minating paragraphs on topics such as the historiography of the Scientific Revolution—it won't be a very direct help to the teacher or student seeking a guide to the attached bibliography or wanting to bone up on topics such as the development of evolutionism.

Yet sometimes the couplet of essay and bibliography does succeed, providing an illuminating discussion of the state of the art that also keys into the bibliography. This tends to work best in the more philosophical essays, where the issues are clearly polarized and pro's and con's can be argued. Michalos's piece on the philosophy of science recovers from a cardboard historical account to give a workmanlike and instructive discussion of front-line issues such as induction, the validity of empiricism, falsification, and the nature of scientific "law" (even if his angle is conventional enough to skimp radical attacks on traditional philosophy of science such as that of the anarcho-subjectivist Paul Feyerabend, whose books are astonishingly not listed).

Diana Crane's essay on science policy studies benefits from tight organization and useful subdivisions, and Jerry Gaston's on sociology of science and technology is a similarly readable and useful piece because Gaston has had the courage to simplify the range of his subject into two main traditions, the Mertonian and the Kuhnian, each, as he sees it, valuable in its own right (Kuhn's model showing how the content of science changes, Merton's indicating the social operation of science). Gaston's essay is also refreshing precisely because he boldly evaluates the worth of various contributions to the literature.

The most successful, however, in my view, is Carl Mitcham's piece on the philosophy of technology. Sensibly limiting himself to a few main issues (for example the epistemological status of technology and its responsibilities to civilization), Mitcham gives lucid and extended accounts of little-known trends in the field (such as Eastern European theories about connections between relations of production—the class structures behind manufacturing—and technologies), as well as focused perspectives on familiar figures such as Lewis Mumford and Herbert Marcuse.

It is a mark both of the coming of age of these academic disciplines and of Balkanizing specialization within them that handbooks of reference and bibliography have recently become so vital. Some—such as the *Dictionary of Scientific Biography* (16 volumes) and the *Isis Cumulative Bibliography* (four volumes to date)—though exhaustive and splendid are, alas, too dear or just too bulky to be the handy volume lying within hand's reach on the desk. Though less readily usable than it might have been, this *Guide* will rightly find its place there.

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Physics and Its Milieu

Selected Papers of Léon Rosenfeld. ROBERT S. COHEN and JOHN J. STACHEL, Eds. Reidel, Boston, 1979 (distributor, Kluwer Boston, Hingham, Mass.). Cloth, $74; paper, $28.50. Synthese Library, vol. 100. Boston Studies in the Philosophy of Science, vol. 21.

Léon Rosenfeld was one of Bohr's closest associates, and perhaps the most lucid interpreter of the "Kopenhagenischer Geist." He was an eminent theoretical physicist—he made important contributions to quantum field theory, nuclear physics, thermodynamics, and statistical mechanics—who throughout his life had a deep and continuing interest in the history and philosophy of science. (Among his first published papers in 1927–28 are two on Newton's theory of colors and several dealing with the philosophical foundations of mathematics.) It may well be that Rosenfeld will be remembered primarily for his contribution as a historian and philosopher of science, for he brought to these activities erudition, clarity of thought, felicity of expression, and sensitivity to the social context.

This impression is reinforced by the volume of his selected papers that has been issued under the careful editorship of Robert Cohen and John Stachel. They have gathered Rosenfeld's most important writings (Rosenfeld himself helped in the selection) and have made available many of his previously inaccessible, oft-quoted (but one suspects little-read) papers. These are grouped under four headings—History of Science, Epistemology, Theoretical Physics, and Social Relations of Science—and are introduced by two short but valuable essays, one by the editors, the other by Stefan Rozental. The volume also contains a fairly complete bibliography of Rosenfeld's writings.

Although there is much of interest in each of the four sections, the papers that reflect Rosenfeld's strong interaction with Bohr will probably be the ones most valued. Thus the section on epistemology contains the important and famous 1933 and 1950 Bohr-Rosenfeld papers on the measurability of field and charge in quantum electrodynamics (the first of which appears here for the first time in English). It also contains most of Rosenfeld's philosophical papers on the foundation of quantum mechanics (complementarity, wave-particle duality, causality, the measuring process). These essays are clear, eloquent statements of Bohr's views interpreted as representing a basically materialistic view of the world. They argue convincingly against the idealist position forcefully propounded by Heisenberg.

The historical section includes most of Rosenfeld's previously published recollections and reminiscences of Bohr. They are warm, appreciative evocations by someone who was closer to Bohr's intellectual ruminations after 1930 than anyone else. The section on theoretical physics is a testament to Rosenfeld's contribution to that field. It includes his classic papers on the definitions of the energy-momentum and angular-momentum tensors in a quantum field theory. Also represented are his expository papers on the foundations of thermodynamics and statistical mechanics. These are succinct, didactic, and masterly presentations and are worthy successors to the Ehrenfests' earlier classic statement. Also included is one of Rosenfeld's papers on the dynamical theory of nuclear resonances, which gives clear proof of his appreciation of the role of esthetics in the formulation of physical theories. The papers in the section on the social relations of science contain astute insights into the changing role of science and scientists in his own lifetime.

Taken together the essays give a vivid picture of the efforts a sensitive, highly intelligent and gifted individual—an undogmatic Marxist—made to give coherence to his intellectual life. They are most welcome: physicists, historians, and philosophers of science—anyone interested in understanding how one consistent interpretation of quantum mechanics was forged—will find reading and studying them rewarding. It is good to have these stimulating and informative essays all in one place.

