': The Study of Scientific Research in the Soviet Union."

55 Mikulinsky was the director of the Institute of History of Natural Sciences and Technology of the USSR Academy of Sciences.

56 Mirsky, "Science Studies in the USSR," 283

57 Rabkin, "'*Naukovedenie*': The Study of Scientific Research in the Soviet Union," 74.

58 Kokowski, "The Science of Science (*naukoznawstwo*) in Poland," 160.

research in the field of infometry should be attributed.[59] In 1966, thanks to the organization of a Soviet-Polish conference in Lvov,[60] a real meeting between the *naukovedenie* and the *naukoznawstwo* took place. At that time, according to Dobrov[61], it would seem that the emergence of the label *naukovedenie* covered not only the science of science (and naukoznawstwo), but also the concept of Science Policy that was starting to emerge in those years in Europe. In fact, in 1971 the International Council for Science Policy Studies (ICSPS) was founded in Moscow, the first effective international institution in the field of Science and Technology Studies (STS). This international institution played a strategic role in linking Western STS with Soviet *naukovedenie* and social studies on science in some Third World countries. At the time of its foundation, De Solla Price was appointed president and two vice presidents from both sides of the Iron Curtain were named: the Soviet Mikulinvski and the French Jean-Jacques Salomon. This organization included researchers from the Soviet bloc and others from the Western capitalist bloc at the same time. Among the most active members of the Soviet bloc in the ICSPS—engaged, obviously, with the *naukovedenie* and its variations— were Dobrov (USSR); Zdislaw Kowalewski, I. Malecki and Bohder Walentynowicz (Poland); Ladislav Tondl, R. Richta (Czechoslovakia); Nicola Stefanov (Bulgaria); Stefan Balan (Romania); Günter Kröber (GDR); and J. Farkas (Hungary). The spirit in which the ICSPS was born overcame the barriers of the cultural Cold War from the political-intellectual point of view related to techno-scientific questions. This association represented, on the one hand, one of the principal vectors of diffusion of

59 Linda Lubrano, *Soviet Sociology of Science* (Columbus-Ohio: American Association for the Advancement of Slavistic Studies, 1976), 9.

60 Cf. Gennady M. Dobrov, "The Sociology of Science in the URSS," *The Sociology of Science in Europe*, eds. Robert K. Merton and Jerry Gaston (London-Amsterdam, Feffer & Simons, 1977), 316.

61 Dobrov, "The Sociology of Science in the URSS," 316-34.

the *naukovedenie* and, on the other hand, one of the principal circuits by which some Soviets or Germans from the GDR had been able to enter into contact with the Western Science policy.[62]

The intuitions proposed by the Soviet delegates at the 1931 conference (later largely marginalized in the USSR) were re-proposed in an updated version by Bernal (and Bernalists like De Solla Price) who in the meantime had become intellectual points of reference—and privileged interlocutors—in the Soviet Union. In addition, the emergence of the new field of research, Science Policy, fostered an exchange of ideas between East and West. It is therefore a paradoxical dynamic of reverse circulation and of ideas and paradigms between the two sides of the Iron Curtain.[63]

The combined analysis of both the effects of science on social transformations and the impact of society in the production of scientific discourses still represents a fundamental theoretical contribution that Marxism has provided to understand the most urgent problems of our contemporary times. Following the legacy of the 1931 conference, science and technology must therefore be investigated both by researching its economic roots–according to Hessen's expression– and by analyzing and imagining what the social function of science might be today—as Bernal would put it.

62 Aant Elzinga, "The Rise and Demise of the International Council for Science Policy Studies (ICSPS) as a Cold War Bridging Organization," *Minerva* 50, no. 3 (2012): 277-305; Gerardo Ienna, "Science and Technology Studies. Socio-epistemologia storica delle negoziazioni disciplinari" (PhD diss., Alma Mater Studiorum Università di Bologna, 2019), 189-96.

63 For a general perspective on the international circulation of ideas, see Pierre Bourdieu, "Les conditions sociales de la circulation internationales des idée," *Actes de la recherche en sciences sociales* 145 (2002): 3-8 ; Gisèle Sapiro, Marco Santoro and Patrick Baert, eds., *Ideas on the Move in the Social Sciences and Humanities: The International Circulation of Paradigms and Theorists*, (Dordrecht, Springer Nature, 2020). Eglė Rindzevičiūtė, The *Power of Systems, How Policy Sciences Opened Up the Cold War World* (Cornell University Press, 2016).

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.[64] 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[65]:

64 On this point see also Pietro D. Omdeo, "*Boris Hessen's Philosophy of the Scientific Revolution*", in this volume

65 In a footnote, he mentioned Hessen, Clark, Grossmann, and Borkenau: cfr. A. Koyré, *Newtonian Studies* (London: Chapman & Hall, 1965), 6.

> 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.[66]

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.[67] 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."[68] Marxist accounts of science provided the basis for internalists' treatment of science as simply a corpus of ideas.

66 Ibid.,5-6.
67 J.-F. Braunstein, *L'histoire des sciences* (Paris: Vrin, 2008), 92.
68 Werskey, "Introduction," XXIII.

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,"[69] 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*. Their program explicitly aimed to oppose the very tradition which Hessen had initiated. As Baker writes,

69 A. R. Hall, "Merton Revisited, or Science and Society in the Seventeenth Century", *History of Science* 2 (1963): 2

> 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.[70]

This interlude shows how the canonization process and the global circulation[71] 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.

