

should consult other sources, including Eugene Parker's *Cosmical Magnetic Fields* for more physical treatments.

Problems of Biological Physics

L. A. Blumenfeld

224 pp. Springer, New York, 1981. \$36.00

In this volume is L. A. Blumenfeld's view of modern biophysics translated into English from Russian. Blumenfeld has been a pioneer in the physical aspects of modern biochemistry. His long experience in this field, together with his original work, makes him uniquely appropriate to write this book, covering thermodynamic, physical and electronic approaches to bioenergetics. He treats selected topics completely and effectively with a deep and full understanding of their development and present status and formulates interesting and significant questions for the future.

Blumenfeld dedicates a considerable portion of the book to thermodynamic aspects of biology and their relation to statistical mechanics. He places A. M. Zhabotinsky and E. E. Selkov into proper perspective with German and US workers in the field of oscillatory processes.

Blumenfeld treats biopolymers from the point of view of their conformational and configurational changes. His special fields of expertise being the physics of enzyme mechanisms, electron transfer, and energy transformation and accumulation, he thoughtfully reviews physical mechanisms in biological reactions and gives a clear treatment of the role of radicals, tunneling processes, semiconductors and so on. He emphasizes electron tunneling in particular and conveys his own interpretations as well as those in the current literature. Interpretations based on classical grounds will be particularly useful to experimentalists. Blumenfeld provides extensive documentation for his interpretation of the current state of energy transfer and amply evaluates existing theories for energy coupling. He emphasizes the need to consider the existence of the intermediates in the energy coupling process, a view now acceptable to the Mitchell school.

The book does not cover all of biophysics: Protein synthesis and molecular genetics are not included. Blumenfeld, however, treats carefully and thoughtfully the specialized topics he covers. The translation reads well and has few errors. The bibliography is of especial value because of its completeness. It provides access to interesting and useful points of view that appear in Russian works, especially concerning

thermodynamic aspects of biophysics, that are not readily available to scientists in the US.

In summary, this is a thoughtful book, one that is easily read and one that epitomizes important concepts in biophysics. I strongly recommended it to students and to experts.

BRITTON CHANCE

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The Nuclear Many-Body Problem

P. Ring, P. Schuck

716 pp. Springer, New York, 1981. \$46.00

This text traces developments in theoretical nuclear physics from the collective and Nilsson models of the early 1950s through the time-dependent Hartree-Fock theory of heavy-ion collisions of the late 1970s. Its scope and complexity are suited for easy reading by beginning students of nuclear theory. With a crisp and concise style, the authors quickly develop the shell-model approach to the nuclear many-body problem and subsequently devote more than a third of the text to Hartree-Fock and related models, such as the Strutinskii method, the Hartree-Fock-Bogoliubov model and the random-phase approximation.

They devote 40 pages of the text (chapter four) to effective interactions of nucleon-nucleon forces in free space. This is the weakest chapter of an otherwise interesting discourse. They tersely enumerate the general properties of the N-N force, which have been known for almost 30 years, without regard for modern development in our understanding of three-body forces, meson inelasticities and off-shell effects in N-N scattering. The accompanying discussion of many-body perturbation theory suffers from a similar malady. In their attempt to present a simplified version of the basic elements of Breuckner-Goldstone theory, Ring and Schuck omit any discussion of infinite nuclear matter and thereby neglect such questions as the validity of Breuckner-Goldstone theory viewed from the point of view of variational, Monte Carlo and other perturbative approaches.

In contrast, their treatment of other subjects closer to their areas of expertise—such as the generation coordinate methods, the Wigner-Kirkwood expansion and the time-dependent Hartree-Fock approximation—do give the reader an understanding of the successes and failures of theoretical nuclear physics.

The authors, however, have fallen short of their stated goal "to describe in concise form our present theoretical understanding of the nuclear many-

body problem." Owing to their omissions, the reader is left with the myopic view that two-body N-N forces and a variety of approximation schemes provide an adequate foundation for grasping the physics of the nucleus. Conspicuous by their absence are questions concerning mesonic impurities, condensed states and phase transitions in nuclei and nuclear matter, which are important for our understanding of nuclei as well as many-body physics as a whole.

