

One of the most famous papers ever presented at a history of science meeting was 'The Socio-Economic Roots of Newton's Principia', given by the Soviet physicist Boris Hessen at the Second International Congress of the History of Science, held in London in 1931. Although many scholars at the congress were impressed by Hessen's thesis that intellectual achievements such as Newton's are best explained by examining the social context out of which they arose, oddly enough no one thought to apply this sort of analysis to Hessen's achievement. An examination of Soviet Russia in 1931, a time of great political and economic stress, shows that both Soviet physics and Hessen personally were under very unusual pressures. Hessen's main concern in previous months had been to protect Einstein's relativity theory from attacks by vulgar Marxist ideologists. Hessen's paper on Newton was carefully crafted to support this defensive effort and simultaneously was aimed at strengthening Hessen's own political situation.

The Socio-political Roots of Boris Hessen: Soviet Marxism and the History of Science

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It hardly needs to be established that the paper on Isaac Newton given by the Soviet scholar Boris Hessen in London in 1931 at the Second International Congress of the History of Science was one of the most influential reports ever presented at a meeting of historians of science. J.D. Bernal, J.G. Crowther, Hyman Levy, Joseph Needham, Robert K. Merton, Stephen Toulmin, J.R. Ravetz and many other writers and scholars have attested to the significance of Hessen's work in the development of externalist and Marxist interpretations of science.¹ Those authors who have sharply criticized Hessen's approach, such as G.N. Clark, A.R. Hall and R.S. Westfall, have solidified his importance by considering it necessary to refute him.²

The permanent place of Hessen's paper in the history of the discipline of the history of science is further illustrated by the fact

that even today standard journals and references continue to cite it. Arnold Thackray, in the first chapter of Paul Durbin's 1980 *A Guide to the Culture of Science, Technology, and Medicine*, called Hessen's report a 'paradigm-setting analysis' and cited its widespread influence in England and North America.³ In 1981, on the fiftieth anniversary of the London Congress, the memory of the event was still so strong among historians of science that *Isis*, the journal of the History of Science Society, pictured the medallion of the 1931 meeting on the front cover of an issue that featured a special discussion of Marxism and science.⁴ The place of Hessen's paper in the accepted references of the discipline is further shown by the fact that the article on 'externalism' in the *Dictionary of the History of Science*, published in 1981, cites Hessen's paper as its first reference, illustrating that one of the major interpretative concepts of the history of science, externalism, is historically connected with Hessen.⁵

Hessen may not have created externalism, but he will be forever considered one of its founders. His effort to explain Newtonian physics in terms of the social, political and economic context of seventeenth-century England, notwithstanding the fact that it appears inadequate to contemporary Newton scholars, was a truly pioneering work.

In this paper I do not intend once again to support or criticize Hessen's interpretation of Newton. Instead, I wish to point to an almost totally neglected dimension of the 'Hessen Episode'—namely, the social, political and economic context in the Soviet Union out of which Boris Hessen's paper arose. In other words, I wish to make an attempt at doing for Boris Hessen what Boris Hessen tried to do for Isaac Newton—that is, to show how his most important work was rooted in politics and economics. My conclusion is that Hessen's paper is better understood as a result of his peculiar and threatened situation in the Soviet Union than as a model of Marxist analysis of science, either vulgar or sophisticated.

It is extremely ironic that radical historians of science who castigated old-fashioned historians of science for looking upon Newton's physics as if it had 'dropped from the sky' (borrowing a phrase from Engels) accepted Hessen's paper exactly as if it had dropped from the Moscow sky. With the fortunate exceptions of David Joravsky and Gary Werskey, Western historians of science have not asked of Hessen the questions they were beginning to ask of Newton—namely, 'How did his work reflect the constraints and

impulses of its specific social environment?"⁶ And while Joravsky and Werskey did notice the need to examine this question, they did not pursue the issue at length. I will try to do so. At the end of my analysis I believe that Hessen will appear as a very different person from the one he is usually taken to be, and some Marxist scholars will undoubtedly be uncomfortable with the portrayal. Nevertheless, I consider my approach to Hessen to be an illustration of the importance of his methodology, not a diminishing of it.

Some scholars will maintain that it makes little difference if it can be demonstrated that Hessen's paper was heavily influenced by the extreme Soviet political conditions of the early 1930s; after all, the paper had a life of its own in the West outside these conditions. One cannot take this position, however, unless one wishes to deny the importance of externalism in general; if one believes that knowledge is in some sense a social construction, then the conditions of the construction of that knowledge are a primary concern. Hence, one cannot consistently maintain that Hessen's effort to explain Newton in terms of social forces had merit and yet simultaneously deny the value of such an approach to Hessen.