Forms of Bernalism during the 70s and Radical Science Movements

Bernalism, a sort of heir of 'Hessenianism', as a cultural phenomenon gradually expanded to involve both professional scientists engaged with the problem of the social responsibility of scientists and social scientists interested in studying science as a socio-cultural phenomenon. The wide influence of *The Social Function of Science* stemmed from Bernal's accurate prediction of the centrality that

70 J. R. Baker and A. G. Tansley, "The Course of the Controversy on Freedom of Science," *Nature* 158 (1946): 574.

71 Bourdieu, «Les conditions sociales de la circulation internationales des idées».

science would assume in the post-war politics that came to characterize the Cold War.[72] As more and more countries drifted toward fascism or toward socialism in the 1930s, Bernal observed how science took on a different role in capitalist societies. "Science is both affecting and being affected by the social changes of our times, but in order to make this awareness in any way effective, the intersection of the two needs to be analyzed far more closely than has yet been done."[73]

The so-called Radical Science Movements that emerged from the social and political movements of '68 became particularly sensitive to these aspects. In various national contexts, debates and movements based on the idea of the social and political non-neutrality of science rapidly emerged. The focus was the analysis of the social function of science in advanced capitalist society. For example: after its foundation in 1969, the British Society for Social Responsibility in Science (BSSRS) published its manifesto in 1970 in which the non-neutrality of scientific knowledge was clearly argued[74]. During the 1970 conference of the American Association for the Advancement of Science, a group of militant scientists distributed their "manifesto" titled "Toward a Science for the People" (which marks the birth of the homonymous movement).[75] These events consolidated radical science movements in the U.S. and in the U.K.[76] In the same period,

72 Werskey, "Introduction," XXIV.

73 Bernal, *The Social Function of Science*.

74 BSSRS, "'Manifesto', British Society for Social Responsibility in Science," 1970, *Constitution, Manifesto and Other Papers Relating to the Founding of the British Society for Social Responsibility in Science*, Reference K/PP178/11/1/3), Welcome Library Archive, Papers of M H F Wilkins.

75 Bill Zimmerman, et al., "Toward a Science for the People," in *Science for the People. Documents from America's Movement of Radical Scientist*, eds. Sigrid Schmalzer, Daniel S. Chard and Alyssa Botelho (Amherst - Boston: University of Massachusetts Press, 1970), 15–22.

76 Zac Bharucha, *The Radical Science Movement in the U.K. 1968-1978. Struggles Against the Impact of Capitalist Ideology on Science, Technology and Social Relations of Science* (Poland: Amazon Fulfillment, 2018); Sigrid Schmalzer, Daniel S. Chard, and Alyssa Botelho, eds., *Science for the People. Documents from America's Movement of Radical Scientist* (Amherst - Boston: University of Massachusetts Press, 2018).

it is also possible to date the birth of an Italian radical science movement with the writing of the so-called "Varenna Manifesto"[77] and the French movement known as "critique des sciences"[78].

Such forms of New Leftism in science needed to identify authoritative precursors in order to intellectually legitimate their own existence. From this point of view, the cultural and intellectual work carried out by Gary Werskey is one of the most significant. The latter was in fact at the same time embedded in the radical movements at the transnational level and in the process of birth of the new academic sector of the STS (as I will illustrate this in the next paragraph). Werskey entered Harvard as a graduate student in history in 1965, completing his doctorate in 1973 under the joint supervision of Stuart Hughes and Everett Mendelsohn. Between 1968 and 1987, he lived in the United Kingdom, where he taught, in addition to the Science Studies Unit of Edinburgh, "science and industrial sociology" at Leicester, then Bath, and finally at the University of London. During this time, he co-founded the *Radical Science Journal* in 1972 and actively participated in the activities of the BSSRS.

It was in these circumstances, and in the wake of these debates, that 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

77 Gerardo Ienna, «Fisici italiani negli anni '70. Fra scienza e ideologia.», *Physis* LV, n. 1–2 (2020): 415–42.

78 Mathieu Quet, *Politiques du savoir. Sciences, technologies et participation dans les années 1968.* (Paris: Édition des archives contemporaines, 2013); Renaud Debailly, *La critique de la science depuis 1968. Critique des sciences et études des sciences en France après Mai 68* (Paris: Hermann, 2015). A specific analysis should be devoted to the relationship between Bernalism and rationalist movements in France Sylvain Laurens, *Militer pour la science. Les mouvements rationalistes en France (1930-2005)* (Paris: Éditions de l'EHESS, 2019).

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,"[79] 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."[80]

Thanks to this new edition, in the publications relating to the radical science movements of the '70s, references to Bernalism, to Hessen's theses and to the volume *Science at the Crossroads* became a constant point of reference. Bulletins and news journals such as the American *Science for the People* and the British *Science for People* and *Radical Science Journal* (now published under the new title *Science as Culture*) thus hinged on these new interpretative forms of 1930s scientific Marxism in light of the theoretical innovations of the New Left.

Throughout the 1970s, Werskey worked on the British Marxist debates that had emerged since the 1930s by reconstructing a "collective biography" of a group of socialist scientists such as Bernal, Haldane, Hogben, Levy, and Needham. In 1978, he published the already mentioned monograph titled *The Visible College* and various articles on this subject and on other related topics.

79 Needham, "Introduction,"VIII.
80 Ibid., IX.

The importance that Hessen obtained in the context of the radical science movements is also attested to by the references to this author that appear in two cardinal texts by Hilary and Steven Rose (that we therefore propose as examples). Both in *Political Economy of Science* and in *The Radicalization of Science* — both of which were widely considered to be intellectual cornerstones of the radical science movements — Hessen is mobilized in order to show his topicality and analytical potentiality in contemporary debates[81]. Here are two examples of these interpretations:

> **The second strand raised the question of whether a socialist society would generate a specifically socialist science; was there an unique socialist biology, by contrast with bourgeois biology, for instance? In so far as Newtonian mechanics were seen by Hessen as the product of a particular historical period in bourgeois society, the answer to that must have been seen as in the affirmative; what Hessen's contribution in 1931 (and indeed subsequent Soviet discussions in this area) have not adequately analysed out, however, is the question of whether there is indeed a bourgeois, by contrast to a socialist, science. But the unravelling of this argument, though implicit in Hessen, was not perceived by the Marxist British scientists in the 1930s. Rather, like Haldane, they were**

81 In the context of the Radical Science Movements we often refer in a broad sense to the contributions contained in *Science at the Crossroads* even if, both Rose and Rose, as well as other authors, have explicitly emphasized that Hessen's text was the most stimulating of all. "It was indeed from the Soviet Union that the second of our major themes, that of the ideological determination of science, was injected into the British debate with the appearance of the Soviet delegation at the 1931 London conference on the history of science. Although the delegation was headed by Bukharin, its major contribution was provided by a paper from Hessen on "The Social and Economic roots of Newton's *Principia*". Hilary Rose and Steven Rose, eds., *The Radicalisation of Science: Ideology of/in the Natural Sciences*, *Critical Social Studies* (London: Macmillan Press, 1976), 4–5.