Finally, the lack of appropriate problems and examples makes this book a text less than ideal for beginning students of nuclear theory.

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General Relativity: An Introduction to the Theory of the Gravitational Field

H. Stephani

298 pp. Cambridge U.P., New York, 1982. \$49.50

Seventeen Simple Lectures on General Relativity Theory

H. Buchdahl

174 pp. Wiley, New York, 1981. \$23.95

General relativity crossed a watershed in the 1960s and 1970s, leaving the domain of abstract mathematics and joining the mainstream of physics. Fed by the spectacular discoveries in astronomy during that period and by great improvements in the precision with which the theory could be tested, it achieved a secure physical understanding of a number of phenomena that earlier relativists had puzzled over and debated, such as black holes, gravitational waves, and the cosmological Big Bang.

It would only be a slight oversimplification to say that this revolution was the work of two kinds of people: mathematical physicists in the European tradition of relativity, who devised a number of elegant new techniques for studying such problems, and a school of largely American and Soviet theoretical physicists, who developed a physical intuition about relativity to match the one they already had for quantum mechanics and for electromagnetism. Collaborating, these two kinds of investigators have made general relativity a standard tool in astrophysics, have wedded it to the rest of physics with an emerging theory of quantum gravity and have developed it to the point that it is widely taught to graduate students and even increasingly to undergraduates.

Modern introductory textbooks for graduate students heading for research in relativity have come mainly from

the American side of this collaboration—for example, *Gravitation* by Charles W. Misner, Kip S. Thorne and John A. Wheeler or *Gravitation and Cosmology* by Steven Weinberg. It is therefore interesting to see Hans Stephani's *General Relativity*, a book in the more mathematical European tradition. A specialist in obtaining exact solutions of the equations, Stephani writes in a concise, no-nonsense style. The translation from the German by two working relativists, Martin Pollock and John Stewart, is excellent. The order of the material is fairly conventional: Riemannian geometry, physics in curved spacetimes, the Einstein equations, the Schwarzschild metric, gravitational waves, exact solutions, black holes, cosmology, and alternative theories. Prerequisites are mechanics, electromagnetism and special relativity.

What I liked most was the treatment of material absent from or hard to find in other recent texts. Stephani takes the trouble to pull together useful tools in appropriate sections: special coordinate systems and tetrads; methods of transporting tensors (Lie, Fermi-Walker, parallel); classifications of gravitational fields (Petrov, Bianchi); exact solutions; interesting cosmologies (Friedman, Bianchi I, Gödel). Unaccountably, Elie Cartan's "moving frames" method for calculating curvature is omitted.

Unfortunately, the book is unnecessarily weak on physical intuition. Stephani discusses black holes adequately, but does not even mention black-hole thermodynamics and Hawking radiation. His treatment of gravitational waves is confusing, when, for example, he shows that free particles in a plane wave remain in the same position while they accelerate relative to one another, but defines neither "position" nor "acceleration" adequately. Disappointing also is the absence of exercises. These drawbacks limit the book's usefulness for astrophysicists or others mainly interested in relativity's applications. For those who want to do calculations in the theory, however, this book can give a good start.

After a first course in relativity (from Stephani or otherwise), one may have a gnawing feeling that some fundamental questions weren't really addressed. Hans Buchdahl's short and readable *Seventeen Simple Lectures on General Relativity Theory* can provide some relief. Its theme is one of the fundamental principles that guided the revolution in relativity, a kind of operationalism inherited from quantum mechanics: Concentrate on what can be measured and by whom; don't be distracted by mere coordinate effects. For example, although there is indeed a coordinate system in which free parti-

cles remain in the same positions when a gravitational wave passes by, observers on the particles can still discover the wave by reflecting light beams off one another. Because the redshifts and changing reflection times look exactly as they would for relatively accelerating particles in special relativity, the wave may be said to accelerate the particles.

But, as Buchdahl points out, the language we use in relativity does not always convey this operationalism.