Hessen's Background

If one starts examining Hessen's background in the Soviet Union, a number of surprises quickly emerge. The first striking fact is that Hessen's performance in London in 1931 was decidedly atypical of what he had been doing in the Soviet Union. There he did not produce articles about the social context of science, but instead was engaged in a spirited defence of relativity theory and quantum mechanics against vulgar Marxist critiques of these revolutionary developments in physics.⁷ In these articles he maintained that a separation could be made between the intellectual content of a theory and the social context in which it was produced, a view that sounds very similar to the one which the more outspoken external historians of science in the West, citing his work, would eventually question. And another striking feature of Hessen's life in the Soviet Union at this time is that he was having political difficulties: he was a sophisticated Marxist intellectual of the type that had flourished in the immediate post-revolutionary period, but now he was being threatened by a new generation of dogmatists arising

under the tutelage and protection of Stalin. Hessen was fighting a rearguard action against this threat, but eventually he would lose. A few years after returning from the London congress he was arrested, and he died in prison in 1938.⁸ In fact, all but two of the members of the eight-man Soviet delegation to London similarly perished, including Nikolai Bukharin and the famous geneticist Nikolai Vavilov, foe of Stalin's pseudo-geneticist Trofim Lysenko.

Let us look a bit more closely at the life history of Boris Mikhailovich Hessen, and the political circumstances of that life.⁹ Born in 1893 in the town of Elisavetgrad (now Kirovograd) into a middle-class Jewish family, his father was a bank employee. While he was in the local secondary school he became involved in radical politics. Gifted in mathematics, he studied physics at the University of Edinburgh in 1913–14, and at Petrograd University during World War I. After the Revolution he became a soldier in the Red Army and fought the white guards around his home town in the Ukraine. He also served as instructor for Red Army troops in Moscow. When the civil war ended he became a student of natural science at the Institute of Red Professors in Moscow, one of the very few institutions in all of Soviet Russia at that time where the faculty was sympathetic to the new regime. His professional ability in physics was officially recognized in 1931, the year of his trip to London, by his appointment as Professor of Physics at Moscow University. Shortly thereafter he became a corresponding member of the prestigious Academy of Sciences of the USSR. In the last few years of his life he was an assistant director of the physical institute of the Academy, whose director was Sergei Vavilov, future president of the Academy and brother of the geneticist Nikolai who had gone to London with Hessen.

The Great Break

In the years in which Hessen was rising to professional prominence in the Soviet Union, the early 1920s, the political and economic controls in that country were rather lax, at least in comparison with what began to occur shortly before the London conference.¹⁰ The Communist Party would not, it is true, tolerate competing organized political groups; the Soviet Union was even then an authoritarian state, and the state security organs dealt summarily with persons suspected of active political opposition to Soviet power. But for the average Soviet citizen who accepted or was

resigned to Bolshevik rule, the state was not seen as a threat. The economy was a mixed one, with small private enterprises permitted to co-exist with the large nationalized industries. The workers had lost the possibility of actually controlling the factories, as some in the early 1920s had wished to do, but the regime was partial to the workers as a class, and the industrialization programme had not yet attained the strained tempo of the later five-year plans. The peasants were more prosperous than either before the Revolution of 1917 or after the collectivization programme beginning in 1929. They had occupied most of the arable land which had belonged before the Revolution to the church, nobility or crown, and the loose regulations on trade permitted them to profit from the sales of their produce. The academic intelligentsia, still overwhelmingly pre-Revolutionary in educational background and attitudes, was more uneasy than either the proletariat or the peasantry, but still tried to maintain something of its pre-Revolutionary mode of life.

All of this was changing by 1929, the year that Stalin called the Great Break. The first five-year plan, launched in 1928, was marked by the nationalization of virtually all industry and the beginning of a frenetic pace of industrialization. The wrench of rapid industrialization was felt by every Soviet citizen. In late 1929 the peasants were swept into a collectivization programme that within a few months reorganized the entire countryside into massive state or collective farms. Many of the peasants resisted this programme bitterly, destroying their crops and animals when all other opposition failed. The Soviet authorities replied with repressive measures of staggering violence. Stalin is supposed to have told Winston Churchill at Yalta that the collectivization programme was more difficult for the Soviet Union than the later battle of Stalingrad.

The entire framework of Soviet society was being violently transformed in the late 1920s, and the academic world was no exception. Universities and research institutions were suffering the trauma of those years. The Soviet Academy of Sciences was purged and reorganized. In the autumn of 1929, over one hundred workers in the Academy were imprisoned and another five hundred were fired.¹¹ Re-elections of the members of the faculties of the universities resulted in the forcible installation of communist professors. Members of the intelligentsia were exhorted to work for the success of the industrialization and collectivization programmes. Marxist ideologists began scrutinizing scientific theories

for signs of bourgeois ideology.