> to spend their theoretical strength over the next few years in a relatively fruitless endeavour to demonstrate the negation of the negation, the interpenetration of opposites, and the transformation of quantity into quality in a variety of scientific developments. Only when, much later, Needham turned his attention to the history of Chinese science and technology and Bernal attempted first the seminal *Social Function of Science* (1939) and later the rather more synoptic and less satisfactory Science in History, was the Hessen experience to bear fruit[82].

In this passage, it clearly emerges how, compared to an "old left" model, the focus of radical science movements had shifted from the glorification of planned science typical of the socialist system to the elaboration of a critique of the capitalist system of scientific production. This change of axis determined the emergence of one of the thematic sites typical of the contributions of the 1970s, namely the relationship between science and ideology, or rather, the analysis of the ideology intrinsic to scientific activity in advanced capitalist societies. This point, rejected by the orthodoxy of the Soviet Diamat centered on Engels' *The Dialectic of Nature* and Lenin's *Materialism and Empiriocriticism*, represents one of the main tonalities of the new left in the scientific field.

> How has bourgeois history, philosophy and sociology of science come to ignore the unity of science and technology? We can see this in the case of a leading sociologist of science, R. K. Merton, whose early work, *Science, Technology and Society in Seventeenth century England* is a rejoinder to Hessen, a Soviet

82 Rose and Rose, eds., *The Radicalisation of Science*, 5–6.

> physicist who, as part of the Bukharin-led delegation to the International Congress of the History of Science and Technology held in London in 1931, presented a classical Marxist thesis of scientific growth. Hessen took Newtonian mechanics and showed how it was developed directly in response to the needs of burgeoning capitalism. Whilst his internalist British critics at the meeting sought to correct Hessen on small points of 'fact', Merton responded to the theoretical challenge of what was to be called the 'externalist' theory of scientific growth. [...] Merton attempted to show that science develops not solely in response to economic needs, but also requires a supportive value system- namely Protestantism. While this comes close to arguing that the superstructure -in the form of religious ideology -determines the base, Merton was concerned to examine the base/superstructure relationship. However, the emphasis on religious ideology and its compatibility with the scientific ethos pushed the work away from any economic explanation into a form of sociological internalism, characterized by a preoccupation with science as a more or less autonomous subsystem. This preoccupation with the scientific ethos was paralleled by the philosopher Polanyi's conception of the scientific community as a self -governing collectivity. This variant of internalism, which dominated the academic sociology of science for thirty years, ceased to address itself to questions of the interpenetration of science and the social order at the cognitive level, or even of scientists and the social order at the structural level. [...] Thus the fundamental character of science and technology in their social functions was lost to sight[83].

83 Hilary Rose and Steven Rose, eds., *The Political Economy of Science* (London: Macmillan Education UK, 1976), 20–21.

In this quotation, it is possible to see the way in which Hessen's legacy was being re-actualized and operationalized among the militant scientists of the 1970s. Hessen's theses are used as the picklock to unhinge the then hegemonic research agenda of Mertonian-style sociology of science in order to actualize a Marxist view (thus based on a theory of conflict) of the relationship between science and society. In the passage just quoted, it is interesting to note how Rose and Rose -reading Merton's perspective as a form of 'sociological internalism'- place Mertonian sociology in a position of dialectical integration with Polanyi's perspective to which they oppose a rehabilitation of the study, in the Bernalian sense, of the social functions of science.

Another militant scientist who was active in the *Radical Science Journal* wasRobert M. Young, who moved in a similar direction. After defining Hessen's text as a "locus classicus of the base-superstructure approach to the history of science," Young attacks the "bourgeois" [84] perspective of Mertonian sociology.

> **A similar path was taken by Robert K. Merton, the doyen of bourgeois sociology of science, whose original work in the 1930s was littered with footnotes and homages to Hessen. Merton focused on the origins, the class perspectives, the choice of topic, and other parameters of scientific knowledge while avoiding any commitment to seeing the resultant discoveries in ideological terms. The sociology of knowledge thereby became an elaborate study of the context of origination while carefully keeping away from the context of justification, the holy of holies which is so dear to non-Marxist philosophers of science. Within this framework of sociology of science as sociology of knowledge, quite subtle work has been**

84 Robert M. Young, "Marxism and the History of Science," in *Companion to the History of Modern Science*, ed. R. C. Olby, et al. (London: New York: Routledge, 1990), 81.

> **done about scientific communities, patronage, honours, the culture of laboratories, scientific accountability (or the lack of it) to the rest of society, and other topics which take the existing mode of production as given**[85].

As I will highlight in the next section, this kind of criticism of the sociology of institutional science eventually led to the emergence of the Sociology of Scientific Knowledge (from now SSK). The latter is in fact a research program polemically in contrast to Mertonian sociology. If the latter had the ambition to describe the institutional structures within which science operates, SSK aspires to apply the sociological method to the very contents of science.

In the uses of the new left, Hessen's theses and the interventions of *Science at the Crossroads* obtained, in the terms of Bourdieusian sociology, a new social and symbolic labelling[86]. From having been initially received in Europe as one of the canonical expressions of Soviet Marxism in its institutional version, in the hands of the radical science movements, these texts became the instrument to deconstruct the "old left" and also question some aspects of the same Soviet approach from which they came, thus affording thema new life.

Perhaps this passage is still evident if we look at the peculiar reception of this volume in the Italian cultural context. Among the European communist parties, the Italian one was one of the most developed and rooted in the territory at the level of cultural policies. For this reason, in this country, many Soviet works were translated and imported into the debate practically at the same time as they were published. However, this wasn't the case with *Science at the Crossroads*. Although the text had been commented upon and quoted by

85 Ibid., 84.

86 Cfr. P. Bourdieu, «Les conditions sociales de la circulation internationales des idées», *Actes de la recherche en sciences sociales*. N. 145, 2002.

Italian scholars (first of all Gramsci who criticized the approach developed by Bukharin[87]), the text was translated until 1977.

The meta-scientific debates of the 1970s in Italy were characterized by what I have called the "Italian Science Wars", or the wide series of *querelles* characterized by heated debate over the political neutrality/non-neutrality of science and technology[88]. This controversy — both academic and public — was characterized by the epistemological and political clash between the positions of Ludovico Geymonat (and his Milanese school), the positions of the philosopher and historian of science Paolo Rossi (and his school) against a large and varied group of scientists and militants of the extreme left inspired by 1968. Paradoxically, unlike the Anglophone "science wars", in the Italian context, it was the professional scientists (Radical Science Movements) who criticized the neutrality of science, while humanists (Geymonat and Rossi) defended its objectivity and a-political character[89]. The use of the theses of the Soviet delegates to the '31 congress found themselves, at one point, at the center of this debate.

The most attentive readers and major importers of the Soviet epistemological debate in Italy during those years were Geymoant and his student Silvano Tagliagambe (with particular emphasis on the history and philosophy of physics). The program developed by Geymonant's so-called "Milanese school" was largely centered on the attempt to find an intersection between dialectical materialism and the neo-positivism developed by the Vienna Circle. One might expect, then, that the reception (as well as the translation) of *Science at the*

87 Pietro Daniel Omodeo, «Egemonia e scienza. Temi gramsciani in epistemologia e storia della scienza», *Gramsciana* 2016, no. 2 (2016): 59–86.

88 Giuliano Pancaldi, «Purification Rituals: Reflections on the History of Science in Italy», in *Impure Cultures. Interfacing Science, Technology and Humanities* (Bologna: CIS, 2010); Ienna, «Fisici italiani negli anni '70. Fra scienza e ideologia».

89 Ienna, «Fisici italiani negli anni '70. Fra scienza e ideologia», *Physis*, LV, 1-2 (2020)415–42.

Crossroads might have been an initiative coming from this intellectual group. Consider in fact that Hessen had been one of the supporters and promoters of the reception of the innovations of the theory of relativity and quantum mechanics in the USSR despite the fact that these were judged to contradict *Diamat*. As is well known, Hessen's intervention in London had an ironic and provocative character and aimed to show that even the Newtonian physical theory (accepted in the USSR) had bourgeois roots. The criticism of the ideological drifts of the Soviet *Diamat* and the defense of the autonomy and neutrality of science (especially in relation to the debates in contemporary physics) was exactly one of the cardinal points on which the rehabilitation of dialectical materialism was based for the Milanese school.

However, it was rather the radical movements for science that cited this volume extensively and enthusiastically. Thanks to the publication of the new English edition in 1971, a group of militant physicists and Italian radicals had come into contact with this text finding its theses particularly stimulating. In *L'ape e l'architetto* (*The Bee and the Architect*) , a volume widely considered the manifesto of the Italian radical science movements, it is in fact possible to see this enthusiasm:

> Of great importance for us was therefore the recent discovery, through the re-edition in England of the interventions of the Soviet delegation at the Conference on the History of Science and Technology held in London in 1931, of a current of dialectical materialism apparently very much alive until the beginning of the Stalinist era, which explicitly and articulately supported points of view very close to those expressed in the works collected here. The volume mentioned is *Science at the Crossroads*, which appeared in 1971 and reached us less than a year ago.

In the wake of this enthusiasm, *Science at the Crossroads* progressively became one among the points of reference for Italian Radical Science Movements. It was in fact on the initiative of a group linked to the *L'ape e l'architetto* that the publisher De Donato of Bari published the first Italian translation of the text. The text [with the Italian title *Scienza al bivio*] appeared as the first volume in a book series titled "Storia e critica delle scienze" ("History and critique of science") conceived and directed by Giorgio Israel.[90] In the Italian editorial note it is possible to read a clear statement of how the interventions of "Science at the Crossroads" could be a cardinal theoretical resource in the debates on the "non-neutrality" of scientific knowledge:

> **It is almost superfluous to underline the topicality of the themes that emerge from this book in a period such as this, in which the question of the "non-neutrality" of science, the relationship between science and society, the problem of whether scientific theories contain a planning aspect and whether this can be reduced to the subjectivity of scientists or to a class finalism, and finally what answers can be found on these themes in Marxian and Marxist thought are at the center of the debate. Around all this, the interventions contained in this book provide a precise answer that, whatever the judgment that can be given, addresses the issue of the specific contents of the sciences of the 1930s and engages in the lively scientific debate of that crucial period, referring to the concrete experience of the attempt to build socialism in the USSR.**
>
> **For all these reasons, it seems to us that this book can be an important instrument to critically reflect on the themes that**

90 Luca Di Bari, *I Meridiani. La casa editrice De Donato fra storia e memoria* (Bari: Dedalo, 2012), 217.

> **are today at the center of a debate that has relevant theoretical and practical implications.**[91]

Immediately after its publication, the text was panned with a review by Tagliagambe in the newspaper organ of the Italian Communist Party "l'Unità". While acknowledging the interest in the publication of *Science at the Crossroads*, Tagliagambe emphasized that the papers presented by the Soviets in London were "instruments that are by now dated or, in any case, marked by a distance that is anything but irrelevant with respect to the most advanced acquisitions of the current debate".[92] The review focuses on showing how dangerous it is to affirm the topicality of a text without having adequately reconstructed its socio-historical roots. This type of cultural operation "cannot but be considered a further and diseducative example of that halved and schizoid externism that, unfortunately, is experiencing in the cultural atmosphere of today's Italy its greatest splendor".[93] In fact, according to the author, there has been a "disconcerting nonchalance with which interventions tending to assert the need, for a historian of science, to take into account the political, economic and social conditions in which a specific scientific contribution has matured" have been presented "in a totally uncritical and ahistorical way".[94] On the contrary, Tagliagambe focuses his attention on the socio-historical context from which Hessen's intervention emerges as "anything but weak and inessential". In fact, the author highlights how Hessen was part of the group of dialectical materialists led by Deborin, whose objective was to "create a common front of philosophers and scientists

91 Nikolaj Ivanovič Bucharin, ed., *Scienza al bivio: interventi dei delegati sovietici al Congresso internazionale di storia della scienza e della tecnologia, Londra 1931* (Londra: Frank Cass and Company Limited, 1971; Bari: De Donato, 1977), 6.

