BORIS HESSEN AS PHILOSOPHER AND POLEMICIST. IDEOLOGY, POLITICS AND THE NEW PHYSICS IN THE SOVIET UNION IN THE 1920s AND 1930s

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Abstract. Boris Hessen, a Soviet philosopher and physicist active in the 1920s and 1930s, made significant contributions to the history of science, in particular the so-called externalist approach, and to the development of the Soviet epistemology, dialectical materialism (sometimes referred to as *diamat*). His contributions were noteworthy in particular in showing how general relativity and quantum mechanics were commensurate with *diamat*. Yet in the increasingly tense period of early Stalinism, seemingly abstruse debates in the philosophy of science became a matter of life and death. This article explores Hessen's work in the philosophy of physics, first providing a discussion of the institutional reception of relativity and quantum mechanics in the USSR, then turning to the discussions of physicists, philosophers and Stalinist ideologues, with the latter arguing that the epistemological implications of the so-called new physics. The outcome of these debates led to the purging of many specialists who were accused of being anti-Soviet – and to the arrest and execution of Hessen in 1937.

Keywords: Boris Hessen, physics, Soviet Union, Stalin, dialectical materialism

Introduction

Boris Hessen[1], a philosopher and historian of physics, a practicing physicist and convinced Marxist, spent much of his adult life in an attempt to persuade other scholars of the commensurability of dialectical materialism, the Soviet philosophy of science, and modern theoretical physics, and also how the new physics and Marxist philosopher were mutually beneficial. To do this he defended the theory of relativity and quantum mechanics and the physicists who assimilated these areas of study, such as his close friend Igor Tamm, future Nobel laureate, from the attacks of such physicists as Arkady Timiriazev and Stalinist philosophers as Aleksandr Maksimov, who, being unable to grasp the new ideas and having exhausted scientific arguments, employed ruling Marxist philosophy to disprove and/or reject the new theory as a bourgeois one. Hessen tried to convince not only his "academic colleagues" but the Soviet political authorities that the theory of relativity and Marxist philosophy were compatible.

These efforts provoked the enmity of Stalinist ideologues and several of Hessen's academic colleagues who persisted in adhering to a Newtonian, mechanistic interpretation

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of such concepts as space, time, and motion. The attack on Hessen became especially pronounced in the early 1930s when a conflict between two camps of Soviet philosophers, the so-called Mechanists, on the one hand, and Dialecticians, on the other, spilled over from such Marxist scientific institutes as the Communist Academy of Sciences into the scientific community at large.

Stalin's revolution from above and cultural revolution from below (as they are widely known), plus forced collectivization, and industrialization, made it nearly inevitable that such intellectuals as Hessen would face hostile scrutiny from all sides; in Stalin's Russia vigilant philosophical disputes rapidly became personal and political ones. Even so, Hessen became dean of the physics department at Moscow University. Suddenly, he lost his job, was arrested in August 1936, and was shot in December 1937 (although the physicist Evgenii Feinberg offered different dates) during the Great Terror. From this point he acquired the dreaded referent "enemy of the people."

Hessen is best known for his article on the socio-economic roots of Newton's *Principia* whose genesis Loren Graham discusses as connected with an Aesopian defense of relativity theory and its originator, Albert Einstein, through the person of the equally revolutionary representative of the "bourgeoisie," Isaac Newton.[2] The corpus of Hessen's published writings is significantly larger, and many more manuscripts remain unpublished, some of which lie in draft form in Russian archives, especially at Moscow State University. Those writings share a devotion to the task of explaining the meaning, significance, and philosophical importance of new concepts in relativity theory and quantum mechanics such as indeterminacy and complementarity, and new understandings of the relationship between mass and energy, subject and object, and so on. Perhaps only in the Soviet Union at the confluence of cultural revolution, industrialization and forced collectivization, and fear of "hostile capitalist encirclement," and only under Stalin, his violent consolidation of power, and country-wide fear of "enemies of the people," could Hessen's writings on the new physics have provoked such misunderstanding, criticism, and hostile personal vindictiveness that led to Hessen's arrest and execution. Nikolai Krementsov, Ethan Pollack and others have written skillfully about the way in which scientists learned to play the "rules of the game" in their encounters with party officials and administrators in matters of financing, research direction, and ideology.[3] Yet Hessen's case – and he was hardly alone as hundreds of leading scientists perished without reason during the terrors of the 1930s – reveals that those "rules" were arbitrary, and the fact that Soviet scientists managed to accomplish as much as they did in spite of ideological scrutiny should not obscure the fact that murder is not a solution to scientific disputes.

The stage for Hessen's unfortunate end was set in the first decade of the Bolshevik revolution when intellectuals within the party and outside of it, radical workers, and bureaucrats debated the significance of the intellectual heritage of Marx, Engels, and Lenin for the future of the Soviet Union. Many of the issues centered on Marx's theory of history, known as historical materialism, and the inevitability of a workers' revolution. For the sciences, more important was the underlying epistemology of dialectical materialism (known in Soviet parlance as *diamat*). To understand these issues and this history, this essay will briefly summarize *diamat*, and the political circumstances of the events surrounding Hessen's life, including Bolshevik economic and cultural revolutions in the 1930s. It will then consider the history of the reception of relativity and quantum

mechanics in the USSR in the 1920s and 1930s, Hessen's writings on the subjects, and will conclude with an evaluation of Hessen's legacy.

The Background of Hessen's Defense of the New Physics: Dialectical Materialism

Dialectical materialism is founded on the beliefs that all that exists is real, that reality is matter-energy in motion, and that matter-energy develops in accordance with universal regularities or laws. There were three dialectical laws of nature as set forth by Engels: 1) the interpenetration or unity of opposites (for example the north and south poles of a magnet); 2) the negation of the negation (life, death and reproductive processes); and 3) the transformation of quantitative changes into qualitative ones and vice verse (various chemical formulae and the like).[4]

In the philosophy of physics in the seemingly arcane epistemological debates of the viability of *diamat* as a powerful tool of natural scientists, on one side stood mainstream theoreticians at Academy of Sciences institutes around the country. Such physicists as Iakov Frenkel, Vladimir Fock, and Igor Tamm participated in the development of relativity and quantum theory. They were able to separate their philosophical reservations about aspects of modern physics from their certainty that it accurately described physical phenomena. They strove to remain apolitical in an academic world increasingly in turmoil. Many scientists naively believed that normal scientific activities such as research, publication and peer review would continue unimpeded in a country beset by rapid political, economic, and cultural change. They watched as such new institutions of proletarian science as the Communist Academy of Sciences were founded, but could not grasp, of course, how they would create an entire cadre of specialists who worried excessively about bourgeois epistemologies.[5] Mistakenly they ignored their opponents until the late 1920s, when Stalin had solidified his rule, and as he and his supporters pushed to limit the power of so-called bourgeois specialists – scientists and engineers with special knowledge of value to the regime, yet seen as capable of subverting the regime – even through philosophy. Hessen was on the side of these scientists in the Academy, although he also worked at Moscow State University.

On the other side of debates of the philosophy of science was a strange mix of philosophers such as Aleksander Maksimov, muckraking journalists such as Vladimir Lvov, and such physicists largely concentrated at Moscow State University as Aleksandr Timiriazev who, out of personal animus, lack of understanding, or other grounds, rejected the new physics. They often did so on the anachronistic grounds of supporting a strictly Newtonian view of the physical world, even for such phenomena as light and energy. In public meetings and private strategy sessions, in published articles and signed denunciations, they seized upon Stalinist formulae to press their case for scientific preeminence. In a time of perceived "hostile capitalist encirclement," they stressed the "Russian-ness" of their members and the ideological significance and priority of Soviet science. The Moscow university professors highlighted as unambiguous the dangers arising from epistemological deviations from Stalinist dogma and the idealist contamination by foreign bourgeois scientists and their alleged representatives, i. e. *the new physicists* in the Soviet Union.

The Muscovites had great resources. First, they had the ear of the Communist

Party, and to Party officials their arguments made sense. They could accuse the theoreticians of advancing notions, concepts and publications that did little for the industrialization effort. After all, what impact did Schrödinger's "wave packets" have on increasing cement production? Second, the Soviet Union was indeed an armed camp under Stalin. Enemies abounded within its borders and beyond. The former were Trotskyites, "enemies of the people," so-called kulaks (well-to-do peasants), and all of their relatives; virtually no on was beyond suspicion. Third, many of the theoreticians were Jew[6]s, and my critics of the new physicists were anti-Semitic. Finally, officialdom held to a Newtonian, mechanical view of the universe. This agreed closely with what little Engels, Marx, and Lenin had written about "matter in motion."