The Soviet Union was entering the most strenuous period of its cultural revolution, a period described by Sheila Fitzpatrick as 'an iconoclastic youth movement directed against "bureaucratic" authority...', and 'an attack on accepted ideas'.¹² Meanwhile, Soviet security organs were becoming much more active in searching for conspiracies among Soviet citizens. In the aftermath of a series of court trials beginning in 1928, thousands of pre-revolutionary 'bourgeois specialists' were arrested.¹³

Hessen's Response to Attacks on Physics

As the cultural revolution became ever more heated, physicists in the Soviet Union such as Hessen became increasingly worried about the attacks being made upon relativity theory and quantum mechanics. The criticism came from two different sources: old-fashioned physicists who could not adjust to the new theories, and radical Marxist ideologists who believed that these theories were laden with idealistic philosophies derived from the bourgeois environments in which they had developed.¹⁴ Relativity theory was particularly troublesome, for Einstein had recognized the importance in its development of the ideas of the Austrian physicist Ernst Mach, whom Lenin had severely criticized in his book *Materialism and Empiriocriticism*. Mach's philosophy, Lenin wrote, was 'confused idealism' and 'a jumble of idle and shallow words in which he himself does not believe'.¹⁵ The hostility of Soviet critics toward quantum mechanics and relativity physics was heightened when a number of prominent west European philosophers and scientists concluded that the probabilistic approach of quantum mechanics meant the end of determinism as a world-view, while the equivalence of matter and energy postulated by relativity theory marked the end of materialism.¹⁶ Several Western writers concluded that relativity physics and quantum mechanics were irreconcilable with Marxism.

Sophisticated Marxists like Boris Hessen, knowledgeable both in politics and in physics, saw the intellectual poverty of the attacks on modern physics by their Soviet colleagues. Hessen went to the front line in this battle, simultaneously defending Marxism and modern physics. Writing in 1927 he insisted that just because it was possible on the basis of relativity theory and quantum mechanics to draw conclusions that were unacceptable to Marxists, it was no

reason for 'throwing out the physical contents of the theories'.¹⁷ If Soviet Marxists condemned relativity theory as anti-Marxist then what would they do, asked Hessen, if relativity turns out to be correct as a physical theory? The only way to avoid the conclusion that Marxism was in error, he continued, was to see the difference between the physical core of science and its philosophical interpretation, a theme to which he would return in his famous paper on Newton.¹⁸

Hessen noted in articles written before this trip to London that this problem of linking science too rigidly to ideology did not arise with relativity theory. Newtonian physics, so hotly defended in the name of materialism by such Russian physicists as A.K. Timiriazev, had also been used for philosophical purposes which Marxists could not accept. Newtonian physics easily lent itself to an ideology of a 'divine first impulse' that set the solar system in motion. Newton himself found this view attractive. Yet Hessen obviously thought it ridiculous for atheists and Marxists to reject Newtonian mechanics for this reason.¹⁹

In the process of making these arguments Hessen incurred serious criticism. A.A. Maksimov, a physicist turned philosopher, in 1928 called Hessen a 'Machist' and 'Right deviationist', labels which carried increasingly ominous implications. Meanwhile, Stalin described 'Right deviationists' as people who favoured the interests of the bourgeoisie over the proletariat.²⁰ Despite the fact that Hessen did not agree philosophically with the followers of Bukharin to whom this label was most frequently applied, he was vulnerable to the criticism because of the fact that he came from a middle-class family and was the son of a bank employee, a particularly disliked profession. To the radical young student workers and peasants being pushed to the top of the Soviet educational system Hessen was a typical member of the old-fashioned Russian intelligentsia, perhaps 'progressive' at the time of the Russian Revolution, but distinctly falling behind the times as Stalin called for proletarian militance.

Hessen under Attack

In 1930 and 1931 relativity physics was under heavier criticism than at any time in the five years before or after this date. The early attacks on relativity led by old-fashioned physicists continued, but they were now more than matched by newer threats. Beginning in

1930 a worrisome danger arose with the appearance of the 'Bolshevizers' of philosophy and science, younger militants who wanted to 'reconstruct' physics on the basis of dialectical materialism.²¹

Hessen and his views on physics came under very heavy criticism at a conference on the state of Soviet philosophy that was held 17–20 October 1930. Although present, he was not permitted to speak in his own defence.²² He was denounced as a 'metaphysicist of the worst sort',²³ a 'pure idealist',²⁴ and as a deserter of the cause of materialism who interpreted relativity physics in the same spirit as the notorious Western mystic Arthur Stanley Eddington.²⁵ He was criticized for paying insufficient attention to the ideas of Engels and Lenin.²⁶ Particularly mistaken, said his detractors, was his definition of matter as a 'synthesis of space and time', a wording which came from one of his defences of relativity physics.²⁷ In the final resolution of the conference Hessen was censured by name twice, once for his philosophical views on relativity theory and again for his opinions based on quantum mechanics.²⁸