92 Silvano Tagliagambe, «Scienziati e ideologi», *L'Unità*, 22 September 1977, 3.

93 Ibid.

94 Ibid.

committed, while respecting the autonomy of their fields of research, to the elaboration and diffusion of a new type of culture, capable of penetrating the masses and inspired by an open reflection, and above all free of preconceptions and dogmatic closures, on the relations between Marxism and science". [95] In this sense, being faithful to the theoretical orientation of the "Milanese school", Tagliagambe directs his reading towards an actualization of Hessen's theses as precursors of the epistemological positions in defense of the "neutrality of science".

In response to this, Diego De Donato, the director of the publishing house, sent a letter to the director of L'Unità Alfredo Reichlin in order to denounce "the more or less transparent reasons for such nonchalance in the service of such prejudicial animosity"[96]. In the actually published version of the letter, De Donato deconstructs Tagliagambe's assertions showing how the volume reported a historical framework in the translations of the preface and introduction by Needham and Werskey. It is also possible to read in the letter:

> **The intentions behind the not easy undertaking of a series dedicated to the problems of contemporary science, of which *Scienza al Bivio* is only the first volume, are not to provide an additional tool to the spirit of controversy that seems to animate Prof. Tagliagambe, but to offer the possibility of a new way of thinking about the problems of contemporary science. Tagliagambe, but to offer safe points of reference (certainly, also "philologically") and a space that does not pretend to be neutral but neither predetermined in a summarily ideological way to a debate that registers so far, even in the ranks of the left, deep and openly irremediable divisions.** [97]

95 Ibid.

96 This archival document is quoted in: Di Bari, *I Meridiani. La casa editrice De Donato fra storia e memoria*, 218.

97 Diego De Donato and Silvano Tagliagambe, «Scienza e società nell'URSS degli anni '30», *L'Unità*, 24 ottobre 1977, 3.

This letter was published with an additional response from Tagliagambe. Tagliagambe reiterated in his text how this publication had been "a missed opportunity" for a serious study of the relationship between science and society in the USSR: "On the contrary, it was decided not to insist on this theme, nor can it be said that the brief — and for other things taken for granted and not supported by a serious and thorough documentation — considerations of Werskey, constitute a satisfactory answer to the above-mentioned need".[98] These attacks were not without further defence by the Radical Science Movements. Marcello Cini wrote a review in *Il Manifesto*, Giorgio *Israel in Rinascita* and two critical notes appeared in the historic popular science magazine *Sapere* (which was also militantly oriented at the time).

The Institutional 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

98 Ibid.

mentioned the Hessen theses in a presentation at a conference[99] 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.[100] 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.[101]

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 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).[102] The first aim of this new program was to establish a fruitful dialogue between history, philosophy, and the sociology of science.

99 Kuhn participated at the congress in honor of George Sarton with an intervention titled "Mathematical versus Experimental Traditions in the Development of Physical Science." cfr. T. Kuhn, *The Essential Tension* (Chicago: The University of Chicago Press, 1977).

100 Ibid., vi, 32

101 On this point see also Pietro D. Omdeo, "Boris Hessen's Philosophy of the Scientific Revolution", in this volume.

102 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, science is treated by Mertonians as a "black-box."

The U.K. academic context in which SSK emerged was characterized on one hand by a broad dissemination of Bernalism,[103] 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 figure in building a bridge between the Marxist tradition and STS scholars, as he dedicated a great number of articles to the intersection between the two domains as well as his *The Visible College* (1979), which was mentioned above. Among other contributions, he published a paper in 1971 titled "British Scientists and 'Outsider' Politics, 1931-1945" in the first issue of the field's "flag journal," *Science Studies*[104] (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.'"[105] 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."[106]

For his part, Barnes had contended that Marxism in science "found its most single-minded application" in the Hessen theses.[107]

103 For example, the *Rede lecture* of 1959 titled *The Two Cultures* by Charles Percy Snow gave a broad public, political and academic resonance to Bernalism. This lecture has also had the effect of stimulating the birth of many interdisciplinary programs or research 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.

104 It is remarkable that the first issue of the most prominent journal in the field provided 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.

105 G. Werskey, "British Scientists and "Outsider" Politics, 1931-1945", *Science Studies*, 1/1 (1971): 83.

106 Werskey, "British Scientists and "Outsider" Politics, 1931-1945", 83.

107 B. Barnes, ed., *Sociology of Science* (Harmondsworth: Penguin; 1972), 18.

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)[108]

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."[109] 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.[110]

108 Ibid.
109 B. Barnes, *Scientific Knowledge and Sociological Theory* (London: Routledge 1974), 106.
110 M. Mulkay, *Science and the Sociology of Knowledge* (London-Boston: Allen & Unwin, 1979), 7-8.

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.**[111]

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.[112] 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,[113] 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**

111 Ibid.
112 S. Shapin, "A Course in the Social History of Science," *Social Studies of Science* 10/2 (1980): 231-258.
113 S. Shapin, "Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism-Internalism Debate", *History of Science* 30 (1992): 333-369.

> 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.[114]

On the same line, also in his bibliographical essay for *Scientific Reason*, he mentions Hessen's and Zilsel's works among the classics of the history of science.[115]

In 1984, another protagonist of STS, Simon Schaffer, published an article entirely dedicated to Hessen titled "Newton at the Crossroads" in the journal *Radical Philosophy*.[116] 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

114 Ibid., 362.
115 S. Shapin, *The Scientific Revolution* (Chicago: The University of Chicago Press, 1996).
116 S. Shaffer, "Newton at the Crossroads", *Radical Philosophy* 37 (1984): 23-28.

> **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.**[117]

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.[118]

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."[119]

An Hessenian Renaissance?

The first edition of the text *The Social and Economic Roots of Newton's Principia* is the English the one of 1931 in the collective volume entitled *Science at Crossroads,*[120] whose editorial operation had

117 S. Shaffer and S. Shapin, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life, 2nd Ed.* (Princeton-Oxford: Princeton University Press, 2001): XXIV.

118 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.

119 T. Pinch and W. E. Bijker, "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 and T. J. Pinch (Cambridge-Mass: MIT press, 1987), 19.

120 B. Hessen, *The Social and Economic Roots of Newton's 'Principia'*, in *Science at the*

already been proposed by Hogben in the first days of the conference and published, with translations made in a very short time, at the Russian embassy in London a few days later. The same volume was then reissued in 1971 with contributions from Werskey and Needham[121]. In Russia, the first edition in of Hessen's paper to appear independently comes from 1933[122] of which an extract also appeared in the form of article in the magazine *Priroda*[123] (a second full version already appeared in print in 1934).[124] In 1946, an Australian publisher inSydney reprinted, this time independently, the text of Hessen in English.[125] In 1968, only an extract of the original text appeared in the United States in a collection edited by Basalla titled *The se of Modern Science: Internal or External Factor?* [126] Simultaneously with the second edition of all the Soviet contributions of 1971, Robert S. Cohen published a complete and independent version of the text of Hessen for a New York publisher.[127] In 1972, it was followed by the Swedish edition, [128] in 1974 by the German one edited by the sociologist Peter Weingart,[129] and in

Cross-Roads. Papers presented to the International Congress of the International congress of the History of Science and Technology, held in London from June 29th to July 3rd, by the delegates of the USSR (Kniga, London, 1931), 149-212

121 Ibid.

122 B. Gessen, «Sotsial'no-ekonomicheskie korni mekhaniki N'iutona», *Doklad na II meehdunarodnom kongresse po istorii nauki i tekhniki* (Moskva-Leningrad, 1933).

123 B. Gessen, «Klassovaia borba epochi angliskoi revoliutsii i mirovosreniie N'iutona», in *Priroda,* 1933, N. 3-4: 16-30.

124 B. Gessen, «Sotsial'no-ekonomicheskie korni mekhaniki N'iutona», *Doklad na II meehdunarodnom kongresse po istorii nauki i tekhniki* (Moskva-Leningrad, 1934).

125 B. Hessen, *The Social and Eonomic Roots of Newton's Principia* (Current Book Distributors: Sydney, 1946).

126 Basalla, ed. *The Rise of Modern Science: Internal or External Factors?* (D.C. Heath: Lexington, 1968) 31-38.

127 B. Hessen, *The Social and Economic Roots of Newton's Principia,* ed. R.S. Cohen (New-York: Howard Fertig, 1971).

128 B. Hessen, «De sociala och ekonomiska forutsättningarna för Newton Principia», in *Ide och klass*, ed. R. Ambjörnsson (Stockholm: PAN/Nordstedts, 1972), 90-145.

129 B. Hessen, «Die sozialen und ökonomiscbe Wurzeln von Newton's Principia» in *Wissenschaftssoziologie II*, *Determinanten Wissenscgaftkicher Entwicklung*, ed. P. Weingart (Frankfurt am Main: Athenäum Verlag, 1974), 261-325.

1977 by the Italian one that I already mentioned.[130] All three, however, were contained in larger collections which were not exclusively dedicated to Hessen. In 1985, Pablo Pruna realized the first Spanish edition published in Cuba in La Havana (the first from the Russian text of '33)[131] and in 1986, the first Japanese edition was published by Hōseidaigaku shuppan-kyoku and Hosei University Press.[132]

However, starting from the 90s, within the main theoretical formulations in the field of meta-scientific studies, references to Marxist terminology, especially the Hessenian one, decreased drastically. The fall of the Berlin Wall, the so-called "end of ideologies" and their consequences in the field of cultural production were certainly a determining cause of this loss of interest.

It is only since the 2000s that there has been a *nouvelle vague* of interest in the methodological perspective elaborated by Hessen. Compared to the previous ones, however, this new season of studies has had some notable points of originality. As I mentioned, until the end of the '80s, the reception of Hessen was limited to the reading of his famous *The Social and Economic Roots of Newton's Principia*. It is at this stage, in fact, at the end of a *longue durée* work of canonization of Hessen that the first critical editions of his work emerged, as well as the rediscovery and republication of other texts of this author that allow today a historiographically more solid interpretation of the same 1931 London intervention.

This new phase opened with the appearance of a 1999 publication in Spanish by Pablo Huerga-Melcon (the first accompanied by

130 B. Hessen, «Le radici sociali ed economiche dei *Principia* di Newton», in *Scienza al bivio*, ed. N. Bukharin (Bari: De Donato, 1977), 183-244.

131 B. Hessen, *Las Raices socioeconomicas de la mecanica de Newton*, ed. and trans., Pedro Pruna (La Habana: Academia, 1985).

132 B. Hessen, ニュートン力学の形成—『プリンキピア』の社会的経済的根源 (叢書・ウニベルシタス) 単行本, 東京 [Tokyo]: 法政大学出版局 (Hōseidaigaku shuppan-kyoku; Hosei University Press, 1986).

a careful critical reconstruction) that has the merit of looking at the figure of Hessen in a more complete and organic way. The full-bodied volume titled *La ciencia en la encrucijada*, in addition to including the text of 1931, also contains various other contributions by Hessen, presented for the first time in translation.[133] 2006 saw the first critical French edition edited by Serge Guérout and Christopher Chilvers[134] (the text of the translation had already been available in an unpublished version since 1979 to the users of the fund "science et societé" of the inter-university library of Jussieu)[135].

This renaissance of interest also extends toward a more detailed historiographical reconstruction of Hessen's impact onmeta-science studies. An exemplary case from this point of view was the workshop titled "Science at the Crossroads: Geopolitics, Marxism, and Seventy-Five Years of Science Studies" (2006) organized at Princeton University and aimed at trying to retrace the history of Science Studies following the evolution and involution of Marxist theory. As can already be seen from the title, the references to the Hessenian text and to the famous London convention of 1931 were once again recognized and identified as the pivotal point from which to unravel a whole series of receptions of this type. Werskey, among those invited to the meeting, retraced a long historiographic path of the relations between Marxism and science studies, proposing a Visible College Revisited.[136]

133 B. Hessen, «*Las raices socioeconimicas de la mecanica de Newton*», in *La ciencia en la encrucijada*, ed. P. Huerga-Melcon (Oviedo: Pentalfa, 1999).

134 B. Hessen, *Les racines sociales et économiques des* Principia *des Newton*, ed. S. Guérout and rev. C. Chilvers (Paris: Vuibert, 2006).

135 Before being published, we have at least two instances where translations were circulated informally in library funds: B. Hessen, *Les fondements sociaux et économiques des* Principia *de Newton*, trans. Serge Guérout (Paris: Bibliothèque interuniversitaire scientifique de Jussieu, 1978 [Unpublished translation but made available to library users]) but also, B. Hessen, «Raices sociales y economicas de los *Principia* de Newton», in *Newton, el hombre y su ombra*, trans. H. Valanzano (E.U.B.C.A., 1988 [Version printed at the University of Montevideo]), 1-60.

136 Cfr. G. Werskey, *The Visible College Revisited: Second Opinions on the Red Scientists of the 1930s*, in *Minerva*, V. 45, N. 3, 2007, pp. 305-319; e Cfr. *The Marxist Critique of Capitalist Science: A History in Three Movements?*, in *Science as Culture*, V. 16, N. 4, 2007, pp. 397-461.

In 2009, we saw the appearance of the first edition of Hessen's speech of 1931 in modern Greek.[137] An important turning point in the re-circulation of Hessen's thought is to be found in the re-edition in English of Hessen's famous speech. In 2009, Gideon Freudenthal and Peter McLaughlin published in the Boston Studies in Philosophy of Science series of Springer publishers— therefore bringing the work into global circulation—an edition titled *The Social and Economic Roots of the Scientific Revolution* that collects and combines Hessen's text with a series of essays by Grossmann dedicated to modern science.[138]

Both editors of this volume are well immersed in German-speaking debates and are close to the research in German historical epistemology which developed around figures such as Peter Damerow, Wolfgang Lefèvre[139] and Jürgen Renn, and which then consolidated in the programs developed at Department I of the Max Planck Institute for the History of Science in Berlin on the material conditions of scientific production. The juxtaposition of the theses of Hessen and Grossmann, besides being justified by their consonance and integrability, is also motivated by further socio-historical reasons. In the German context, Grossmann's contributions to Marxist economics have been an important intellectual reference in the circles of the German post-Sixties New Left since the 1970s.[140] As already pointed out, Hessen had already been introduced into the German context by Weingart

137 B. Hessen, Οι κοινωνικες και οικονομικες ριζες των Αρχων Φυσικης Φιλοσφιας του Νευτωνα, ed. Dimitris Dialetis (Athens: Nefeli, 2009).

138 B. Hessen, *The Social and Eonomic Roots of Newton's Principia*, in *The Social and Economic Roots of the Scientific Revolution. Texts by Boris Hessen and Henryk Grossmann*, ed. G. Freudenthal and P. McLaughlin (Dordrecht/Boston: 2009).

139 The most notable attempt to rehabilitate the Marxist tradition in history and philosophy of science in the 1920s and 1930s is contained in Lefèvre's 1978 volumentitled *Natural Theory and Mode of Production (Naturtheorie und Produktionsweise)*.

140 Boris Hessen and Henryk Grossmann, *The Social and Economic Roots of the Scientific Revolution*, ed. Gideon Freudenthal e Peter McLaughlin (Boston/Dordrecht: Springer Netherlands, 2009), 252.

in 1974 through the publication of the text of '31 in an anthology of texts on the sociology of science which probably had a smaller circulation than the works of Grossmann already available in the original German. The volume edited by Freudenthal and McLaughlin is therefore intended to give Grossmann greater legitimacy on the international level and, at the same time, to reintroduce Hessen's work in the German context.

It was probably also due to the new interest aroused by the resumption of the international debate on these topics that in 2013 Rose-Luise Winkler, one of the leading experts of Hessen's thought[141], published a new German language version of the 1931 London intervention.[142] Rose-Luise Winkler is also to be credited with the rediscovery of the anthology of texts from the history of modern science (which we publish here in English) that Hessen had compiled before his untimely death. This anthology collects all the sources that the author had used to develop the arguments presented in "The Social and Economic Roots of Newton's *Principia*".[143]

Such an international revival is probably also the basis of the revival of interest in this author in Russia. In 2015, the volume *Борис Михайлович Гессен (1893-1936)* was published, which aims to propose a general reconstruction of the figure of Hessen by providing a detailed reconstruction of his bibliography and a complete list of his

141 See Rose-Luise Winkler, 1987/88) "B.M. Hessen," in *Porträts russischer und sowjetischer Soziologen. Sonderheft Soziologie und Sozialpolitik. Beiträge aus der Forschung* (Berlin and Moskau: Akademie der Wissenschaften, 1987/88), 208–21 and Rose-Luise Winkler, *An den Urspüngen wissenschaftssoziologischen Denkens. Erstes Drittel des XX. Jahrhunderts (Russland/Sowjetunion)* (Berlin: trafo Wissenschaftsverlag, 2013).

142 B. Hessen, „Die sozialökonomischen Ursprünge der Mechanik Newtons." In *An den Ursprüngen wissenschaftssoziologischen Denkens: Erstes Drittel des XX. Jahrhunderts: Russland/Sowjetunion*, ed. R.L. Winkler (Berlin: Trafo Wissenschaftsverlag, 2013), 243-344.

