ing form factor analysis with Feynman diagrams. It is perhaps a related feature that Scheck discusses radiative corrections, in most places, only superficially. The one notable exception to both of these criticisms is the very clear discussion of the process $\pi^- \to e^- \bar{\nu} \gamma$.

Scheck's textbook should be useful as a practical guide for students and researchers. It will probably be of particular value to those interested in the interface between nuclear and particle physics. Although Scheck does not discuss the subtleties of nuclear structure, he is well aware of them, and he often points out where particular nuclear corrections can be plugged into his analyses. To those seeking a broader introduction to modern theoretical particle physics, I would recommend the excellent textbook *Elementary Particle Physics* by Otto Nachtmann (Springer-Verlag, 1990).

MICHAEL E. PESKIN
SLAC, Stanford University
Stanford, California

Dusty and Self-Gravitational Plasmas in Space

Paval Bliokh, Victor Sinitsin and Victoria Yaroshenko
Kluwer, Norwell, Mass., 1995. 250 pp. $132.00 hc
ISBN 0-7923-3022-6

While dust is an almost ubiquitous component of the cosmic plasma environment, the study of cosmic dusty plasmas was pursued until recently by only a handful of scientists. The observation of peculiar features in the Saturnian ring system (such as the radial "spokes") by the Voyager spacecrafts in the early 1980s could not be explained by purely gravitational means, and thus gave a major boost to this field. Since then the study of dusty plasmas has seen rapid progress.

Early studies of the motion of charged dust in planetary magnetospheres under the combined influence of planetary gravity and the Lorenz force ("gravitoelectrodynamics") led to a series of successes including, more recently, the only plausible explanation of the high-speed collimated streams of fine dust found, by the Ulysses and Galileo spacecraft, to emanate from Jupiter. These dynamical studies have in more recent times been complemented by the study of collective processes in dusty plasmas, leading to the discovery of a whole slew of new wave modes and associated instabilities, with important consequences to transport and heating in various dusty cosmic environments.

While a number of international conferences and workshops have been devoted to the physics of dusty plasmas and resulted in published proceedings in recent years, *Dusty and Self-Gravitational Plasmas In Space* by Pavel Bliokh, Victor Sinitsin and Victoria Yaroshenko is the first monograph to treat the subject. Its first chapter deals with the central topic, namely the electrostatic charging of both isolated grains and grain ensembles in a plasma, and discusses a number of physical consequences of charging, such as grain fragmentation and coagulation. The following chapter deals with the gravitoelectrodynamics of charged dust in planetary magnetospheres. Subtle processes, such as the so-called gyrophase drift associated with the changing charge on the grain during its epicyclical motion, are clearly explained with the aid of useful figures. The next two chapters deal with collective processes in dusty plasmas (waves and instabilities).

The main difference between the present formulation and those of other authors is the inclusion of self-gravity, which requires the supplementary Poisson equation relating the gravitational potential to the mass distribution. While this leads to more general dispersion relations, with more cumbersome algebra, the self-gravitational term plays no important role in virtually any problem of interest, at least within planetary magnetospheres. A possible exception is considered in the final chapter in connection with the narrow rings of Uranus, where a drifting, growing Jeans instability is associated with small-scale longitudinal inhomogeneities. In this case, however, the electrical forces play no significant role. This last chapter concludes with a useful review of the various theories of spoke formation, all of which invoke electromagnetic effects.

All in all, I consider this text a well-organized presentation of a wide variety of topics in this interesting field. It will be useful both to specialists and beginning graduate students. Perhaps the only significant omission is the fascinating recent laboratory demonstration of crystallization of dusty plasmas. While the existence of such crystals in space is debatable, it is interesting to note that the inspiration for at least one experiment was provided by the suggestion that such structures may form in the "cold" dusty plasma environment of deep space, such as the Uranian rings.

D. A. MENDIS
University of California, San Diego

Semiconductor Characterization: Present Status and Future Needs

Edited by W. Murray Bullis, David G. Seiler and Alain C. Diebold
AIP, New York, 1996. 729 pp. $78.00 hc
ISBN 1-56396-503-8

Semiconductor characterization has proved to be fundamental in the development of semiconductor technology and in the improvement of semiconductor manufacturing. As a tool, it has made possible the determination of the structure, composition, properties and performance of materials and the interrelationships among those characteristics.

Over the years, semiconductor materials have become more varied and complex, an example being the GaSb/AlSb/InAs (gallium antimonide/aluminum antimonide/indium arsenide) heterojunction. In addition, the requirements placed on "old" standbys such as silicon and gallium arsenide have become more stringent: Higher purities and crystal perfection are desired, the push for ever-smaller geometries has seen microstructures giving way to nanostructures, and the marketplace has demanded that integrated-circuit manufacturing plants (now costing close to two billion dollars) provide greater yields and higher reliability.