Attacks in the Soviet Union on relativity attained a new level after November and December 1930, when Einstein published articles in the *New York Times Magazine* and the *Berliner Tageblatt* under the titles 'Science and Religion' and 'What I Believe', in which he defended a form of deism similar to that of Spinoza. One of Einstein's Soviet critics responded that deism was logically inherent in the concept of a four-dimensional space-time continuum and that therefore relativity must be rejected. He noted Hessen's defence of relativity theory, a doctrine which he condemned as 'a rotten swamp'.²⁹

In December 1930, Stalin himself entered the debate over philosophy, announcing that the philosophical faction to which Hessen belonged, the Deborinites, had not been criticized severely enough.³⁰ This group of philosophers were, said Stalin, supporters of 'Menshevizing idealism', and they combined both philosophical and political errors.³¹ Stalin's intervention was followed, on 25 January 1931, by an official decree reorganizing Soviet philosophy and demoting many of Hessen's supporters. A number were expelled from the Communist Party and punished. Shortly before Hessen's departure for the famous London conference, the young 'red specialists' of the Communist Party called for the reconstruction of the natural sciences and demanded that the older specialists reform themselves or get out.³²

Kolman's Testimony and Role

One of the members of the Soviet delegation to London was Arnost Kolman, a philosopher of science of Czech birth who lived for many years in Moscow. In order to learn more about Hessen and the delegation, I interviewed Kolman in Moscow when I was there in 1971 for the Thirteenth Congress of the History of Science, a meeting that was a direct descendant of the London Congress. In later years I kept in contact with Kolman, especially after he emigrated to Sweden in 1976, declaring his disillusionment with the Brezhnev regime.

From Kolman I learned several items of information that helped clarify Hessen's situation at the time of the London Congress. First of all, Kolman told me that he (Kolman) had been the Communist Party secretary for the delegation, and was thus responsible for Party discipline. He had been asked to keep an eye on Bukharin and Hessen, who had committed ideological deviations and were under suspicion. Their performances in London were seen as tests of their ideological orthodoxy.³³

Kolman agreed with me that Hessen's London paper was atypical of his interests. He further added that those members of the delegation who belonged to the Communist Party (Bukharin, Hessen, Kolman, Rubinstein) had been instructed by no less an important body than the Politburo to emphasize Marxism in their reports, while the non-Party members (Joffe, Zavadovsky, Vavilov, Mitkevich) had been given greater freedom in choosing their themes. Kolman continued that Bukharin had not carried out the instructions satisfactorily, and lectured on 'praxeology' in a 'heretical' fashion. On his return to the Soviet Union, Bukharin had been criticized for his performance, said Kolman, but the other Soviet scholars, including Hessen, had performed well.³⁴

Looking back at the book *Science at the Crossroads* with Kolman's remarks in mind, several of its characteristics shifted into a slightly different focus. The reports of the non-Party delegates were the least concerned with politics. The two non-Party physicists, Joffe and Mitkevich, had nothing to say about Marxism, while the two non-Party biologists, Zavadovsky and Vavilov, gave political elements a secondary place to discussions of their research interests. The irrepressible Bukharin, 'the favourite of the whole Party' in Lenin's words, continued the practice which so irritated the Stalinists of discussing Marxism as if he were an independent intellectual who could interpret it in his

own terms, making references to a galaxy of west European scholars, Marxist and non-Marxist. His belief that dialectical materialism naturally grows out of scientific research, rather than directs it, was by this time known in the Soviet Union as 'mechanism', a heresy which had been officially condemned.

Before talking to Kolman I had assumed that Bukharin, the official head of the delegation to London, had enjoyed unchallenged authority over the Soviet group. Now I realized that Kolman, as Party secretary assigned to watch over Bukharin and Hessen, was a much more significant person in this story than I had earlier thought. I decided to look up the articles that Kolman had been writing in Moscow in the months immediately preceding the London conference to see if some further clues could be found to the political context surrounding the formation of the Soviet delegation that went to London.

From his articles published in 1930 and 1931 it is clear that Kolman was a loyal Stalinist who was expressing views of the type that so worried Hessen.³⁵ Furthermore, Kolman had attacked both Bukharin and Hessen in print, accusing them of philosophical and political errors on opposite ends of the Soviet ideological spectrum. Bukharin, according to Kolman, was a member of the Right Opposition who often presented 'incorrect', insufficiently 'class-oriented', analyses of politics and economics.³⁶ Hessen was a 'Menshevik idealizer' who uncritically accepted Western scientific theories, especially relativity physics.

In an article published in January 1931, Kolman maintained that 'wreckers' were trying to corrupt Soviet physics just as wreckers had earlier tried to disrupt Soviet industry. The implication was serious, since the engineering 'wreckers' had been brought to trial and many of them imprisoned. Kolman tried to illustrate how the wreckers in physics were trying to discredit materialism:

'Matter disappears, only equations remain'—this Leninist description of academic papism in modern physics gives the clue to the understanding of the wrecker's predilection for the mathematization of every science. The wreckers do not dare to say directly that they want to restore capitalism, they have to hide behind a convenient mask. And there is no more impenetrable mask to hide behind than a curtain of mathematical abstraction.³⁷

Kolman asserted that it was time for Marxists to reject Hessen's view that abstract relativity theory was inherently Marxist and to recognize that the 'most harmful and dangerous of all things is empty, naked theoretization'.³⁸ He continued that Marxist phil-

osophers should notice that Stalin had announced that ‘technology in the current stage decides everything’ and therefore they should turn from analyses of theoretical science to analyses of the practical tasks of industrialization.³⁹

In an article published only three months before the group of Soviet scholars left for London, Kolman issued a direct challenge to Hessen, calling on him to change his ways, to correct his political mistakes:

Comrade Hessen is making some progress, although with great difficulty, toward correcting the enormous errors which he, together with other members of our scientific leadership, have committed. Nonetheless, he still has not been able to pose the issue in a correct fashion, in line with the Party’s policy... One must speak directly here, and say that there is no Bolshevism in Hessen’s science, nor in that of his comrades. This has to be said forthrightly. Comrade Hessen now has the possibility of showing in his practical work that he really wants to correct his mistakes.⁴⁰

This quotation places the whole episode of Hessen in a clearer light. When he went to London in the summer of 1931 he was in deep political trouble. The man who demanded that Hessen corrected his ways—Kolman—was the political guard of the Soviet delegation. Hessen’s London appearance was a crucial moment for his career back in the Soviet Union.

Re-reading Hessen’s Paper

Hessen’s London paper satisfied the requirements that Kolman laid down. It eschewed theoretical physics and mathematics, contrary to most of his previous papers. It strongly emphasized the role of practice in determining theory. It obeyed Stalin’s command to stress technology. Hessen wrote that although Newton’s *Principia* is ‘expounded in abstract language’, its ‘earthy core’ is actually technical problems arising out of industry and trade in the seventeenth century.⁴¹ Throughout the paper Hessen copiously quoted Marx, Engels and Lenin.

When reading the essay I have always been struck by its flamboyant application of an elementary form of Marxism to social and intellectual relations. Especially strong is the emphasis on technology as a formative force in intellectual life. After studying Hessen’s other articles written in the Soviet Union, at first I had difficulty recognizing the same author. Normally, he was a sober

and careful scholar writing on such topics as probability theory or relativistic mechanics. In the other articles he stressed logical and philosophical themes, not technology. Deep down, however, there is a continuous theme in Hessen's London paper and his Soviet articles: the unlinking of the value of a scientific theory from the ideological framework in which it developed.

The overwhelming impression I gain from the London paper is that Hessen had decided 'to do a Marxist job' on Newton in terms of relating physics to economic trends, while imbedding in the paper a separate, more subtle message about the relationship of science to ideology. He must have realized that by interpreting Newton in elementary Marxist economic terms, he could accomplish two important goals: first of all, he could demonstrate his Marxist orthodoxy, something being seriously questioned by his radical critics back in the Soviet Union; second, he could, by implication, defend science against ideological perversion by pointing to the need to separate the great merit of Newton's accomplishments in physics from both the economic order in which they arose and the philosophical and religious conclusions which Newton and many other people drew from them. Hessen knew that not even the most radical critics of relativity physics in the Soviet Union questioned Newtonian physics; if he could show that the same contextual critique could be made of Newton that some Marxists in the Soviet Union were making of Einstein, then the lesson seemed clear. Hessen was illustrating that Marxists should simultaneously recognize the value of Newton's physics while seeing that it developed in mercantilist England and was used as a tool to support religion; therefore, they should similarly recognize the value of Einstein's and Bohr's physics while acknowledging that they arose in imperialist Europe and are often used to counter Marxism.

When it came to discussing the relationship of physics to economics, Hessen pulled out a textbook Marxism which he employed to great effect. After years of trying to warn his colleagues in Moscow about the damage that could be done with an unrestrained Marxism, it must have been satisfying for him to realize that in London he could only help his cause and that of Soviet physics by letting fly full force. His performance carried the implicit message to Bolshevik critics of relativity physics: 'What you do to Einstein and Bohr, I can do to Newton; so let's leave the physics alone.' This message became almost explicit when Hessen in the paper praised the 'great results' and 'elements of healthy

materialism' contained in Newton's *Principia*, while criticizing his 'general religio-theological conception of the universe.'⁴² Back in the Soviet Union he had been saying the same thing about Einstein.

From contemporary accounts of the London meeting, I gain the definite impression that Hessen was enjoying himself as he affronted all the sensibilities of the assembled bourgeois scholars, and that his satisfaction turned to amusement as his audience, by its fascination, demanded to be shocked even more. Hessen knew his Marxism thoroughly, and producing a simplified version of economic determinism was easy for him. The essay shows all the marks of having been written hastily, but brilliantly.

But despite all these concessions to his critics, Hessen left room for the defence of theoretical physics and its differentiation from ideology. By placing emphasis on technology and practice in determining theoretical physics he freed physics itself from being condemned merely by the philosophical or theological interpretations that may be placed on it. He believed that the development of twentieth-century physics could be analysed in the same way that he explained Newtonian physics, and thought that there was no more reason to accept attacks on materialism in the name of twentieth-century physics than there had been to accept such attacks in the name of Newton, whose religious views were merely a 'product of his time and class'.⁴³ The unwritten final line was that when Einstein wrote on religion or philosophy he also merely expressed his social context and therefore these views should not be held against his physics.

Discussion

It is ironic, but not contradictory, that Hessen was doing to Newton something rather similar to what Hessen's ideological critics in the Soviet Union were doing at the same moment to Einstein. Hessen was maintaining that Newton's physics was based on the ideological assumptions and promoted by the economic interests of bourgeois England in the seventeenth century. Hessen's foes in the Soviet Union were maintaining that Einstein's physics was based on the ideological presuppositions and buoyed by the economic interests of imperialistic Europe of the late nineteenth and early twentieth centuries. But Hessen did not draw the same conclusion from his social analysis of Newton that his

Soviet critics drew from their social critique of Einstein, and that was the important point. Hessen wished to differentiate between the social origins of science and its cognitive value. As a professional physicist he was a strong defender of both Newtonian and Einsteinian physics, each in its proper realm. He knew that he would have an easier time convincing militant Soviet Marxists that Newtonian physics has enduring value despite its bourgeois social origins, than he would demonstrating that the still little-understood relativity theory also must be valued despite its social origins in capitalistic central Europe.

Hessen's position can be further illustrated by noticing that if he had given a paper in London that directly reflected his main concerns during those years—the defence of relativity physics—Westerners would have paid no attention to him, while his Marxist critics in the Soviet Union would have castigated him for pandering to Western interests. So he took a different path that was compatible with his larger goal.

Knowing how much Hessen's paper was influenced by Soviet political currents helps us to understand its style and structure. The example of Hessen's presentation clarifies, however, a larger point: externalist historians of science have not been as thorough as they should have been in their exploration of the social conditions which affect intellectual discourse. They have been much more willing to apply an externalist interpretation to the scientists they study than they have been to apply it to the historians who are studying the scientists. But surely social conditions affect historians as much as scientists. And this observation points to the need for the contextual study of historians of science going far beyond the subject here, Boris Hessen.

There is a final insight to be gained from the Hessen episode. Similarly to the way that Hessen differentiated between the social origins of Newtonian and Einsteinian physics and their cognitive value, we can also differentiate between the social origins of Hessen's interpretation of Newton and its inherent value. In an ironic way, Hessen's paper was far greater than the occasion which prompted him to write it. Just because Hessen's paper was, in a sense, a product of Soviet politics, does not mean that his approach to the history of science has no meaning or significance outside that framework. Over fifty years after Hessen's influential salvo in the writing of externalist history of science, we can see clearly that externalism was a refreshing and helpful development

in the history of science. But the realization that Hessen was a participant in a fierce Soviet debate over the relationship of the social origins of science to its cognitive value should help us to understand why Hessen presented a talk which was elementary and provocative in its interpretation of the relationship of science to economics, but sophisticated and suggestive in its treatment of the relationship of science to ideology. By speaking both messages Hessen could help his domestic Soviet position and at the same time remain loyal to his own form of Marxism.