143 Rose-Luise Winkler, "Ein unveröffentlichtes Manuskript von Boris M. Hessen: 'Materialien und Dokumente zur Geschichte der Physik.'" *Sitzungsberichte der Leibniz- Sozietät* 92 (2007): 133–152.

works both published and unpublished.[144] Between 2018 and 2019 the Russian open access journal *Epistemology & Philosophy of Science* republished in the original language (with the addition of abstracts in English) three texts by Hessen allowing a greater global dissemination (many of the texts by this author are in fact not easily available).[145] At the same time, also in the Russian language, several articles and essays dedicated to Hessen have been published.[146]

After the aforementioned 1986 Japanese edition, Hessen's text continues to circulate in Asia thanks in part to the 2016 Korean translation of the 1931 intervention.[147]

In 2017, in collaboration with Giulia Rispoli and Pietro Daniel Omodeo, I edited the first critical and autonomous edition in Italian starting with a comparison between the English text of 1931 and the Russian text of 1933 (comparing it with the French, Spanish and Italian translations). In this context, we have deepened the biography of Hessen, his writings and the socio-political context in which it was situated, clarifying the misunderstandings related to the first English translation that have been perpetuated for many years. This collaboration opened up a still ongoing research project aimed at legitimizing Hessen as a cardinal author for historical epistemology and political epistemology (of which this volume is further evidence). We have published several papers on this line of research and others are still in the process of being published.

144 С.Н. Корсаков, А.В. Козенко, and Г.Г. Грачева, Г.Г., *Борис Михайлович Гессен (1893 — 1936)* (Москва [Moscow], Наука [Nauka], 2015).

145 Boris Hessen, «Выступление на заседании Президиума Коммунистической Академии. 1 августа 1931 г.», *Эпистемология и философия науки* 55, n. 3 (2018): 205–10; Boris Hessen, «Материалистическая Диалектика и Современная Физика. Тезисы Доклада на i Всесоюзном Съезде Физиков в Одессе 19 августа 1930 Г», *Эпистемология и философия науки* 56, n. 1 (2019): 209–15; Boris Hessen, «Выступление на Научной Сессии Института Философии, Посвящённой 25-Летию Выхода в Свет Труда в.и. Ленина "Материализм и Эмпириокритицизм". 22 июня 1934 Г», *Эпистемология и философия науки* 56, n. 1 (2019): 216–24.

146 Cfr. S. Winkler, *Selected Bibliography*, *Societate si politica*, XIII, no. 1 (2019): 103-109.

147 B. Hessen, 뉴턴 역학의 사회경제적 근원, 서울 [Seoul]: 북스힐 (Bugseuhil: Books Hill, 2016).

In 2019, Sean Winkler edited a special issue of the journal *Societate şi Politică* [*Society and Politics*] entirely dedicated to Hessen's thought. In addition to a number of interesting essays, this special issue published a translation of a text by Hessen in English titled "Preface to Articles by A. Einstein and J.J. Thomson" (translated and edited by S. Winkler). The latter helps to shed light on the approach of this author both in the field of the history of physics and in that of theoretical physics. In the same trajectory, in 2020 another paper by Hessen entitled Materialist Dialectics and Modern Physics: Abstracts of the Report at the First All-Union Congress of Physicists in Odessa on 19 August 1930 was translated into English for the journal Historical Materialism and accompanied by an essay by Winkler.

In 2021 Chris Talbot and Olga Pattison 2021 have translated and edited the first English edited volume of Hessen's contribution published before his famous '31 intervention: *Boris Hessen: Physics and Philosophy in the Soviet Union, 1927-1931. Neglected Debates on Emergence and Reduction*. This operation, together with the unpublished anthology that we are now publishing in English, lays the groundwork for a more complete and organic interpretation of the figure of Hessen. Both these volumes, if read at the same time, allow one to see how much Hessen's historiographical theses were embedded in deep reflections on the foundations of contemporary physics (especially quantum mechanics and relativity) and vice versa. The possibility of consulting these documents, so far unpublished, allows us to have a complete view of the integrated historical-epistemological approach proposed by Hessen.

Conclusion

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."[148] 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,[149] Hessen's work passed through various labelling 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[150]). 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,[151] and stimulated the renaissance of *naukovedenie*. There was,

148 Koyré, "Introduction," in *Des révolutions des orbes célestes (Du livre I, chapitres 1-11)*, by N. Copernicus (Paris: Librairie Félix Alcan, 1934 [1543]), 4.

149 Bourdieu, «Les conditions sociales de la circulation internationales des idées».

150 In other national cases, such as French or USSR debates, the institutionalization of disciplinary studies of science followed different trajectories.

151 E. M. Mirsky, "Science Studies in the USSR (History, Problems, Prospects)," *Science Studies* 2/3 (1972): 281-294; Y. M. Rabkin, "*Naukovedenie*: The Study of Scientific Research in the Soviet Union", *Minerva* 14/1 (1976): 61-78.

therefore, a sort of bidirectional circulation of research paradigms between the two sides of the iron curtain. During the post-'68 period, Radial Science Movements emphasized the importance of Hessen's work for the analysis of the entanglement between science, technology and socio-political contexts. In this phase, new forms of actualization of Hessen's theses emerged, aimed at showing the non-neutrality of scientific knowledge. 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.

As we have seen, there has been no single way of reading Hessen. Being identified as a stimulus for the construction of new paradigms of research and analysis, his theses have been constantly subjected to a labelling process that has led the Soviet author to be identified as a precursor and prophet of a vast number of intellectual positions, some of them contradictory.

What should be noted, however, is that even though Hessen has been repeatedly accused by mainstream scientific historiography as too 'crude' of an author, his legacy has not ceased to stimulate new forms of reflection for more than ninety years. This indicates that it is not as easy to curb his significance as the so-called internalist current would like. 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.

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The long lost textbook by Soviet scholar Boris Hessen (1893-1936) provides a backdrop for his attempt to develop a historical materialist account of physics as a model for the history of early modern science. It shows that this attempt, signaling the rise of the social history of science, took the complexities of scientific development seriously, in order to provide a deeper understanding of science as such, not only for Marxists. Hessen claims that historical knowledge and its sources provide a rich reservoir, without which science education remains incomplete:

> No matter how new and unusual the theories of contemporary physics may be, no matter how radically they differ from the outlook of classical physics, the contemporary stage of development in physics is still a historical phase of its overall development. Therefore, knowledge of the history, of the origin, and development of physical theories not only aids in understanding its contemporary condition, but also helps to establish its historical roots and, by doing so, clears the way for new research.

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