From the mid-1930s until Stalin's death in 1953, the new physics fell under attack; by back-room negotiations if not majority vote, physicists debated whether to pass a resolution condemning the new physics, thereby removing it from textbooks, schools, and institutes. But the strength of Soviet theoreticians was in their diverse backgrounds and personalities, the courageousness of their leaders, and the very success of their research institutes from which important fundamental and applied scientific discoveries, including the atomic bomb, issued. Still, Boris Hessen and others fell.

The Political Context: Stalin, Cultural Revolution and Physics

Boris Hessen was active in several research institutes, including Moscow State University that remained relatively independent of state control until the early 1930s. Hessen also worked in such party strongholds as the Communist Academy of Sciences and special higher schools for workers (*rabfaky*) that were controlled by Marxist scholars from their inception.[7] In the first years of Soviet rule the interplay between communist and non-communist institutions was modest, so that the reception of relativity theory and quantum mechanics occurred within two separate spheres. In the early 1920s the scientific publication industry recovered from the economic turmoil of the Russian revolution and Civil War. Over thirty different tracts appeared on relativity (and later a larger number on quantum mechanics) that included works by so-called "idealist" philosophers (Pavel Florenskii, Aleksandr Bogdanov and his followers), and such scientists as Iakov Frenkel, Viktor Frederiks, Aleksandr Friedmann, Sergei Vavilov, and Igor Tamm.[8]

In 1929, when the Bolsheviks set rapid industrialization and forced collectivization in motion, they introduced new polices toward the sciences to put them more at the service of national economic programs. These "Stalinist" policies – the introduction of long-range planning requirements, the redoubled emphasis on applied research at the expense of fundamental, pressures to place specialists of working class origin or party membership into positions of responsibility, autarky in science, and officially approved ideological scrutiny – resulted in Party interference in the conduct of research, and had significant implications for theoretical physics.[9] In the main, they reflected Party insistence that research should have a clear impact on agricultural and industrial production, and a rejection of so-called "ivory tower" and empty theorizing. Fortunately, physics research was not far removed from the practical problems facing the government of electrification, communications, metallurgy, and so on.

At the same time, cultural revolution (1929-1931) unfolded. It involved the penetration of increasingly militant young party members into positions of responsibility

and power in virtually all educational, scientific, economic, and social institutions of Soviet society.[10] These "advanced" workers, called *vydvizhentsy,* often lacked skills and it was difficult to train them. There were few "working class" or party scientists; in fact, of all professional "scientific" groups in the USSR in 1929, physicists had the lowest percentage of Party members. Also, *vydvizhenie* encountered opposition from leading scholars, even at the height of the movement. For these reasons, advancement failed in the physical sciences,[11] although some physicists felt obligated now to consider more directly Marxian ideas about the sciences, and certainly to be more aware of the implications of "class war" for all citizens in the Stalinist USSR. Indeed, beginning during the cultural revolution period, party officials carried out a kind of class war against those who were deemed to be representatives of the old order: former Tsarist factory managers, school teachers, leftist intellectuals in the Party, and so-called "bourgeois specialists" in science and technology. They orchestrated two show trials of engineers for "wrecking" and sabotage in the late 1920s--the Industrial Party and Shakhty affairs--to demonstrate that it would control the scientific, technological, and engineering enterprises.[12]

Cultural revolution helped create an environment in which Marxists and non-Marxists, scientists and philosopher reevaluated the ideas of *diamat.* Most physicists shared a number of attributes and aspirations, and this limited the immediate impact of cultural revolution on the discipline.[13] They were uncomfortable with the "proletarianization" of science. They believed that doctrines of class struggle made little sense in the exact sciences. This enabled physicists to develop a common approach to ideological encroachment. There were, to be sure, significant differences among the scholars on many of the thorny questions advanced in quantum mechanics and atomic, molecular and nuclear physics, but mainstream physicists largely rejected the intrusions of Stalinist ideologues to defend their discipline against charges of "idealism."

Hessen worked in this environment. He was active in Party study circles that were established during cultural revolution to ensure the elaboration of the proper worldview among the bourgeois specialist and worker alike. Party officials hoped these circles would help convert or coopt physicists through broad discussion of party history, dialectical materialism and Marxist methodologies, and by developing new curricula for the dialectical materialist teaching of physics. By 1932 hundreds of circles existed in research institutes in Moscow, Leningrad, Kharkov, Bukhara, Tashkent and Gorky. Participants in circles read two works by Friedrich Engels that predated the Einsteinian revolution in physics, *Anti-Dühring* (1877) and *The Dialectics of Nature* (1883, unfinished), for the theoretical background necessary to comprehend fully the kinetic theory of matter, and then Lenin's *Materialism and Empiriocriticism* (1908), only three years after the publication of Einstein's paper on the special theory of relativity, and fifteen years before quantum mechanics began rapidly to unfold, for clarification of the electronic theory of matter. According to Party activists and philosophers, such reading was intended to overcome nearly two decades of idealism among such "bourgeois" physicists as Arthur, Eddington, James Jeans and Walter Nernst, the mathematics of David Hilbert and Hermann Weyl, Einstein and Bohr, and their Soviet followers in the name of the "proletarianization" of science.[14]

One study circle held a workshop to enlighten school physics teachers about the

power of dialectical materialism. It involved such representatives of early dialectical materialism as Hessen and several leading physicists. They lectured on relativity, quantum theory, and cosmology. The talks given included: Hessen's "Problems of the Methodology of Physics"; Tamm's "The Physical Foundations of Relativity Theory"; and Sergei Vavilov's "Fundamentals of Quantum Theory"; Vavilov later became director of the Physics Institute of the Academy of Sciences (FIAN). In order to join the circles one had to fill out a form consisting of such questions as "In what way and how in your work have you shown yourself to be a materialist?" with answers such as "I rebuffed an idealist presentation at a meeting."[15]

Other than study circles there were two ways in which the Party tried to "proletarianize" science: through curriculum changes and the publication of articles and monographs geared to a less sophisticated audience to highlight the achievements of Soviet physics. Hessen had an active role here, too. One new book series, "Classics of Science [Klassiki estestvoznaniia]," under the editorship of Hessen, I. I. Agol, Maksimov, and Vavilov, was devoted to publication of new editions of classical figures of science to assist in discussions of diamat.[16]

The Physical Context: The Reception of the New Physics in Soviet Russia

Soviet physicists were well-prepared to consider the philosophical ramifications of the new physics. They established a number of leading research centers – A. F. Ioffe's Leningrad Physical Technical Institute (LFTI), the FIAN, a special institute at Moscow University, Petr Lazarev's Institute of Physics and Biophysics, the Ukrainian Physical Technical Institute in Kharkiv, and others – each of which employed sophisticated and well-versed theoreticians. They participated in the development of the new physics. For example, Iakov Frenkel, director of the theoretical department of the Leningrad Physical Technical Institute from 1928 until his death in 1952, published over one hundred articles and twenty full-length monographs in his life. He wrote the first "non-popular" guide on relativity theory in Russian for students with a university mathematics background.[17]

Frenkel generally found *diamat* a distraction from the work of physicists. In 1931 at the All-Union Mendeleev Chemistry conference, he contended that the Marxists knew nothing about physics, and that *diamat* could contribute nothing to physics. Frenkel voiced the opinion that "scientific objectivism" was the only appropriate methodology, and expressed the hope that those "leftists" in the Communist Party who espoused the glories of *diamat* would fall silent. Frenkel insisted on having read both Marx and Lenin and found them original but of little use to him as a physicist. Meetings of the Society of Militant Materialists and other Marxist scientific societies were organized around the country to discuss Frenkel's transgressions. Frenkel was criticized, along with physiologist Ivan Pavlov, in a general resolution of the membership of the Institute of the Red Professoriat on December 31, 1931, for harboring "bourgeois tendencies hostile" to Soviet socialism including Machist epistemology – named after Austrian physicist Ernst Mach – as manifested in seeing the electron as a function of probability, that is, not real matter.[18]