• NOTES

1. J.D. Bernal, *The Social Function of Science* (London: George Routledge & Sons, 1939), 406; Hyman Levy, *Modern Science* (London: H. Hamilton, 1939), 97; Robert Young, 'Man's Place in Nature', in Mikulas Teich and Young (eds), *Changing Perspectives in the History of Science* (London: Heinemann, 1973), 389; Robert K. Merton, *Science, Technology and Society in Seventeenth-Century England* (New York: Howard Fertig, 1970), 142–43, 163, 185–87, 201, 206; Stephen Toulmin, 'From Form to Function: Philosophy and History of Science in the 1950s and Now', *Daedalus*, Vol. 106 (Summer 1977), 150; Jerome Ravetz, 'Bernal's Marxist Vision of History', *Isis*, Vol. 72, No. 263 (September 1981), 393–402. A recent article citing the influence of Hessen's essay on left-wing scientists is Simon Schaffer, 'Newton at the Crossroads', *Radical Philosophy*, No. 37 (Summer 1984), 23–28. For descriptions of the London conference, see Paul Gary Werskey, 'Introduction', in *Science at the Crossroads* (London: Frank Cass, 2nd edn, 1971), xi–xxix; and J.G. Crowther, *Fifty Years with Science* (London: Barrie & Jenkins, 1970). For Soviet views, see S.Ia. Plotkin, 'O II mezhdunarodnom kongresse po istorii nauki i tekhnike', *Voprosy istorii estestvoznaniia i tekhniki*, No. 44 (1971), 31–36; and A.T. Grigorian and A.P. Iushkevich, 'Mezhdunarodnye nauchnye svyazi sovetskikh istorikov estestvoznaniia i tekhniki', *ibid.*, No. 23 (1968). One of the Soviet participants also described the event in emigration: Arnosht Kol'man, *My ne dolzhny byli tak zhit* (New York: Chalidze Publications, 1982), 172–77.

2. G.N. Clark, *Science and Social Welfare in the Age of Newton* (Oxford: Clarendon Press, 1937); A. Rupert Hall, *Ballistics in the Seventeenth Century* (Cambridge: Cambridge University Press, 1951); Richard S. Westfall, 'Reflections on Ravetz's Essay', *Isis*, Vol. 72, No. 263 (September 1981), 402–05.

3. Arnold Thackray, 'History of Science', in Paul T. Durbin (ed.), *A Guide to the Culture of Science, Technology, and Medicine* (New York: Free Press, 1980), 14–15.

4. *Isis*, Vol. 72, No. 263 (September 1981).
5. W.F. Bynum, E.J. Browne and Roy Porter (eds), *Dictionary of the History of Science* (Princeton, NJ: Princeton University Press, 1981), 145–46.
6. Gary Werskey, in his introduction to the second edition of *Science at the Crossroads* (op. cit. note 1), made an effort to inquire into the disputes occurring in the Soviet Union at the time of the London conference. He did not have access, however, to the Russian language materials about the disputes over relativity theory. David Joravsky provided very helpful background to the philosophical disputes of the late 1920s and early '30s, and Hessen's place in them, in his *Soviet Marxism and Natural Science, 1917–1932* (New York: Columbia University Press, 1961), but he did not bring this information directly to bear on the London conference, except for some tantalizing hints in his 'Soviet Views on the History of Science', *Isis*, Vol. 46, Part 1, No. 143 (March 1955), 3–13, esp. 5, fn 8.
7. See, for example, the following works on which Hessen was an author or co-author: 'Teoretiko-veroiatnostnoe obosnovanie ergodicheskoi gipotezy', *Uspekhi fizicheskikh nauk*, N.5 (1929), 600–29; *Osnovnye idei teorii otositel'nosti* (Moscow: *Moscow Worker* 1928); 'Predislovie k stat'iam A. Einsteina i Dzh. Dzh. Tomsona', *Pod znamenem marksizma*, No. 4 (1927), 152–65; 'Statisticheskii metod v fizike i novoe obosnovanie teorii veroiatnostei R. Mizesa', *Estestvoznamie i marksizm*, No. 1 (1929), 3–58; 'Mekhanicheskii materializm i sovremennaiia fizika', *Pod znamenem marksizma*, No. 7/8 (1928), 5–47; 'Idealisticheskie techeniia v sovremennoi fizike i bor'ba s nimi', *Molodaia gvardiia*, No. 3 (1929). 'Marian Smolukhovskii (k desiatiletiiu so dnia smerti)', *Pod znamenem marksizma*, No. 9 (1927), 144–48; with I. Podvolotskii, 'Filosofskie korni pravogo oportunizma', *ibid.*, No. 9 (1929), 1–29; with V. Egorshin, 'Ob otnoshenii tov. Timiriazeva k sovremennoi nauke', *ibid.*, Nos 2–3 (1927), 188–99; with I.K. Luppol, 'O kruzhkakh po izucheniiu dialekticheskogo materializma sredi molodykh nauchnykh rabotnikov', *Kommunisticheskaiia revoliutsiia*, No. 14 (1928); with V.P. Egorshin, 'Piatyi s'ezd russkikh fizikov', *Pod znamenem marksizma*, No. 1 (1927).
8. The fact that Hessen was arrested in 1935 and died in prison in 1938 is widely known in the Soviet Union among historians of science. David Joravsky wrote that Hessen perished as an 'enemy of the people'. Dirk Struik obtained the arrest and death dates when doing research for an article on Hessen for the *Encyclopedia Judaica*. See Joravsky, op. cit. note 6, 293, and letter to the author from Dirk Struik (21 December 1976).
9. For biographical information on Hessen I have drawn on Manuscript Division, Lenin Library, Moscow, fond 384, karton 6, ed. 15, as well as the information from Dirk Struik (loc. cit. note 8).
10. See the discussion in Loren Graham, *Science and Philosophy in the Soviet Union* (New York: Alfred Knopf, 1972), 9–16, 206–08, and passim.
11. See Loren Graham, *The Soviet Academy of Sciences and the Communist Party, 1927–1932* (Princeton, NJ: Princeton University Press, 1967).
12. Sheila Fitzpatrick, 'Cultural Revolution as Class War', in her edited *Cultural Revolution in Russia* (Bloomington, Ind.: Indiana University Press, 1978), 11, 31.
13. Kendall E. Bailes, *Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentsia, 1917–1941* (Princeton, NJ: Princeton University Press, 1978), esp. 69–121.
14. Joravsky, op. cit. note 6, especially 233–49. See also Loren Graham, *Between Science and Values* (New York: Columbia University Press, 1981), 88–98.

15. V.I. Lenin, *Materialism and Empiriocriticism* (New York: International Publishers, 1927), 24.
16. Arthur Stanley Eddington noted in his Gifford Lectures of 1927, published in 1928 as *The Nature of the Physical World*, that he was 'combatting' materialism on the basis of the new physics: see Graham, op. cit. note 14, 80. L. Houllevigue remarked that 'The atom dematerialises, matter disappears', in his *L'Evolution des Sciences* (Paris: A. Colin, 1914), 87–88.
17. Hessen and Egorshin, 'Ob otnoshenii . . .', op. cit. note 7, 192.
18. *Ibid.*, 193.
19. Hessen, 'Predislovie . . .', op. cit. note 7, 158.
20. Joravsky, op. cit. note 6, 187. While Hessen was criticized by Stalinists like Maksimov for his support of relativity theory, he was also ridiculed by some Soviet physicists, including very good ones, for his defence of Marxist philosophy. George Gamow misunderstood Hessen's position in his entertaining but inaccurate *My World Line: An Informal Autobiography* (New York: Viking Press, 1970), 94–99.
21. See Alexander Vucinich, 'Soviet Physicists and Philosophers in the 1930s: Dynamics of a Conflict', *Isis*, Vol. 71, No. 257 (June 1980), 236–50; and Joravsky, op. cit. note 6.
22. *Raznoglasia na filozofskom fronte* (Moscow-Leningrad: State Political-Economic Press, 1931), 240.
23. *Ibid.*, 72.
24. *Ibid.*, 71.
25. *Ibid.*
26. *Ibid.*, 234.
27. *Ibid.*, 71.
28. *Ibid.*, 279.
29. See M. Mitin, 'Ocherednye zadachi raboty na filozofskom fronte v sviazi s itogami diskussii', *Pod znamenem marksizma*, No. 3 (1931), 14; and V.E. L'vov, 'Nauka i zhizn': Al'bert Einshtein v soiuze s religiei', *Novyi Mir*, No. 10 (1931), 195. The latter article appeared after the London conference, but L'vov's opinion of Einstein's article was well known earlier in the year.
30. Hessen's association with the Deborinites has been independently established by Western scholars. See Joravsky, op. cit. note 6, 185–88, 285–86, and passim. See also René Zapata, *Luttes philosophiques en URSS, 1922–1931* (Paris: Presses Universitaires de France, 1983), esp. 302.
31. Joravsky, op. cit. note 6, 262.
32. *Ibid.*, 268.
33. Interview with Arnost Kolman, Moscow (22 August 1971).
34. *Ibid.*, and letter, Arnost Kolman to Loren Graham (22 April 1977).
35. See, for example, A. Kolman, 'Boevye voprosy estestvoznaniia i tekhniki v konstruktivnyi period', *Pod znamenem marksizma*, No. 3 (1931), 56–78; Kolman, 'Vreditel'stvo v nauke', *Bol'shevik*, No. 2 (1931), 73–81; Kolman (ed.), *Na bor'bu za materialisticheskuiu dialektiku v matematike* (Moscow: 1931); Kolman, 'Bor'ba za vladenie nauki v novykh usloviakh', *Pravda* (4 October 1931), 2; and Kolman, 'Khod zadom filosofii Einshteina', *Nauchnoe slovo*, No. 1 (1931).
36. Kolman, 'Boevye voprosy . . .', op. cit. note 35, 62.
37. Kolman, 'Vreditel'stvo . . .', op. cit. note 35, 75–76.
38. Kolman, 'Boevye voprosy . . .', op. cit. note 35, 63–64, 69.
39. *Ibid.*, 57.

40. Ibid., 77.
41. B. Hessen, 'The Social and Economic Roots of Newton's *Principia*', in *Science at the Crossroads*, op. cit. note 1, 171.
42. Ibid., 190–91.
43. Ibid., 182–83.

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