The book also does something else. It reminds us that we really know very little of the broader intellectual interactions that produced the epistemological foundations of quantum theory. Although Forman, Feuer, and Petersen have made notable starts in that direction no one, for example, has as yet written on the role of Piagetan psychology in these developments. Reading these essays one wishes that the Bohr-Rosenfeld

correspondence were published, and, more generally, that the entire Bohr correspondence were readily available. It also reminds one of one of the great desiderata of modern intellectual history: a biography of Niels Bohr. Perhaps the 1985 centennial celebration of his birth will be a stimulus for such an undertaking.

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Geophysics

Nutation and the Earth's Rotation. Papers from a symposium, Kiev, U.S.S.R., May 1977. E. P. FEDOROV, M. L. SMITH, and P. L. BENDER, Eds. Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.). xvi, 622 pp., illus. Cloth, $34; paper, $21. International Astronomical Union Symposium No. 78.

The earth's variable rotation has interested astronomers, mathematicians, and geophysicists for at least the last 200 years. That this interest has been maintained for so long follows from the planet's nonrigid behavior when subjected to external and internal forces. Thus the motion not only is unpredictable, it also provides some insight into the global nature of these forces and into the nature of the earth's response to them. Discussion of the earth's rotation is conveniently and traditionally focused on one of three aspects: the rotation in space, that is, the precession and nutation; the motion of the instantaneous rotation axis with respect to the earth's crust, that is, the polar motion; and the variations in the speed of rotation about this axis, that is, the changes in length of day. This subdivision is due partly to the different observational techniques employed in studying the different aspects and partly to the properties of the equations describing the motion.

This book of symposium proceedings is concerned mainly with the first component, and in particular with the forced nutations. The forced nutations are the small periodic oscillations superimposed upon the precessional motion of the rotation axis about the pole of the ecliptic. They are the consequence of periodic variations in the gravitational torques exerted by the moon and sun on the nonspherical earth. To an adequate approximation these motions can be described by rigid-body theory, but small discrepancies between observations and such a theory do exist, mainly owing to the earth's fluid core. That the observations of nutation terms contain information on the structure of the earth's interior was recognized by Kelvin in 1876, but in general the geophysical information to be gleaned from such observations is more limited than what may be deduced from the other rotation components. For that reason geophysicists, apart from some notable exceptions, particularly Jeffreys, have not given the nutations much attention.

The interest of astronomers in these rotational motions is largely a consequence of their efforts to establish a precise lunar and planetary ephemeris, an interest recently renewed by the possibility of measuring lunar and planetary motions with unprecedented accuracy by means of laser ranging and long-baseline radio interferometry. The volume under review reflects this interest in that many of the papers deal with the analysis of the astronomical observations and the estimation of the amplitudes of the principal nutation terms. It appears from some of the reported discussions that the emphasis at the meeting was largely on establishing a set of nutation parameters to be used in conjunction with theories so as to establish consistent ephemerides. If the resolutions passed at the meeting and published at the end of the book are an indication, a consensus on "best values" was indeed reached. But no error estimates are given, and these decisions are only of limited geophysical use.

In addition to the forced nutations, the earth has two free nutations, of which the Chandler wobble is the best known. The other free nutation is a nearly diurnal motion introduced by flow in the core past the mantle. These nutations, perhaps more properly grouped in the polar motion category, receive some attention in the book, particularly in papers by F. A. Dahlen and M. L. Smith, who discuss the increase in period compared to rigid body rotation due to the presence of the oceans and core and to the elastic yielding of the mantle. It has long been recognized but is not always remembered that these polar motions have a counterpart in the motion of the rotation axis in space and that the latter is much amplified if the polar motion is retrograde and nearly diurnal. This is the case for the free oscillation introduced by the fluid core, and the amplitude of the motion in space should be about 400 times that of the motion with respect to the crust. Several papers discuss the astronomical evidence for this oscillation, and the general conclusion appears to be that if it exists its amplitude relative to the crust must be small indeed, less than 5×10^{-4} arc second. Even the long-baseline radio interferometry methods discussed in a useful paper by W. H. Cannon and J. L. Yen will be taxed beyond their promise if this oscillation is observed.

The most complete geophysical discussion dealing with the nutation is a paper by T. Sasao, S. Okubo, and M. Saito, who have computed the nutation for a realistic earth model that takes into account the mantle elasticity, a stratified fluid core, and dissipative coupling of the core to the mantle motions. The paper clarifies and updates the important work published by M. S. Molodensky in 1961.

Taken together, the papers present in a summary way—many of them are really little more than abstracts—a status report on research in this field some three years ago. The papers are of variable quality, and many have a certain déja vu air about them, for the publication of the proceedings postdates the actual conference by three years, a number of the papers have already been published or updated in a more extensive form elsewhere, the papers present arguments that have been voiced on many similar occasions, and there has been a proliferation of conferences on similar subjects.

Specialists interested in aspects of the astronomical data may find useful contributions in this volume, but for a more general audience it is indeed of limited value. The latter will benefit more from studying relatively recent papers by Rochester, Jensen, and Smylie (*Geophys. J.* **38**, 349 [1974]) and Smith (*ibid.* **50**, 103 [1977]) and requesting reprints of the better papers in this volume.

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Genetics in Russia

Animal Genetics and Evolution. Papers from a congress, Moscow, Aug. 1978. NIKOLAY N. VORONTSOV and JANNY M. VAN BRINK, Eds. Junk, The Hague, 1980 (U.S. distributor, Kluwer Boston, Hingham, Mass.). x, 384 pp., illus. $99.

The publication of this book is a signal event in the history of genetics. That its contents are scientifically rather unexciting is a detail that most geneticists will overlook. For these are papers that were presented at the 14th International Congress of Genetics held in Moscow in 1978. That such a congress was assembled in the Soviet Union at all is a remarkable example of the unsinkable spir-