Also from LFTI, Viktor Frederiks and Aleksandr Friedmann (or Fridman) wrote widely on the general theory of relativity. Friedmann is better known because of his work "Über die Krümmung des Raumes" (1922) which first proposed equations describing a

non-static universe. Frederiks, who had studied under Hilbert in Göttingen from 1914-18, published the first Russian description of the general theory of relativity in 1921. He was arrested in the late 1930s, tortured to confess that he was personally involved in a plot to kill Stalin, and died in prison of pneumonia in 1944.[19] In their first joint work, *Osnovy teorii otnositel'nosti* (*Foundations of the Theory of Relativity*, 1924, the only volume to be published of a planned five-volume book project on the foundations of the theory of relativity, Friedmann and Frederiks used tensor analysis to "set forth relativity theory sufficiently rigorously from a logical point of view."[20]

Soviet physicists similarly contributed significantly to quantum mechanics. They rapidly embraced quantum mechanics, and debated its philosophical implications and physical content. They engaged in its development from the mid-1920s onward, either while abroad (Vladimir Fock and Frenkel in Germany; Lev Landau in Denmark; George Gamov in England and Denmark), or in any one of a number of seminars in Soviet institutes. Soon after the first articles by Werner Heisenberg, Erwin Schrödinger and Niels Bohr on quantum mechanics appeared in *Nature*, *Die Naturwissenschaften*, and *Zeitschrift für Physik*, Soviet physicists published several of these in translation in their own journals in 1926.[21] By the time of the Sixth Congress of the Russian Association of Physicists in 1928, Soviet theoreticians had turned their attention wholly to quantum mechanics, and debated the interpretations of the Copenhagen and Göttingen positions. The activities of Frenkel, Fock, and Viktor Bursian in particular stimulated the development of quantum mechanics in Soviet Russia. An informal seminar at the LFTI attracted a number of people. The periodic seminar considered the work of Louis de Broglie, Erwin Schrödinger, and Max Born, and also literature reviews of European journals.[22]

The Philosophical Context: Marxist Philosophers and the New Physics[23]

For Soviet physicists, aside from the pressure to plan applied research, the most troubling aspect of Stalinist science policy was the attempt to control the ideological, and hence epistemological, content of the new physics. As physicists probed deeper into atomic structure, first using X-ray devices to understand the interaction of matter and energy in crystal lattices, then various accelerators to enter the very nucleus, they uncovered a number of paradoxes. They debated these paradoxes, and thought debate to be their bailiwick, not that of party officials and philosophers. The scientists believed they did not understand the paradoxes of the new physics including the behavior and nature of such subatomic particles as electrons and the alpha, beta and gamma particles emitted by radioactive atoms; visible light, ultraviolet light, and X-rays; and so on. Scientific research on this new micro-world was based on discoveries of such scientists as Max Planck, who had proposed that energy was distributed in a discrete, discontinuous, form called "quanta," and Albert Einstein, whose relativity theory overturned Newtonian concepts of absolute space and time, removing the distinction between moving and stationary observers.

Astounding developments in atomic theory meanwhile gave rise to quantum mechanics. Experiments confirmed the interrelation of continuous and discrete phenomena such as light that manifests both wave and particle properties, and the

existence of matter-energy. Quantum mechanics required the synthesis of statistical and dynamic laws to describe the behavior of subatomic phenomena, and pointed to the inherent difficulty in accounting for the interaction of the "subject" and the "object" in subatomic processes, including measurement itself. This was Werner Heisenberg's "uncertainty" principle.[24] When we observe a macroscopic object, the perturbation in its behavior introduced by our observation is negligible. In the micro-world, measurement, literally shedding light on the object, influences its behavior. We can know either its location or its momentum with complete precision, but not both at once. Schrödinger's wave mechanics, Heisenberg's matrix mechanics, and other statistical and probabilistic methods were employed to describe the particle's behavior with a great degree of confidence, but not with Newtonian certainty. A second crucial concept of quantum mechanics was the notion of complementarity. According to this principle, the complete description of two apparently incompatible aspects of a situation must incorporate both without rejecting either, for example the wave and particle aspects of light, or the Newtonian and quantum aspects of atomic systems. Niels Bohr, whose 1913 model of the hydrogen atom provided a foundation of quantum mechanics, and whose Institute of Theoretical Physics in Copenhagen was a magnet for leading theoreticians including Soviet scholars during the 1920s, set forth complementarity.

The representatives of the two major trends of Marxist philosophy, the Deborinites and Mechanists, organized a number of "Marxist" research institutes in the mid-1920s with a two-fold purpose. They wished to become more conversant with recent advances in the sciences, and they desired to attract natural scientists to their fold. They experienced limited success in both endeavors with such scholars as Hessen being the exception. Hessen participated in the development of the Deborinite or Dialectician's position that largely accepted relativity theory and quantum mechanics, and argued that they were commensurate with dialectical materialism.

The Deborinites believed that the epistemological questions that had arisen in response to the major developments in the first third of the century demonstrated the compatibility of modern physics and dialectical materialism. The dialecticians shared the physicists' belief that quantum mechanics and relativity theory accurately described physical phenomena. There were three institutional strongholds of the Deborinites: the Communist Academy of Sciences (until 1924 the Socialist Academy); the Sverdlov Communist University in whose department of philosophy Hessen organized a section on the natural sciences in which Igor Tamm and mechanist Arkadii Timiriazev participated in debates; and the Institute of Red Professoriat where Hessen offered courses in physics on the nature of matter, energy, and relativity theory to complement others in biology, medicine, and chemistry.[25]

The Deborinites authored the three major treatises on relativity theory: Vladimir Egorshin's *Estestvoznanie, filosofiia i marksizm* (1930)[26]; Semen Semkovskii's *Teoriia otnositel'nosti i materializm* (1924)[27], and Hessen's *Osnovnye idei teorii otnositel'nosti* (1928).[28] (Egorshin was a student of Deborin; Semkovskii was the leading Marxist philosopher of science in Ukraine.) These works share a common respect for relativity theory, the recognition that classical explanations for matter, electricity and motion were inadequate, a belief that relativity theory and dialectical materialism were commensurate in epistemological matters, and a conviction that physicists, not philosophers should be the

final arbiters in matters of physics. For example, The Deborinites recognized the dialectical, if not revisionist qualities of Marxism; Marxism was not stagnant, but should reflect advances in science.

The Mechanists took exception to a number of the Deborinites' positions. From their strongholds in Moscow State University and the Timiriazev State Scientific Research Institute, they published five volumes of collected articles between 1926 and 1929 in which they sought to bring scientists and philosophers together with the understanding that all processes in the external world could be explained in terms of laws of classical mechanics.[29] Their studies of the works of the leading Marxist scholars – Engels and Lenin in particular, on mathematics, mechanics, electrification, chemistry and biology – demonstrated, they believed, that mechanical processes in both the organic and inorganic worlds reduced to the notion of matter in motion and to the concept that all qualitative differences are differences of quantity.[30]

What were the mechanists' criticisms of relativity theory and quantum mechanics, and in particular of Hessen, Frenkel, and other theoreticians? The mechanists objected to the rejection of Newtonian mechanics required by relativity theory. This objection went so far as to require the maintenance of a mechanical ether to explain the transmission of electromagnetic energy through space. The Mechanists relied on Dayton Miller's repetition of the Michelson-Morley experiments to support their position, although mainstream Soviet physicists had repudiated those experiments.[31] The Mechanists also rejected relativity theory on philosophical grounds, asserting that Einstein's theory led to philosophical relativism and concomitant denial of the existence of any kind of objective reality.

More crucial was the fact that relativity theory was the bugaboo of Timiriazev who seems to have had a personal animus for Hessen. Timiriazev (1880-1955), son of the famous agronomist and biologist Klement Timiriazev, was a professor of physics at Moscow State University and a party member from 1921. He was devoted to Newtonian classical mechanics, precisely positing an aether that filled the universe to explain the transmission of electromagnetic energy mechanically through space. Timiriazev was troubled by the increasing role of statistical laws, the "mathematicization" of matter, and the precarious status of the laws of causality, to name the most salient objects to the new physics. Timiriazev's hostility to Einstein took on such proportions that he sarcastically denied in a public meeting having suggested that Einstein be shot. On another occasion, in a presentation at the Institute of Red Professoriat, Timiriazev snidely showed his ignorance by deriding the equivalence of matter and energy by asserting that the equation $E=mc^2$ promised only the combustion of matter "cleaner than in a crematorium!" At the university Timiriazev tried to force graduate students and faculty alike into his circle of militant mechanistic physicists, reserving his most hostile commentary for such Jewish theoreticians as Frenkel, Leonid Mandelshtam, and Lev Landau, a commentary that resembled the opposition of "Aryan" physicists to relativity in National Socialist Germany.[32]

Timiriazev engaged the scientist and philosopher Aleksandr Bodganov and Hessen in rancorous debate within the walls of the Communist Academy of Sciences, and later took on physicists Tamm, Vavilov, Frenkel and Ioffe, an effort which culminated in

his *Vvedenie v teoreticheskuiu fiziku* (Introduction to Theoretical Physics, 1933), the most complete defense of his mechanism; the book was poorly received.[33]

Since his physics was attractive in the main to the mechanists who were in the minority against physicists and dialecticians, Timiriazev resorted to political intrigues to achieve his ends, ultimately at the cost of his reputation. The Communist Party cell of the university physics department reported late in 1929 to the Central Committee that Timiriazev associated with faculty whose politics resembled those of the Black Hundreds, a pre-revolutionary reactionary and anti-Semitic group. This accusation weakened his leadership and the influence of the party among other scientists at a crucial moment when the Party was striving to extend its influence. According to a university report, the groups that Timiriazev supported were not only politically bankrupt, but interested in "personal and material gain, not even political ends."[34]

Timiriazev resented Hessen and strongly disagreed with the way he and Sergei Vavilov, the future Academy of Sciences president, ran the university's physics program, from teaching to research. In written "Theses" to the university party organization, Timiriazev outlined his objections about their actions. His criticisms encompassed every aspect of university life, from pedagogy and course content to the poor state of the laboratory, from practicums at factories to introduce workers to modern science, to the study of theoretical physics. So full of vitriol were Timiriazev's "theses" that the party organization rejected them out of hand. A commission appointed to investigate Timiriazev's charges that included Vavilov and Hessen concluded that there was nothing to his constant accusations.[35] Yet in the an environment of cultural revolution and rising fears about technocratic tendencies among specialists, Timiriazev and his allies were able to

The Mechanists were trapped by their strict allegiance to Newtonian laws of mechanics and a reductionist, simplistic interpretation of Engels and Lenin. They lacked an understanding both of the physical and the philosophical content of the new physics. The reductionism of the Mechanists, while seeming to provide Marxian interpretations of the new physics, simply could not accurately describe the physics of the micro-world or electromagnetic phenomena. Yet personal animus rather than scientific disputes explains the vehemence of the attacks of the mechanists on the theoreticians. Tied to the university and communist institutions, they resented the prestige and perquisites of Academy of Science institutes. They felt slighted and ignored, and they had no qualms about using the tools of Stalinism – denunciation, public criticism, personal attack – to achieve what they could not through normal scientific channels.

Stalinism and Physics

Of course, quantum mechanics and relativity theory did not threaten the new socialist state. But in the early 1930s, a period of forced collectivization of agriculture and rapid industrialization, of cultural revolution and the first rumblings of the Purges, the seemingly abstruse epistemological debates acquired great significance. Educational institutions came increasingly under the control of more militant communists. New entrance rules permitted workers and peasants to matriculate in greater numbers than ever before. In research institutes, where "bourgeois specialists" predominated, scientists felt the pressure of growing ideological scrutiny.

At first, it seemed that the philosophical controversies would not envelop Hessen and other scientists. At the Second Congress of Marxist Scientific Research Institutes in 1929 the Deborinites succeeded in passing a resolution that officially repudiated the Mechanists' philosophical position. The publication of an article in *Pravda* on January 26, l930, however, signaled a sudden end to the Dialecticians brief hegemony in the philosophical sphere, and triggered an assault on scientists who were seen as representatives of idealist philosophy. The Communist Academy stood at the forefront of the effort to bring about the penetration of "correct," that is, party-endorsed dialectical materialist philosophy into physics, chemistry and biology. Ideologues, philosophers and their scientific allies decided the Deborinites and theoretical physicists were enemies of Marxist philosophy. They accused them of "menshevizing idealism" and failure to acknowledge the role of class struggle in physics. They believed that idealism of any sort in science would lead directly to a weakening of the power of the proletariat, perhaps because capitalist countries hostile to socialist power surrounded the USSR. This approved version resembled mechanism in some aspects and had little appreciation for the new physics.[36]

Hessen himself ultimately fell into the sights of Stalinist philosophical gatekeepers as a "meshevizing idealist" in 1931. Hessen engaged in what became in the Soviet confessional an obligatory "self-criticism" to defend himself – and the new physics – from further attacks. Hessen admitted that he had not paid enough attention recently to economic issues, that his work had lost touch with the problems set forth by the party, and that in this way he had adopted a mistaken attitude toward relativity theory.

But later that year in London, he delivered his defense of the new physics in the Aesopian language of the explanation of the social and economic roots of Newton's *Principia*.[37] Behind Hessen's contention that the value of Newton's physics was not diminished by the fact that he believed in God and was a product of the bourgeoisie was Hessen's unspoken argument that although Einstein was a Jew, allegedly a follower of an empiricist, subjective idealist philosophy akin to that of Ernst Mach, and a product of bourgeois society, all this did not require rejection of relativity theory, a valid scientific concept. In spite of the best efforts of Hessen, and of dozens more physicists, some more competent than he, the entire physics enterprise fell under suspicion of idealist philosophy, and would remain a philosophical battleground until after Stalin's death in 1953.

Already at the end of 1928 Hessen had begun to face attack from his colleagues, even among fellow thinkers, at a general meeting of the Society of Militant Materialist--Dialecticians for "bourgeois eclecticism and philistinism." Egorshin, a former Deborinite ally, began the attack on idealism in physics. He maintained that this idealism had four manifestations: 1) the mathematicization of physics – the overuse of the tools of mathematics outside of available empirical evidence – which resulted in the substitution of formulae for "concrete reality"; 2) the destruction of Newtonian concepts of space and time and their replacement by philosophically relativist ones; 3) the elimination of causal notions and their replacement by indeterminacy in quantum mechanical notions of uncertainty; and 4) such external factors as the crisis of capitalism abroad and the presence of a class enemy at home, all of which led directly to mysticism and idealism. Egorshin

attacked Hessen and Frenkel for subjective idealism, relativism, and "muddle [*putanitsa*]," the latter a charge that carried some weight for it was one of Lenin's favorite philosophical criticisms.[38]

The philosopher Aleksandr Aleksandrovich Maksimov had been a long-time party member in the 1930s when he turned against his former dialectician colleagues like Hessen at the university and such Academy physicists as Ioffe, Vavilov, Frenkel and Tamm. He grew more and more Stalinist throughout his career, seeing the slightest manifestation of idealism as deviationist, defending the Party's prerogative to establish epistemological standards, and rejecting open discussion as dangerous for the proletariat.

Maksimov (1891 - 1976), of peasant origins but with university education, entered the Bolshevik Party in 1918, and spent the next two years fighting the Whites in the Civil War. Eventually he was evacuated to Moscow and demobilized in October 1920 to enter a career of public education. He worked as a deputy director in a workers' faculty, then in Moscow University as scientist and teacher, then in Sverdlov Communist University. During this time he gained interest in philosophy of science, and sought a middle ground between the Dialecticians and Mechanists. He recognized that political and scientific revolution gave great importance to questions of philosophical worldview.[39]

Maksimov was an active organizer and writer. With the assistance of other like-minded and aspiring philosophers of science, Maksimov founded the Institute of Red Professoriat in 192l. The professors established a department of natural sciences in 1922 with Maksimov as its chairman. Several scientists in the Physics Institute of Moscow University gravitated to the department, including Hessen. Maksimov published articles on science and dialectical materialism in the journals *Revoliutsiia i kultura* [Revolution and Culture], *Pod znamenem marksizma* [Under the Banner of Marxism], *Nauchnoe slovo* [The Scientific Word], and *Molodaia gvardiia* [Young Guard].

Maksimov returned to the USSR after a sabbatical in Berlin in 1929 ready to lead the Red Professoriat's division of natural sciences through the years of cultural revolution. From his two positions, one at the university and the other at the institute, Maksimov lectured at various scientific research institutions where scientists had begun to study *diamat*, pushing a version that came to be the standard of the Stalin era. In 1934 most institutes of the Communist Academy of Sciences and Institute of Red Professoriat were subsumed within the Academy of Science's new Institute of Philosophy. The Academy itself had fallen under communist control in 1929.[40] From the Institute of Philosophy, Maksimov and other specialists sought to direct the development of the philosophy of science, becoming increasingly hostile to the new physics. Maksimov now showed his true colors as a toady to the Stalinists. He hurled the insult "enemy of the people," a dangerous epithet that, when it stuck, meant the arrest of the individual so identified, without a thought for their well-being. Many of his attacks were directed at his colleague of a dozen years, Boris Hessen.[41]

Ernst Kolman joined Maksimov in the assault. Kolman was a faithful critic of Hessen and of alleged idealism in modern science. His criticisms were more telling than those of Egorshin or Maksimov since he displayed more complete comprehension of theoretical physics. Kolman criticized the indeterminacy of Heisenberg; found fault with many of the philosophical views of Einstein; and rejected the "idealist" understandings of probability in the wave mechanics of De Broglie and Schrödinger. Kolman did not

believe that quantum mechanics should be rejected out of hand, but that any of its idealistic epistemological conclusions about the relationship between subject and object – that grew out of influence of the subject on the object through the process of measurement – should be rejected. Regarding relativity, he wrote, "The rational nucleus of relativity theory was sufficiently grounded and verified by practice," although some of its adherents had jumped to idealist conclusions when they attempted to create multi-dimensional space with mathematics.[42] Such physicists as Vladimir Fock and Dmitrii Blokhintsev joined Kolman in stressing the importance of using dialectical materialism in the development of quantum mechanics.

More than anyone else, Timiriazev criticized Hessen. This made Moscow State University, where both of them worked, the stage upon which Hessen's fate played out. Not surprisingly, the physics department at the university experienced cultural revolution much more keenly than laboratories in Academy physics institutes. One reason for this was the fact that universities had opened their doors to a more radical student body including demobilized soldiers and workers who gained admission by virtue of their class, not necessarily scores on entrance examinations. As cultural revolution unfolded, the classes of students admitted to graduate work were largely of the right background. For example, nine of ten graduate students admitted to the university in 1930 were party members or candidates for membership in the Party.[43]

Another reason that Moscow University experienced cultural revolution more intensely was that it was the site of an unlikely conglomeration of persons who came to detest Russia's leading theoreticians. Not only Timiriazev, but Dmitrii Ivanenko, a stellar physicist with several fundamental discoveries to his credit, used his position at the university to vent his growing frustration over what he perceived as the neglect of his Academy of Science colleagues, and enlisted many of his students in this endeavor.[44]

Initially, Hessen deflected criticism, continued to write in the philosophy of science, and filled his position as dean of the physics institute ably. Then, at a special session at the Communist Academy in June 1934, which commemorated the twenty-fifth anniversary of the publication of *Materialism i Empirio-criticism*, Stalinist philosophers "exposed" idealism in physics, and subjected its western representatives in Heisenberg, Schrödinger, Bohr and Born, and alleged Soviet leaders – Hessen, Ioffe, Frenkel, and Tamm – to stern rebuke. Hessen, Vavilov, and Ioffe participated in the proceedings, and argued that contemporary physics, far from being idealist, confirmed the presence of dialectical laws in nature.[45]

Hessen appears to have been the only philosopher-Marxist in attendance at this session who defended physics from charges of idealism. Hessen, building upon his introduction to Haas' text on quantum mechanics, spoke about "The Problem of Causality and Laws in Classical and Contemporary Physics." Hessen discussed changes in the concepts of physics, and called for modification, if not rejection of "old causality" through a materialist evaluation of the relation between statistical and dynamical laws. Yet all other philosophers tarred contemporary theoretical physics with the brush of Stalinist epithets: they attacked "bourgeois physicists" and their Soviet sympathizers; (philosophical) relativism; mathematical formalism; subjectivism and other "-isms". Kolman welcomed Ioffe's criticism of the Mechanists, "who stand in the way of progress

and see idealism in relativity and quantum theory and everything not in agreement with Maxwell and Faraday." Yet he too singled out a number of Leningrad physicists and Hessen for sharp commentary.[46]

Over the next three years, the Soviet Union was a nation under siege at home and abroad. The rise of fascism in Germany coincided with Stalin's insistence that the USSR could build "socialism in one country." There would be no world revolution, and the country would have to become an armed fortress to protect its borders. At home, the increasingly xenophobic leadership saw dangers everywhere – among peasants, among loyal party members, among those with foreign professional contacts or relatives abroad. Millions of persons perished in the labor camps ("gulag") or were executed outright. No profession, vocation, or walk of life was immune. Perhaps ten percent of all physicists were arrested, although theoreticians suffered inordinately. Those who died or "disappeared" include Matvei Bronshtein, Viktor Frederiks, Viktor Bursian, and dozens of others; in all perhaps ten percent of all physicists.[47]

Hessen, too, became an "enemy of the people." The charges included the fact that he had not addressed the concrete political questions of the time in an article on the ergodic theorem; had not demonstrated the tie between theory and practice; was inclined to follow uncritically the lead of bourgeois scholars, especially regarding a series of articles by the statistician Richard von Mises; and in his work on relativity substituted a synthesis of space and time for matter. He had, Maksimov asserted, made one of the leading Soviet physics journals, *Uspekhi fizicheskikh nauk* (hereafter *UFN*), founded in 1918, an idealist publication. Timiriazev later asked rhetorically, "Isn't it well known that from 1930-1936 the enemy of the people Boris Hessen ran the Physics Institute of Moscow University? And that on the editorial board of a journal which consisted of five people, two, Hessen and Apirin, were enemies of the people?"[48] Hessen was removed from editorship of *Uspekhi* in 1936, shortly later disappeared, and executed months later. Many libraries excised Hessen's articles from journals; in 1947 the editors of *UFN* published an index of the first thirty volumes of the journal, excluding Hessen from mention. What was the nature of Hessen's works? Were his views idealist? The following brief examination of his major works indicates that Hessen may have been a middling physicist, but he was sincere in his efforts to reconcile *diamat* and the new physics, and these efforts surely did not merit arrest and execution.

Boris Hessen, Relativity Theory and Quantum Mechanics

Boris Hessen studied the philosophy of physics. According to an autobiographical statement in the archives of the Communist Academy, Hessen spent the 1913-14 academic year at Edinburgh University studying mathematics, at the same time as Igor Tamm matriculated there. (He and Tamm were friend's from childhood, entered gymnasium together, and continued to meet often until the end of 1922, when they both met up in Moscow. Indeed they worked at the physics institute of the university from 1928 until Hessen's arrest in 1936.[49]) When Hessen return from England, he studied statistics in the economics department of Petrograd Polytechnical Institute, simultaneously auditing courses in calculus at the university; as a Jew he was not admitted as a regular student. Until October 1917, Hessen was secretary of an organization of internationalists in Elisavetgrad, a position that, no doubt, opened him to attack as a Trotskyite in the

1930s. After the Bolshevik coup in 1917, Hessen became secretary of the Soviet of Workers' and Peasants' Deputies.[50]

Hessen continued his involvement in education in the first years of the revolution. In 1919-1921 he was an instructor in politics, and from 1921 through 1924 an instructor in political economy at the Communist University. At this time Hessen entered the Institute of Red Professoriat for further training in mathematics and physics. He seems to have studied closely with another leading scientist, Leonid Mandelshtam, who discovered the combinatorial scattering of light, and Tamm. Hessen published regularly in such journals as *Estestvoznanie i marksizma* [*The Natural Sciences and Marxism*], *Pod Znamenem Marksizma* (*Under the Banner of Marxism*) *UFN*, and *Molodaia gvardiia*. He later headed the physics section of the Communist Academy. Hessen proselytized physics among the working class, for example, in agitational efforts among workers at the Dinamo, Elektrozavod, and Moselektrik factories. He also lectured frequently at the Institute of Philosophy and the Institute of History of Science and Technology, which he helped Nikolai Bukharin, the last Old Bolshevik opponent of Stalin who was murdered in 1938 after a show trial, to establish. Hessen worked tirelessly to reconcile every aspect of physics, from the mechanistic worldview of classical physics to relativity theory and quantum theory, and from contemporary theories on matter and energy to the nature of space and time with a *diamat* perspective.[51]

