mention the Soviet–German geneticist Nikolai Timofeev-Resovsky; all these men worked in the USSR after their deportation from Germany following the end of the Second World War. The subject of the nuclear disaster of 1957–58 in the Urals is still off limits. Beria is never mentioned. And although Andrei Sakharov was rehabilitated by Gorbachev more than two years ago, Sakharov is also conspicuously absent from the book.

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Science, Philosophy, and Human Behavior in the Soviet Union

Loren R. Graham
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There has been a resurgence of discussions concerning the relationship between science and philosophy. Experimental confirmations of quantum mechanics have in recent years forced philosophers to rethink their positions on realism and instrumentalism. More specifically, John S. Bell's famous theorem and subsequent experiments have seriously undermined David Bohm's hidden-variable models in quantum mechanics, which provided some hope for the realist view of our world. The influence of scientific theories and experiments on philosophy is unquestionable. The influence of philosophical, ethical, religious and even political theories or beliefs on the creation—and justification—of theories is more controversial. That such influences have occurred has been documented by historians and sociologists of science.

Science, Philosophy, and Human Behavior in the Soviet Union is Loren Graham's unique and impressive study of how the philosophy of dialectical materialism influenced the development of Soviet science in the cases of both theory creation and theory justification, as well of science's influence on dialectical materialism. The strength, and paradoxically also the weakness, of Graham's study is that he tries to show for every major scientific discipline how dialectical materialism usually pushed science into interesting new directions. The weakness lies in the fact that Graham's examples are, by the very nature of his project, usually sketchy. It is difficult to provide a comprehensive account when one tries to cover in 12 chapters practical-

ly all of the main branches of science in the Soviet Union.

The major potential counterexample to the thesis that philosophy, in this case dialectical materialism, had a positive effect on scientific creativity is Trofim Lysenko's banning of Mendelian genetics. For this reason Graham is particularly aggressive in his discussion of Lysenko. He correctly points out, however, that it was not dialectical materialism but its perversion by Lysenko for purposes of personal advancement that was responsible for the tragic ban. He even finds kind things to say about Lysenko as a practical agronomist. For example, concerning Lysenko's tenure as "boss" of a particular collective farm, Graham writes, "This extraordinary position, compiled with Lysenko's undisputed talents as a practical agronomist, resulted in his farm being among the severally outstanding ones of the region in terms of farm production." (It would have been interesting if in this chapter the author had discussed the role, if any, that Lysenko may have played in the Stalin-engineered famine in which about 7 million peasants died on Soviet Ukrainian territory in 1933.)

I know of no better introduction to the principles of dialectical materialism and how they evolved than the second chapter of Graham's book. Graham traces the formulations of materialism from Marx and Engels to Georgi V. Plekhanov, who coined the term "dialectical materialism," and finally to Lenin, the most influential of the group. Lenin not only subscribed to the view that "all that exists is material," but also claimed that, in his words, "to be a materialist is to acknowledge objective truth, which is revealed to us by our sense organs." In the West this last statement is usually taken to be a definition of one kind of realism and not materialism. Many Western philosophers as a result accuse Lenin of confusing the two. Graham, consistent with his sympathetic treatment, claims that Lenin must have been aware of the difference at least by the time he wrote his *Philosophical Notebooks*, which were published posthumously. I do not think that this modification gets Lenin off the hook with respect to his more influential *Materialism and Empirio-Criticism* (1905).

Discussing the implications of the concept of matter in the chapter on quantum mechanics, Graham says, "Lenin's assertion that a dialectical materialist must recognise the existence of matter separate and independent from mind, while not inherently contradictory to quantum mechanics, could be regarded as at least uncongenial to the Copenhagen school's disinclination to comment upon matter in the absence of sensible measurement." I would think that in view of recent experimental results that strongly confirm quantum mechanics, one could use a stronger word than "uncongenial." It is also worth mentioning that a new interpretation of the nature of matter was put forth by Bonifatti M. Kedrow, head of the history of science section of the Soviet Academy of Science, at the 5th International Congress of Logic, Methodology and Philosophy of Science in London, Ontario, in 1975. There, in a symposium on the nature of matter, Kedrow did not give a philosophical definition of matter but proceeded to highlight the results of each of the sciences. His message was that for a specification of the nature of matter and materialism one has to go to science and not to philosophy: Dialectical materialism does not precede science, but follows it. If one takes this view of matter it is hard to see any possibility of conflict ever arising between science and materialism.

In the chapter on quantum mechanics Graham discusses in some detail the views of three physicist-philosophers: Vladimir Fock, Dimitri Blokhintsev and Mykhailo Omel'ianovskii. In his *V. I. Lenin and Twentieth-Century Physics* Omel'ianovskii, the leading interpreter of quantum mechanics in the 1950s, claimed that the correct interpretation of quantum mechanics began with a recognition of microparticles, not with problems of cognition. "And so," he said, "we have come to the conclusion that Heisenberg's uncertainty principle, like Bohr's principle of complementarity, is a generalized expression of the facts of the dual (corpuscular and undulatory) nature of microscopic objects"—not, as some would say, a limitation on our knowledge, but a direct result of the nature of micro-objects. From the 1950s to the 1970s he became a dominant positive force and left a lasting imprint on studies in the history and philosophy of science, first in his native Ukraine and then for more than 20 years in Moscow.

Besides the concept of matter, the other constraining elements of dialectical materialism are the laws of dialectics. By dialectics, says Graham, Engels meant the laws of all motion in nature, history and thought. Engels called them the Law of the Transformation of Quantity into Quality, the Law of the Mutual Penetration of Opposites, and the Law of the Negation of the Negation. The most important constraining element in

science for a Marxist scientist, according to Graham, is the first law: that quantitative increases of some element result at certain points in qualitative new properties. Add heat to water and the result is a qualitatively new phenomenon—steam. Mind is not matter in motion, but an entity that contains new properties that emerge at higher orders of complexity of matter than can be found at the atomic level. Graham correctly points out that a dialectical materialist must be antireductionist. He should be committed to the view that psychology is not reducible to biology, nor biology to chemistry, physics or a combination of the two.

I hope that my brief summary will not leave the reader with the impression that Graham's book is weak on details. For a historian Graham exhibits an impressive knowledge of science, philosophy and sovietology. But in spite of his mass of interesting data, the evidence for the thesis that dialectical materialism influenced the direction of Soviet research in science remains inconclusive. I hope Graham's groundbreaking study will encourage future historians and philosophers of science to provide more detailed studies of individual scientists who were committed to the philosophy of dialectical materialism.

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Kinetics of Nonequilibrium Low-Temperature Plasmas

L. M. Biberman, V. S. Vorob'ev and I. T. Yakubov
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Plasmas are central to a number of existing and developing technologies. Although much has been written on high-temperature fully ionized plasmas, which are relevant to fusion research, comparatively little is available on low-temperature plasmas. *Kinetics of Nonequilibrium Low-Temperature Plasmas* ameliorates this deficiency by providing extensive consideration of the fundamental collisional and radiative processes that underlie the plasmas used for such applications as lasers, plasma chemistry, and plasma deposition and etching of thin films. These applications make use of the special properties of low-temperature nonequilibrium plasmas, such as the capability of producing population inversions of atomic and ionic states or of enhanc-