The contents of *Semiconductor Characterization*, edited by Murray Bullis, David Seiler and Alain Diebold, demonstrate the extent to which instrumentation and techniques have been developed to meet those and many other challenges. The emphasis throughout is on the semiconductor industry. Thus, there is substantial coverage of methods for on-line, off-line, ex-situ, in-situ and real-time control and monitoring. Of course, the traditional electrical, physical, chemical and optical methods are also covered, complementing and updating earlier books on the subject. (Dieter K. Schroder's *Semiconductor Material and Device Characterization* (Wiley, 1990; reviewed in PHYSICS TODAY, April 1991) devoted about 80% of its contents to electrical methods; *Optical Characterization of Semiconductors* (Academic Press, 1993) by Sidney Perkowitz dealt with optical methods.)

Although the traditional meaning of the term "metrology" is the science of measurement, in this book it is sometimes used interchangeably with "characterization." Thus in the first chapter, by Tom J. Shaffner, in which there is discussed the "key role metrology plays in modern process development," one figure features the role of analytical techniques. Plotted against time are the "Best *X*–*Y* Resolutions," ranging from centimeters in the 1960s down to the several picometers that became possible in the 1980s with the advent of scanning tunneling and atomic force microscopies. The improvement in resolution over the years came about because of a host of revolutionary new techniques, of which about thirty are listed on the plot.

The comprehensive nature of the volume comes from the qualifications of the 180 authors—experts all—from many countries, many from industry and industry-related organizations and government laboratories. *Semiconductor Characterization* includes just over a hundred articles, representing the great majority of the papers presented at an international workshop held at the National Institute of Standards and Technology in Gaithersburg, Maryland in 1995. I cite two of the contributions, the first of which, by John C. Bean, seemed to me to have served as a keynote. Bean, in contrasting research and factory perspectives, writes, "In the redirected 90s, many researchers have been cast into the brave new world of the factory," and he goes on to make his observations from "a critical and irreverent factory viewpoint." The second, by coeditor Bullis, begins with the early days of the transistor, traces many developments anecdotally and takes us right to the present, where standardization is still "an elusive goal." A real treat for old-timers.

I have been told that the response to the NIST workshop and to the papers presented in this text has been so enthusiastic that a second workshop, in what will become a series, has been scheduled for early 1998. But don't wait! The combination of informed authors, conscientious editors and a handsome production job (including an effective index, critically needed for books with such broad coverage) make *this* volume a must for those in the field.

LAWRENCE G. RUBIN
Massachusetts Institute of Technology
Cambridge, Massachusetts

Fluctuations and Order: The New Synthesis

Edited by Mark Millonas
Springer-Verlag, New York, 1996.
455 pp. $49.00 hc
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The study of fluctuations in physical systems, less euphoniously known as noise, has occupied a hallowed place in theoretical physics for well over a century. James Clerk Maxwell's kinetic theory of gases and his eponymous distribution function provided the modern foundation for a molecular worldview. Albert Einstein's fluctuation theory and his later theory of Brownian movement provided Jean Perrin with the motivation to measure Avogadro's number and finally clinch this atomistic perspective.

Lars Onsager extended this thinking to nonequilibrium processes and helped develop our modern understanding of the fluctuation dissipation theorem, the cornerstone of irreversible thermodynamics. This kind of thinking advanced rapidly with the advent of the laser and modern light-scattering techniques. With these techniques and an appreciation of the fluctuation–dissipation theorem, it is possible to do Rayleigh–Brillouin light scattering on an equilibrium fluid and to determine accurately the values of such nonequilibrium properties as the shear and bulk viscosities, the heat conductivity, the speed of sound and the sound attenuation coefficient.

The subject of phase transitions and critical phenomena was reenergized at about the same time. Here the connection with noise is fundamental through the fluctuation correlation interpretation of susceptibilities. With *Fluctuations and Order: The New Synthesis*, Mark Millonas presents us with the notion that another surge has occurred.

This volume is the proceedings of a workshop held at Los Alamos National Laboratory in 1993. It contains 26 separately authored chapters ranging over topics such as stochastic resonance, noise and chaotic systems, path integral methods, thermal ignition, chemical reactions, epitaxial growth, pattern formation, thermal ratchets, ion channels, noisy neurons and quantum noise in cosmology. This panoply of applications is truly impressive. These chapters make for good reading and bring the reader up to date in several rapidly developing areas of research. The influence of the widespread availability of rapid computing capability is evident throughout the volume, with numerical simulations making up an important part of most presentations.

Nevertheless, the title of this volume may mislead some readers. There is no new synthesis. Synthesis requires much more than mere juxtaposition. The editor's preface even contains a disclaimer: "Now is not the time for a comprehensive summary of these new ideas, and I am certainly not the person to attempt such a thing." What Millonas has attempted to do is to demonstrate a historical progression in our view of noise that spans the gamut: Noise is ignorable, that is, a nuisance; noise is disorder, merely a dressing up of determinism; noise creates order, that is, it nucleates transitions between states of different stability that are themselves purely macroscopic, and within "the active noise paradigm," the nature of the noise is a strong determinant of the macroscopic states. It is this fourth category upon which the book is focused, according to the editor.

I find the contents of the book valuable, but I don't think the case has been made for the editor's viewpoint. Partly, this is a reflection of his relative youthfulness within the field. The opening sentence of the preface is surely a very personal statement: