Plasma Physics

Principles of Plasma Diagnostics. I. H. HUTCHINSON. Cambridge University Press, New York, 1987. xvi, 364 pp., illus. $65.

Recent experiments conducted within plasma devices worldwide have tested the skills of physicists in developing diagnostic equipment to measure the many parameters of the plasma. Understanding the transport properties of plasmas in a modern tokamak requires a comprehensive set of data. Since most values must be inferred from indirect measurements, one must understand the strengths and weaknesses of the measurement techniques. Ian Hutchinson's book describes the principles upon which these techniques are based.

One parameter of plasmas in a tokamak, the temperature of the electrons, can be measured in at least three standard ways. The first, Thomson scattering, depends on dispersion of coherent light by the free electrons in the plasma and evaluation of the Doppler broadening of the spectral line. The second, far-infrared Fourier transform spectroscopy, depends on the radiation emitted at the cyclotron frequency of the free electrons in the local magnetic field, whose strong gradient provides spatial information. The third, bremsstrahlung emission in the soft x-ray spectral region from the electron acceleration in the electric field close to an ion, depends directly on the electron temperature. It is evident that different principles underlie these techniques and that their sensitivities to nonideal plasma behavior might also be very different.

It is this dependence of plasma parameters on different physical processes that leads plasma physicists to seek confirmation of their data by comparing concurrent measurements. *Principles of Plasma Diagnostics* provides a firm theoretical basis for the diagnostic techniques and a clear understanding of the principles involved. Hutchinson extends the theory beyond the ideal cases. He considers the effects of high-energy tails in the electron- or ion-distribution functions that are so integral a part of plasmas heated by resonant radio frequency or by high-energy particle beams and explains how these effects can distort the measurement. Alternatively, he shows that these effects can be used to infer other properties, such as an additional driven current in the plasma.

The author has organized his chapters according to the physical principle involved rather than the plasma parameter of interest. This enables him to develop the theoretical arguments in each area. Relevant material is cited at the end of each chapter, and comprehensive, up-to-date references to actual observations are provided at the end of the book.

Hutchinson describes the book as at the intermediate graduate level. But the self-contained nature of the chapters and of the referenced source material will make it useful as well to scientists trying to understand the principles behind particular measurements. The book focuses on laboratory plasmas, especially magnetically confined plasmas, but the physics discussed is fully applicable to inertially confined or space plasmas.

This book is an important contribution and should be on the shelves of most plasma physicists. It is easy for theorists and modelers to use graphs of electron temperature or some other plasma parameter as functions of time or position without being aware of the complex physics involved in achieving the measurement. This book can provide that awareness. It gives diagnostic physicists access to physical descriptions of their own techniques as well as to the physics of complementary observations. It provides graduate students with an effective guide for applying theoretical concepts to their experiments.

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Dynamism and Invariance

Symmetries, Asymmetries, and the World of Particles. T. D. LEE. University of Washington Press, Seattle, 1988. xii, 66 pp., illus. $9.95. The Jessie and John Danz Lectures.

Thirty Years Since Parity Nonconservation. A Symposium for T. D. Lee. (New York, Nov. 1986.) ROBERT NOVICK, Ed. Birkhäuser Boston, Cambridge, MA, 1987. viii, 198 pp., illus. $25.

In the prologue to his fascinating book, set in the world of particle physics, Tsung Dao Lee recounts a conversation he had with Chairman Mao Zedong in 1974. Mao's opening question was "Tell me, why should symmetry be of importance?" Symmetry Mao had imagined as a purely static concept, something that ran against his dynamic grain. Lee responded instantly. He could produce a homely but brilliant demonstration—nothing more than a pencil rolling on a tilting pad of paper—that clearly brings out a dynamic aspect of symmetry. The Chairman was satisfied. T. D. Lee's clarity and inventiveness as teacher are now put at our service in this all-too-slim volume. He invents for a general audience some marvelous illustrations of mirror symmetry, translation invariance, charge symmetry, and time reversal invariance; and he brings out by means of concrete examples how symmetry principles are connected with conservation laws—for example, translation invariance with conservation of momentum.

In fact, however, several hitherto sacred symmetry principles have been experimentally overthrown over the past few decades, and other symmetry notions have been known from birth to be only approximate. This raises the question, Where there is no symmetry, why focus on symmetry? There are two answers. For one thing, certain symmetry principles, though not obeyed exactly, are almost exact—they hold true to good approximation over large, reasonably well-defined domains of particle phenomena. In such instances symmetry concepts are clearly of immediate service, to within small corrections. More fascinating, however, is the contemporary focus on other symmetries that are not even remotely hinted at in empirical observations. Back of this seeming madness is a notion that the laws of physics at their deepest in fact incorporate certain *exact* symmetries, which, however, do not show up in phenomena; that the breakdown of symmetry in the observed world is attributable not to the basic laws of physics but to asymmetry of the vacuum. The vacuum, a churning physical medium, is pictured on this view as the hiding place of missing symmetries. The successful unification of electromagnetism with the weak interactions is based on a scheme of this sort.

It is slightly more than 30 years now since the breakdown of parity invariance (mirror symmetry) was discovered in the weak interactions. Throughout this class of processes (nuclear beta decay, decay of the mu meson, of hyperons, and so forth) the observable asymmetry effects are large and unmistakable, once one thinks to look for them. It was, however, not until the tau-theta puzzle of the middle 1950s that doubts about parity conservation began to surface. In their celebrated paper of 1956, Lee and C. N. Yang, after a careful analysis of the literature, pointed out that in fact no one *had* looked yet (an exception came to light later on), and they told the community what to look for. The rest, as one says, is history. Within a very short time asymmetry effects were being discovered all over the place and the weak interactions blossomed out as a major subdiscipline of particle physics. That history is relived in the proceedings of a symposium for Lee held at Columbia University in the fall of 1986, 30 years after the overthrow of parity. It was the occasion also of T. D.'s 60th birthday and hence the start of his second cycle on the Chinese calendar. The proceedings contain the reminiscences

of a number of the major participants in the parity revolution, in particular Lee's own reminiscences. There are also several reports on contemporary research topics, including a paper by Lee on soliton stars and soliton black holes.

Under Lee's energetic leadership, a program (CUSPEA) was set up in 1980 to identify highly qualified physics students in China for graduate work in American universities. Since then about 800 students have engaged in Ph.D. studies here. The origins, vicissitudes, and successes of CUSPEA merit a book-length account, and one hopes that Lee will some day write it. The proceedings volume concludes with papers by CUSPEA students. It also contains a large number of photographs taken at the symposium. It is good to report that the heroes of the parity revolution have not changed all that much in appearance over the intervening years, least of all Lee himself.

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Piaget Under Scrutiny

Piaget's Construction of the Child's Reality. SUSAN SUGARMAN. Cambridge University Press, New York, 1987. vii, 258 pp. $34.50.

On reading *Piaget's Construction of the Child's Reality*, one is reminded of the panoramic scope of Piaget's description of the development of thinking. Sugarman tackles the formidable task of exegesis in heroic fashion, and she succeeds on her own terms. She painstakingly analyzes Piaget's early works, pointing out that Piaget contradicted himself in fundamental ways, that he made arbitrary claims about connections among his constructs, that his a priori assumptions were not necessarily true, that his results and methodology did not necessarily test his theoretical claims, that negative observations (a child's apparent failure to take others' perspectives, for example) do not necessarily imply positive theses (such as that the child has a special mode of thought that prevents this), and so on. Sugarman constrains the enterprise by limiting herself to Piaget's data, by assuming for the sake of argument that the data are essentially correct, by excluding other data gathered in the 50 years or so since the works were published (20 or 30 years since their translation into English), and by excluding from consideration other theoretical analyses of Piaget's work. Instead, she concentrates on logical coherence within the theory. Piaget's logical inconsistencies are so numerous and profound that they provide much grist for the critical mill. Sugarman performs a sympathetic and thorough analysis and is mostly correct in her assertions about Piaget's shortcomings.