At the Institute of Red Professoriat, Hessen supervised a series of studies on Heisenberg, indeterminacy and causality, produced a textbook for working class physics students, and wrote and edited dozens upon dozens of articles, many of which languished on his desktop never to be published. Hessen and his associates lectured at factories in Kharkov, Dnepropetrovsk, and Leningrad, where there were large audiences of workers accessible to them. He was actively involved in choosing authors to write physics entries for the *Great Soviet Encyclopedia*, the Soviet *Britannica* that was intended to provide a complete proletarian perspective on gathered knowledge, getting Tamm and Mandelshtam, Blokhintsev and Khaikin involved in the effort. With Mosei Markov, then a promising graduate student, Hessen served on a commission to examine methodological questions. Markov, a world class theoretician, himself became embroiled in the controversy over theoretical physics in 1947 with an article that defended the discipline in *Voprosy filosofii*, but survived to rise to the top of the Soviet physics establishment.[52]

These pedagogical, editorial, research, and administrative activities demonstrate Hessen's devotion to the Soviet state. His destruction indicates its arbitrary behavior. It shocked mainstream physicists. Hessen was widely respected among non-Marxists, and knew physics adequately well. But this did not save him. According to a physicist I met, in August or early September of 1937 [could he have meant 1936?], hundreds of physicists from FIAN and the Moscow University physics department filled the great hall of FIAN at 6:00 p. m. to hear invective heaped "upon the poor head of Boris Mikhailovich [Hessen]." From the terms used to describe him, "enemy of the people" and "wrecker," it was clear that his arrest had already occurred. The assembled physicists were only being asked to endorse his elimination. Communist party officials ran the meeting, spreading all kinds of vicious nonsense about Hessen. They claimed he was uncultured, drank vodka with workers into the wee hours, and worse, that he had sabotaged the physics

department's academic plan. Only his closest and most courageous friends, like Grigory Landsberg, refused to add anything to the charges. The meeting ended after midnight.[53]

What were Hessen's major works? Hessen's most complete treatment of relativity, *Osnovnye idei teorii otnositel'nosti* (1928) was intended for a reader with limited mathematical training and rudimentary knowledge of physics. Its structure and content appear to be based largely on Eddington's *Space, Time and Gravitation* (1921). Hessen's reliance on a British scholar perceived by Maksimov and others to be an idealist, the relatively small space he devoted to dialectical materialism, and Hessen's failure to deal decisively with the incessant criticism of such opponents as Timiriazev hurt Hessen. However, his discussion of Newtonian absolute and relativistic space and time, simultaneity, the so-called aether, and physical versus philosophical relativism placed the work firmly within the *diamat* tradition.

Hessen's main argument centered on a demonstration that the epistemological propositions implicit in special and general relativity were compatible with dialectical materialism. These propositions were based on the recognition of four objective properties of the external world: the synthesis and unity of space and time; matter in motion; rejection of absolute, empty, motionless space as the universal frame of reference; and relative motion of matter with respect to matter. Hessen pointed out that the new physics modified the concepts of absolute space and time that had taken on metaphysical eminence in classical physics.[54]

Hessen's treatise on relativity theory begins with a discussion of Galilean relativity, and then turns to the Fitzgerald-Lorentz contraction as a possible way out of the negative result of the Michelson-Morley experiment. But it is a discussion of Newtonian absolute space and time that serves as the real focus of the first third of the book. Hessen criticized Newtonian absolute space and time for having taken on an independent objective reality. This was a metaphysical position, an abstraction, since space and time were inseparable from matter. Hessen wrote:

> ...space and time exist not outside of matter, but in matter, matter is their true reality, their objective synthesis. Neither time in general nor space in general, but concrete space and concrete time, that is, matter in motion, possess objective reality.[55]

Relative space and time, on the other hand, were affirmed by dialectical materialism. All motion was matter in motion with respect to matter, not absolute space. Similarly, there was no absolute time, but processes by which we can compare the course of one process with another.[56]

While rejecting Newtonian absolute space and time as a metaphysical objectivization of an abstract reality, Hessen nonetheless introduced an "aether" with rather striking properties to serve as a universal frame of reference. Because electromagnetic phenomena are dispersed over time Hessen concluded that there must be a medium to carry them. "'Empty space,'" he wrote, "means space that is filled with ether. We do not know any matter more elementary than the ether."[57] To reject the aether would have been pure phenomenalism or idealism, for "to speak about waves and oscillations which occur without a material carrier [in a vacuum], means to speak about

motion without matter. Motion without that which moves is an empty abstraction of motion, like empty space. Real motion is always connected with matter."[58]

How did Hessen's aether differ from that of the mechanistic physicists? Hessen believed that the aether of relativity did not consist of particles or have molecular structure, and therefore the mechanistic conception of motion – "mechanical change of place" – had no meaning. Furthermore, it was impossible to observe the motion of a body with respect to the relativistic aether.[59] Hessen concluded:

> To take empty space, devoid of any kind of physical properties means to objectivize mathematical abstract Newtonian space. This abstraction has no analogy in the external world. Real space that exists not in our heads, but outside of us and independent of us is realized only in matter. The ether of theory of relativity theory is basic matter that realizes space.[60]

While Hessen's work demonstrates a fairly complete mastery of some of the implications of relativity, he failed to see that its acceptance should have led to the rejection of the aether. Acknowledging that the question of the properties of the aether remained open, however, Hessen argued that the resolution of this issue was a matter for physicists and not philosophers to decide: "It would be improper and undialectical to demand mechanical explanations beforehand."[61]

Another major focus of *Osnovnye idei* concerned the epistemological issues surrounding the relationship between subject and object. Maksimov, Timiriazev, and their followers interpreted relativity to mean that all knowledge was relative and dependent upon the condition of the subject[62]; this would violate one of the primary postulates of materialism. Einstein's theory did assert relativity of measurement concerning both the system in question and the condition of the observer (but not the relativism of knowledge). Was it impossible therefore to arrive at a true and complete cognition of nature? Or was all knowledge relative? Hessen's analysis was intended to provide a way out of this difficulty. He agreed that while perception depends on the condition of subject and object, the form of existence of the object in no way depended upon the subject, and no kind of subject is necessary for the existence of the object.[63] Dialectical materialism offered a way out of subjective idealism through the mutual interaction of the subject and object. While there was a moment of relativity and subjectivism in cognition,

> the subject and the object acquire true reality, vital reality only in the process of mutual interaction. The object does not stand in opposition to the subject as some kind of indifferent *thing-in-itself*. No, it is exposed to the subject through mutual interaction. It is cognizable, and this cognition is an eternal process of mutual interaction.[64]

Here, Hessen is apparently raising the thing-in-itself (*Ding an Sich*) to reaffirm that things exist independently of our consciousness, as Lenin spent a long time discussing in *Materialism and Empiriocritism*. As Hessen wrote, "Through this interaction we come to the objective through the subjective, through relative knowledge we approach absolute

knowledge."[65]

Like many other Marxist philosophers, Hessen seemed to argue that the history of cognition is not in the least relativist, but an asymptotic approach to the absolute truth. Hessen rejected the view that relativity theory implied the subjectivity of knowledge or led to philosophical relativism, but was a step toward this truth. Granted, cognition was dependent upon the individual observer.

> All knowledge of necessity includes a subjective element. The process of cognition is the process of the interaction between the subject and the object. In this interaction the object is revealed to the subject more and more fully. At each given degree knowledge is relative, but relative knowledge is a stage on the path to absolute knowledge. The process of cognition is a historical process.[66]

Of course, all knowledge is relative to a person's evidence. But Hessen was not interested in subtleties, assuming that dialectical materialism provided the way to the absolute truth through absolute knowledge. Hessen thus argued that the external world exists independently from the cognition of the subject, adopting a view of cognition as a historical process similar to that espoused by Georgii Plekhanov, the so-called father of Russian Marxism, and Bogdanov. Since Plekhanov and Bogdanov were out of favor, the latter because he served as Lenin's major foil in *Materialism and Empiriocriticism*, this again opened Hessen to critical comments, in spite of the fact that Hessen had attacked Bogdanov's theory of history.