The following apparent contradictions are common in modern texts: Light travels on a locally straight line, but the Sun bends the path of a light ray; galaxies are at rest in the cosmological frame, but the Hubble redshift is a Doppler shift caused by the recession of the galaxies; general relativity is a theory of gravity, but gravity disappears in a local inertial frame. These contradictions all result from using pre-relativistic language to describe relativistic phenomena.

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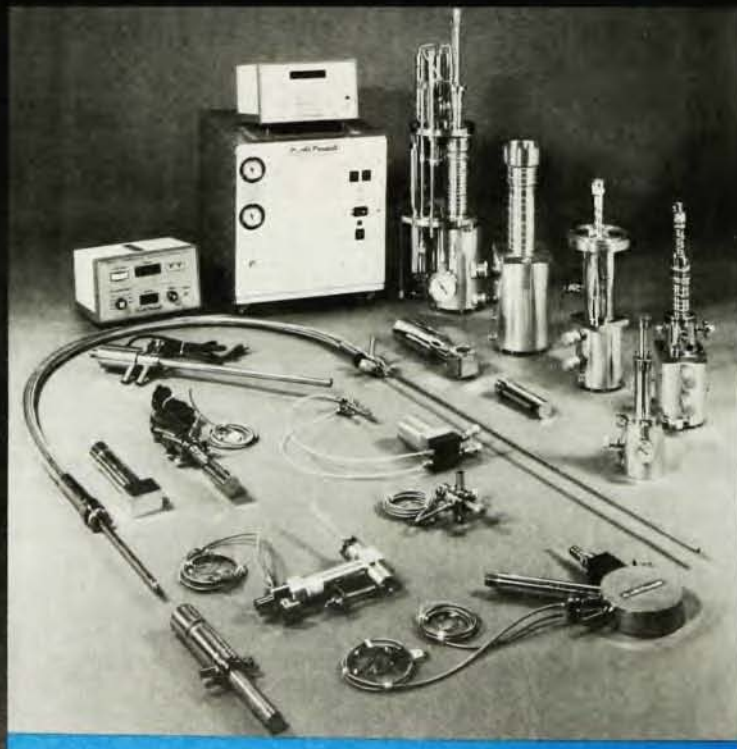
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Buchdahl begins, therefore, by developing the appropriate language while he describes the *gedanken* experiments by which one measures relativistic effects. This dual mission, which occupies the first six lectures, ranges from the construction of local inertial frames through a careful definition of covariance in physical laws, to a discussion of how theories are invented. Having established his conceptual framework, Buchdahl then develops general relativity itself, with economy and elegance. He does not cover all aspects of the theory; rather, he chooses topics to which he can give original perspectives. He derives the Schwarzschild solution in null coordinates, which are regular at the horizon. He derives an analytic interior solution for a compressible star with a generalization of an $n = 1$ polytropic equation of state. Various exact solutions lead to the Kerr metric and gravitational waves. He discusses gravitational energy and, finally, cosmology. The last two lectures return to fundamentals: Mach's principle and the first use in the book of the word "gravity."

The book manages to be thoughtful without being pedantic or tedious. Buchdahl's considerable experience—he has contributed to many branches of relativity during three decades of active research—gives an authority to the discussion that "philosophical" books sometimes lack. But he does not claim to have all the answers and leaves many points unresolved. Because the book is elliptical and because the prerequisites—tensor algebra, classical field theory, special relativity, the equivalence principle—are weighty, these "simple" lectures are far from easy, suitable more for advanced students than beginners. For its careful and occasionally elegant presentation of the theory, however, this unique book deserves to be read by teachers of relativity and especially by the writers of the next generation of textbooks.

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Energy, Force, and Matter: The Conceptual Development of Nineteenth-Century Physics

P. M. Harman
179 pp. Cambridge U.P., New York, 1982.
\$27.50 cloth, \$8.95 paper

The past few decades have seen an explosion of research in the history of the physical sciences, research that has frequently upset long-standing interpretations of how those sciences have developed. New overviews based on that research have been slow in coming, especially those of more recent