It is noteworthy that Sugarman has reached the same bottom line about Piaget's approach as other analysts before her, although the specific debits and credits differ. Those not convinced by earlier critiques are encouraged to read this one. However, her assessment of the current state of the psychology of cognitive development, and of Piaget's role in it, seems wildly distorted. Beyond the small circle she refers to, there are many theorists who have departed radically from the Piagetian perspective. Sugarman asserts that these thinkers are nevertheless "bound to some of the same problematic assumptions that Piaget made" (p. 241), such as the continuity in development from childhood to adulthood. That particular assumption has more to do with Occam than with Piaget. However, to persist in a theory that fails to capture subtle discontinuities is to be simpleminded rather than simple. It remains for Sugarman to demonstrate some connection between Piaget and specific occurrences of such simplemindedness.

In general, Sugarman appears to misapprehend the influence of Piaget in current work. First, she treats moribund constructs equally with viable ones. Second, she devotes much analysis to empirical phenomena that modern techniques indicate are probably nonexistent. Such an endeavor would be useful (for reasons other than historical) to the extent that it made contact with current thinking. Sugarman dismisses the fading of Piaget's persona from the modern stage as mere illusion. However, if Piaget continues to influence cognitive developmental psychology subliminally, she must make these effects manifest. In the absence of references to recent research and theory, she has failed to position her work convincingly in the context of contemporary research.

Most critical surveys begin with a review of the target theory, followed by a critique, which in turn is followed by the author's spelling out the implications of his or her analysis. Typically, increasing emphasis is given to these three components. Sugarman has chosen to spotlight Piaget and to touch only glancingly on the implications of her approach. She does not develop alternatives but delivers a litany of "it could be," "it is not necessarily the case that," and similar open-ended claims. We are left with a plethora of logical possibilities but little guidance regarding what is psychologically plausible. Inevitably, when the only criteria are logical, we find ourselves entertaining exotic possible worlds (for example, ones in which intentionality is not linked with responsibility) on the same footing with empirically supported relationships.

This book is excellent philosophy, closely reasoned and perceptively argued. Unfortunately, however, the author has set the conditions so that the work falls out of the mainstream of science. In science, current data are never irrelevant. It is incumbent upon the theorist to evaluate the data, separating the good from the bad, in accordance with metatheoretical principles. This is the "due process" of science. To say that one will not consider relevant data, or will accept flawed data for the sake of argument, is to place the enterprise outside the accepted forum of adjudication. Piaget's theory is deep, dazzling, and undomesticated by data, and so is this analysis of it. But interesting ideas can be false. Pure logic is paralyzing because there is no perfect experiment, no experiment that embraces every logical possibility. Each discipline has its susceptibilities. In the psychology of cognitive development, we need to inoculate ourselves against the infinite regress of inordinate philosophizing.

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Books Received

Air-Sea Exchange of Heat and Moisture During Storms. R. S. Bortkovskii. Edward C. Monahan, Ed. Reidel, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xiv, 194 pp., illus. $74. Atmospheric Sciences Library. Revision of the Russian edition (Leningrad, 1983).

Aldo Leopold. His Life and Work. Curt Meine. University of Wisconsin Press, Madison, WI, 1988. xvi, 638 pp., illus. $29.50.

Applied Quantum Chemistry. Gábor Náray-Szabó, Péter R. Surján, and Janos G. Ángyán. Reidel, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xiv, 489 pp., illus. $129. Understanding Chemical Reactivity. Revision of the Hungarian edition (Budapest, 1979).

Aquatic Oligochaeta. R. O. Brinkhurst and R. J. Diaz, Eds. Junk, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xvi, 323 pp., illus. $132. Developments in Hydrobiology, vol. 40. From a symposium, Hamburg, F.R.G., Sept.–Oct. 1985.

Aspects of Artificial Intelligence. James H. Fetzer, Ed. Kluwer, Norwell, MA, 1987. xiv, 385 pp., illus. $69. Studies in Cognitive Systems.

Big Bang, Big Bounce. How Particles and Fields Drive Cosmic Evolution. I. L. Rozental. Springer-Verlag, New York, 1988. xii, 129 pp., illus. Paper, $35. Translated from the Russian editions (Moscow, 1984 and 1985).

Biochemistry. Lubert Stryer. 3rd ed. Freeman, New York, 1988. xxxiv, 1089 pp., illus. $47.95.