Hessen concluded by defining philosophical and physical relativism. Philosophical relativism requires the subject for cognition, as a result of which cognition can never advance beyond his limits. Therefore, only relative knowledge was possible. Physical relativism, on the other hand,

> is recognition of the relativity of our concrete knowledge of nature. The essence of the theory relativity consists in the establishment of the absolute character of space and time intervals. Magnitudes of this or that sort essentially depend on the condition of the observer. If we stop at this assertion, and, rejecting the possibility of overcoming this relativity, base this assertion on arguments of philosophical relativism, then the theory of relativity is transformed into principle relativism. But that conclusion in no way is a necessary consequence of relativity theory. On the contrary, in the conception of a four-dimensional world, we see the attempt at overcoming the relativity of space and time measurements and the next step on the path to absolute cognition of the external world, of matter in motion.[67]

For Hessen, relativity theory had provided a way out of a series of problems generated by nineteenth and twentieth century physics. Relativity theory was neither metaphysical nor mystical, nor a philosophical system, nor a complete worldview as the Newtonian system had become, but a definite conception of space and time recognizing

the materiality of four dimensions.

Hessen's major dialectical materialist defense of quantum mechanics, written as the introduction to the translation of Arthur Haas's *Materiewellen i Quantummekanik*, covered many of the same issues as his treatise of relativity. S. I. Vavilov reviewed Haas's study, first published in Leipzig in 1928, and called for its translation.[68] P. S. Tartakovskii translated the book that was published in 1930 with an introductory essay by Hessen. Here Hessen addressed philosophical and physical issues raised by quantum mechanics, the development of statistical laws, the wave-particle duality of matter-energy, the uncertainty principle, and the inherent difficulty of accounting for the interaction of the subject and the object in sub-atomic processes, including measurement. In all cases, Hessen concluded that quantum mechanics and dialectical materialism were consonant.

Hessen suggested that the crisis in physics that dated to the turn of the century and required the transformation of concepts of mass, energy, and the classical notion of the indestructible and unchanging atom, had its roots in certain metaphysical positions first suggested by Newton. This required a reevaluation of the relationship between statistical and dynamic laws, and of epistemology in general. Only dialectical materialism introduced the concept of change and development into the micro-world, pointed to the proper understanding of the relationship between subject and object, and provided a way out of this crisis.

Quantum mechanics, Hessen argued, was a verification of the dialectical law of the unity of opposites in three major cases: the interrelation of continuous and discrete or discontinuous phenomena, the existence of matter-energy, and the synthesis of statistical and dynamic laws. These laws had been discussed at length by Engels in *The Dialectics of Nature*. In each case, Hessen stressed the need for synthesis, not the primacy of one over the other, through the principle of "mutual interaction." Having overriding interest in the mathematical aspects of quantum mechanics, Hessen devoted most of his attention in the essay to the role of statistical laws and probability in modern physics.

Hessen first explained how the classical notion of deterministic causality was based on metaphysical assumptions advanced by Newton and others. Since Newton's day, dynamics had been considered the fundamental and ideal type of physical law and an indication of true cognition, whereas a statistical law was considered knowledge of the second order. Dynamics was based on simple mechanical determinism when later conditions were determined by prior ones; this was a real possibility, Hessen asserted, only when the system being examined was completely isolated. Dynamics was "an abstraction, an idealization of real relationships."[69] But "in the same way that the process of the development of exact natural science led to the transformation of concepts of space and time [in relativity], so the study of the microcosm and interatomic processes led to the reexamination of the questions of the conception of causality."[70] The transition to the study of phenomena of the micro-world required a new approach: statistical laws with stochastic properties. The end of the classical notion of determinism did not require abandonment of causality, however, as Hessen showed through an analysis of the relationship between dynamic and statistical laws.

Statistical laws were in no way acausal. Elsewhere Hessen had provided analysis of the theory of probability as the foundation of statistical laws. "The theory of

probability," he wrote, "is the result of our partial ignorance. Therefore [it] is not complete knowledge, but only surrogate knowledge." Probability theory was thoroughly materialistic since its area of application was conditioned not by our ignorance, but by the objective properties of the object.[71]

Some had argued that causality could be expressed only in the form of a dynamical law; that the development of quantum mechanics was characterized by the predominance of the statistical over the dynamic law; and that this had left the individual phenomenon indeterminate.[72] Had causality been rejected? Did indeterminism reign in the microcosmic world? Hessen answered no to each question:

> The direction of motion of an individual quantum is random not in the sense that it is indeterminate, but in the sense that the behavior of one quantum is not essential for the entire aggregate of quanta, only as a whole which gives the statistical law. Of course, knowledge of this statistical law does not give the possibility to deduce from it the behavior of an individual quantum or the behavior of a coin in an individual toss. But this in no way is proof of acausality of a single phenomenon. The fact that the statistical law does not predict the behavior of individual phenomena that are a part of the agglomeration cannot be attributed to the inadequacy of the law and still less can serve as proof of acausality of an individual phenomenon.[73]

He concluded, "Thus, if we reject the fatalistic conception of determinism on the one hand and recognize randomness not only as a consequence of our ignorance but as an objective category, then the contradiction between dynamic and statistical laws is destroyed."[74]

Hessen concluded his analysis of the commensurability of quantum mechanics and Marxist philosophy of science by pointing out that in the same way as some physicists had incorrectly opposed causality to statistical laws, so a number had taken Heisenberg's principle of indeterminacy--the essence of which consisted in the fact that the position and impulse of elementary particles could not be known simultaneously with any exactitude--to require the abandonment of any causal relationships in modern physics. Indeterminacy was connected with the limitations placed on contemporary experimental physics in terms of measurement.[75]

This led Hessen to a brief discussion of epistemological issues raised by modern physics. As he had in *Osnovy idei teorii otnositel'nosti*, Hessen rejected the notion that modern physical conceptions were founded on idealist philosophical ones. It seemed too many philosophers and physicists that indeterminacy introduced a subjective element into cognition: in measurement or observation the subject influenced the behavior of the particles under study. Were physicists therefore limited by statistical expressions of some arbitrary final states? Had objects lost their objective reality? Relativity theory rejected Newtonian absolute space and time as having independent, real existence, and recognized reality and observability in the synthesis of relativistic space and time in matter.[76] In considering of all these issues, Hessen warned that physicists and not philosophers should decide whether a given physical magnitude is observable or not. It "should be solved in

correspondence with physical theory, not a priori."[77]

In his analysis of relativity theory and quantum mechanics Hessen had shown that philosophical issues raised by the new physics in no way contradicted Marxist epistemology. Both required a new understanding of the relationship between the subject and the object; both demanded the rejection of concepts which had been objectivized as absolute realities; and both raised the specter of relativism and idealism, but were saved from this specter by *diamat*. Relativity theory and quantum mechanics verified dialectical materialism, and in turn were verified by it.

Conclusions: Hessen's Legacy

At the end of the 1920s, as Hessen's work and that of other allegedly "idealist" physicists and philosophers, came under attack from Stalinist ideologues, seemingly harmless philosophical discussions became politicized by a siege mentality brought about by cultural revolution and the attack on "bourgeois" specialists, industrialization and collectivization. At the same time, debates over idealism in science and philosophy among the Mechanists and Deborinites entered the public sphere.

By 1934 it was clear that leading physicists felt compelled to unite to lessen the impact of ideological intrusions from philosophers. A. F. Ioffe assumed a leading role in this defense in a remarkable article, "The Situation on the Philosophical Front of Soviet Physics." Ioffe took issue first of all with the traditional rule of Bolshevik disputation, "He who is not with us is against us." "Is everyone who does not recognize the reality of magnetic force lines and who hopes to go beyond the limits of physics of the middle of the last century an idealist?" he asked.[78] In their anachronistic views and their fear of mathematics the Soviet anti-relativists were doing much more damage to physics than good. The danger lay in fact with these supposed defenders of materialism.

The anti-relativists, Ioffe asserted, were anti-Semitic and reactionary. They had sided with the German scientists Phillip Lenard, a Nobel laureate from 1905, and Johannes Stark, both of whom embraced Nazism and "Aryan physics, while seeing relativity theory as "non-Aryan." Why did they fight against the relativity of Einstein, Ioffe asked, "Who, in spite of his pacifist and Zionist leanings is undoubtedly anti-fascist and democratic"?[79] Regarding charges of idealism, Ioffe pointed out that such mainstream Soviet physicists as Fock, Frenkel, Tamm, Mandelshtam and Landau had produced theories of the solid state and metals, the photoeffect, and diamagnetism recognized worldwide, and they had contributed to the development of quantum mechanics. The Mechanists, on the other hand, had created only the fetishes of the aether, force-tubes and "electrical bagels (*bubliki*)."[80] A dismayed Ioffe concluded:

> I see clearly the objective harm of their activity. They strive to create at [Moscow University] a center for reactionary physics. They carry on intrigues in the best journal on which Soviet physicists are brought up -- *UFN*, striving to hide from Soviet youth the progressive ideas of the leading scholars, thus preserving their authority.[81]

In his defense of the autonomy of physicists, Ioffe defined the rightful province of

physicists' activity and independence. He suggested that Soviet physicists would tolerate little more interference without battle. He suggested that there were boundaries of expertise beyond which philosophers should not tread without having first familiarized themselves with theoretical physics. In part because of these efforts, the discipline was shielded from the kind of ideological and personal onslaught that devastated biology under Lysenko in the late 1940s.

Physicists were not always successful in interceding on the behalf of their colleagues, a number of whom would perish during the Great Terror. This was because more fundamental questions had been resolved by the mid-1930s beyond the epistemological and ontological questions which physicists and ideologues debated. Primary among these was the decision that the Party philosophers gained the authority to intervene in those debates in the first place. Ioffe, Hessen and others tried to limit the damage, the former by fixing boundaries of expertise, and the latter by showing how dialectical materialism and the exact sciences were indeed commensurate. By the mid-1930s, however, the Party had decided that it would control the research agenda through planning and central administration; it would determine the extent of Soviet physicists' contact with western scholars and ideas; and it would inform physicists where idealism lurked in the discipline, both at home and abroad.

At a specially organized session of the Academy of Sciences in 1936, Ioffe himself encountered criticism of his leadership, his scientific style, and his philosophical positions. This was a sign that no scholar would be safe from the party's wrath.[82] Hessen, Bronshtein and many others were arrested, repressed, and shot. Soviet astronomers were purged en masse.[83] Future Nobel-laureate Lev Landau sat in prison for a year after his arrest in 1938. Were it not for the courageous efforts of Peter (Petr) Kapitsa, himself a Nobel laureate, Landau would likely have died. (Kapitsa wrote scores of letters to the authorities, including Stalin himself, about his own mistreatment. In summer 1934 during his annual summer trip home to Russia, the authorities refused to permit Kapitsa to return to England, although they permitted his Russian wife, Anna to leave the country, with the two children. Kapitsa's letters, written at risk to himself, saved Fock and Landau, who had been arrested during the Great Terror.[84] Ioffe, Vavilov, and Tamm many others, too, may have perished, and theoretical physics would have suffered even more. But the result was that physicists lost the fundamental right common to the discipline in other countries to resolve philosophical questions. Now administrative fiat and Party ideological resolutions frequently resolved these issues.

Only after Stalin's death in March 1953 were physicists able to reassert their control over philosophical issues. They had tired of ideological intrusions that threatened the very core of the scientific enterprise. Igor Tamm wasted little time in getting the ball rolling. He wrote Vladimir Fock in December 1954 to alert him to the fact that the Academy of Sciences would soon organize a commission on theoretical physics to set matters straight. The commission would convene a conference to decide basic issues of the direction of research throughout the country including at the universities, set standards for publication, organize critical discussion on the most significant works, and supervise the training of scientists.[85]

The physicists used the occasion of the fiftieth anniversary of the publication of the special theory of relativity to gather within the Academy's walls on November 30,

1955, to celebrate their methodological autonomy. Tamm, Landau, future Nobel laureate Vitali Ginzburg, Fock, and others spoke glowingly about the philosophical implications of Einstein's work. Ginzburg used the approaching International Geophysical Year to call for a satellite to be launched for experimental verification of the general theory of relativity.[86] Scientific, popular scientific, and the popular press including literary journals were filled with articles praising the achievements of contemporary science, including Einstein and Bohr who had been so roundly condemned months earlier. Soon popular Soviet biographies of these great western figures appeared. It helped a great deal that scientists had gained great authority and prestige as saviors in World War II, as creators of nuclear weapons, and as soon-to-be-launchers of Sputniks. Their institutes had grown healthy with stable funding in spite of the worst excesses of the Stalinist upheaval. They now sought greater autonomy in establishing the research agenda, lessening the control of economic organizations over the direction of their institutes, and opening contacts with their western colleagues.

At this time, Tamm sought Hessen's posthumous rehabilitation from the Ministry of Justice. He wrote the ministry that Hessen was "always a convinced advocate of the general Party line and opponent of all oppositions." He insisted that Hessen was "not only not guilty of any sort of crime," but that his life and work were "a model of the life of a true communist." Only with the formal rehabilitation did the authorities acknowledge finally that he had been arrested and shot in 1936.[87]

Another crucial event was a conference on the philosophy of science. In 1957, leading Academy scientists proposed to convene a conference to establish the proper relationship between science and philosophy. They had in mind criticism of the Stalinist philosophical legacy. The Central Committee of the Communist Party endorsed the notion. The conference was held in October 1958 in Moscow. Here leading scientists from around the nation set the philosophical house in order with a series of papers arguing that they, and not Stalinist ideologues or policy-makers, should resolve issues in the philosophy of science. Only biology remained beyond the pale until 1965.

After the 1958 Moscow conference, philosophical seminars served as a forum for much more far-ranging discussion of epistemology and science, and occasionally domestic politics and foreign relations than in the Stalin years. Scientists began to pay lip service to the pronouncements of Marxism-Leninism. Their discussions reflected recognition of a new world order, one where peaceful competition between socialism and capitalism, not the inevitability of war predominated. Soviet scientists were now expected to compete with western scientists in all fields, but hopefully to win scientific preeminence. But major aspects of Stalinist science policy – central planning and bureaucratic inflexibility, autarky, and insidious ideological controls – remained in place to a significant degree, indeed would remain in place until the Gorbachev years. And during the Gorbachev era, Soviet scientists began to investigate openly the significance of Boris Hessen's philosophical legacy.[88]

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[1] Throughout this essay I use essentially the US Library of Congress system of transliteration.

[2] Graham, L. "The Socio-political Roots of Boris Hessen: Soviet Marxism and the History of

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[3] Both Krementsov, N. in *Stalinist Science* (Princeton: Princeton University Press, 1997) and Pollack E., in *Stalin and the Soviet Science Wars* (Princeton: Princeton University Press, 2008) address the methods and ways of communication of scientists and "rules of the game" in the Soviet system.

[4.] For a succinct discussion of *diamat*, see Graham, L., *Science, Philosophy and Human Behavior in the Soviet Union* (New York: Columbia University Press, 1987), 24-67. On these dialectical laws, see Engels, F., *The Dialectics of Nature*, (New York, 1940), 26-34, and 152-164.

[5] David-Fox, M., *Revolution of the Mind* (Ithaca: Cornell University Press, 1997).

[6] Even in such a "Marxist" stronghold as the Institute of Red Professoriat, there was a large Jewish contingent. In the late 1920s eleven of the twenty-four science students were Jewish – and few workers; twenty-two were white collar. See Arkhiv Akademiia Nauk SSSR (hereafter A AN), f. 364, op. 4, ed. khr. 28, l. 127.

[7] For one discussion of the importance of the workers' departments (*rabfaky*) in socialism, see Igumnova, Z. "A Contribution to the History of the M. N. Pokrovskii Rabfak," *Soviet Studies in History*9/4 (1971): page numbers.

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[15.] A AN, f. 351, op. 1, ed. khr. 82, ll. 1-6, 23-26, and ed. khr. 161, ll. 1-2; and "Otchet o rabote kursov fiziki," *Estestvoznanie i marksizm*4 (1929): 211-13.

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[17.] Frenkel', Ia., *Teoriia otnositel'nosti* (Petrograd, 1923).

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