

The last third of this book is devoted to some conventional appendices, plus appendix D, an introduction to basic physics concepts as applied to particle physics. This section is less inhibited in its use of equations and quantitative concepts. It contains exercises for the reader and is clearly intended as a supplement to an introductory physics course.

The book is recommended as a supplementary text for introductory college courses or for advanced high-school courses; science teachers will find it useful for updating their knowledge in an ever-expanding field of physics research.

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Waves in Dusty Space Plasmas

Frank Verheest

*Kluwer Academic, Norwell, Mass.,
2000 \$115.00 (264 pp.).
ISBN 0-7923-6232-2*

Particulate matter in the universe exists in sizes ranging from macromolecules to micron-sized grains to even larger pebbles and boulders. When such particles are present in a plasma, they become charged (usually negatively because of the greater mobility of electrons) and thus contribute to the plasma dynamics as a separate "species." These particles have much larger masses and usually larger charges than those of the plasma ions, but much smaller charge-to-mass ratios. This so-called dusty plasma contains a highly diverse range of collective modes of oscillation, unstable behavior, and linear and nonlinear waves.

The grains of a dusty plasma also have a range of sizes and shapes, and the charge can fluctuate in time, leading to highly complex behavior. Over the years, dusty plasmas have been studied mostly as a theoretical construct, due to a lack of direct observations of dust in space. In the past two decades, however, the situation has changed dramatically: First Voyager mission's observations revealed new planetary rings and intricate structure ("spokes") in the rings themselves; more recently, the Galileo and Ulysses missions made measurements of dust streams from Jupiter, and rocket flights collected data through noctilucent clouds high in Earth's atmosphere.

Dusty plasmas are also now easily made in the laboratory, will be subjects of some experiments on the International Space Station, and, because of self-grown contaminants, occur in plasma-processing devices. Theory and simulations have managed to keep up with this explosion of data, leading to a new and exciting subfield of plasma physics.

In *Waves in Dusty Space Plasmas*, Frank Verheest has captured the diversity of phenomena, the excitement, and the challenges of studying waves in dusty plasmas in space. Verheest has contributed in many significant ways to the understanding of these plasmas over the years and has written an oft-cited review of waves (*Space Science Reviews*, volume 77, page 267, 1996). This book is no rewrite of the review article, but a new, major compilation and summation of this rapidly evolving subject, with its own wide range of topics.

The book naturally divides into three parts. The first part introduces basic concepts, such as charging of dust grains, and provides the observational evidence in space for dusty plasmas. The second part develops the formalism for treating dust as a separate plasma species and describes the basic electrostatic and electromagnetic wave modes in a dusty plasma; unlike many plasma textbooks, the emphasis here is on nonlinear waves as much as linear modes. The final third of the book discusses more complex processes, such as dust grains with fluctuating charges or a distribution of sizes, as well as the astrophysically important issue of dust in self-gravitating systems.

Verheest has written a book that is both highly informative and engagingly readable. His use of the first person throughout the text and his honest discussion of controversial points contribute to the personal style of this book. He assumes the reader has basic background in plasma physics but is not an expert in dusty plasmas or space plasmas. He is quick to point out that, in this still emerging field, a proper mechanism to introduce dust into the plasma equations in a mathematically rigorous manner does not yet exist; instead he extends the standard formalism in a natural way.

His approach is based on a fluid treatment of the plasma, which is almost always valid here, given the mass of grains relative to those of the usual plasma components and resulting behavior at frequencies much lower than those typically found in plasmas. He gives an excellent description of the basic physics, and the

reference list he includes is complete and by itself well worth the price of the book.

Most of the treatment of waves (linear and nonlinear) is analytical. Personally, I think some numerical solutions of these complex plasma equations displayed graphically, such as are found in S. Peter Gary's noteworthy monograph on plasmas without dust (*Theory of Space Plasma Microinstabilities*, Cambridge U. Press, 1993) would add further insight. Overall, Verheest's treatment is excellent and is highly recommended, both for those who are just starting out in the field and for more established researchers.

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Chernobyl Record: The Definitive History of the Chernobyl Catastrophe

Richard F. Mould

*IOP, Philadelphia, 2000. \$57.00
(402 pp.). ISBN 0-7503-0670-X*

My problems with Richard F. Mould's *Chernobyl Record* start with the words "definitive history" in the title. The book is decidedly not a history of events that resulted in the catastrophe. It is rather a mixture of chronicle, traveler's journal, summaries of some aspects of nuclear civilization, and a great deal of statistics. The tone of the narrative varies from emotional eyewitness account to overly dry technical description. Along with authoritative, official information, there are bits with less-than-evident significance, such as pictures of the author's Soviet visa or a camel in the Kazakh steppe. While the comparison of the Chernobyl explosion to the nuclear accidents at Three Mile Island and Tokaimura seems to be too laconic, the comparisons to the Hiroshima and Nagasaki atomic explosions and to nuclear weapons test sites seems out of place.

The 1986 Chernobyl catastrophe was indeed a multidimensional phenomenon, and it may still be too soon to attempt a "definitive" history. But what is striking is that Mould has not even tried to address the very basic historical question: whether Chernobyl was just one of quite a few (even though the worst) accidents of the nuclear era, or whether the Soviet regime was mainly responsible for this misfortune. The question is much

easier to ask than to answer, but no history should overlook it.

The book's most interesting chapter for a historian (and the longest) is the concluding one, "The Legasov Testament." It is an English translation of reflections on the Chernobyl accident by academician Valery Legasov, a nuclear scientist, and one of the principal Soviet officials in the field of atomic energy at the time; he was the head of the Soviet delegation at the first international postaccident meeting. The document was published in the central Soviet newspaper *Pravda* 20 May 1988, two years after Chernobyl and a few weeks after Valery Legasov had committed suicide at age 51.

Mould presents the Legasov text as "a valuable historical account." That may be true, but only within the real historical context of the Soviet Union's responsibility to its people in the management of science. So Legasov's account could—or maybe should—be a starting, rather than a concluding, point in a history of the Chernobyl catastrophe, if what is being built is a "definitive" history.

According to Mould, Legasov's career was ruined "in large part because [he] began to speak out about the problems—instead of keeping quiet and voicing only the Communist Party line." Actually the cause and effect might be quite the other way around: Legasov began to speak after his extremely successful career had stumbled dramatically over Chernobyl in the time of the Communist perestroika. This possibility is supported by Russian sources: The style of the wording of Legasov's "testament" in the original Russian looks more like that of a high-ranking apparatchik rather than of a scientist. It is especially clear in its full version—a transcript of a five-tape recording of Legasov's oral account that is now circulating in Russian on the Internet (<http://litportal.org.ru/catalog/a-rusl>). Another source is Vladimir Gubarev, the science editor of *Pravda*, who urged Legasov to write his thoughts on Chernobyl and who published a heavily abridged version.

David Holloway masterfully demonstrated the penetrability of the Soviet "enigma" in his definitive history of the Soviet atomic bomb, *Stalin and the Bomb* (Yale U. Press, 1994). The field of peaceful nuclear energy in the USSR has much weaker classification restrictions than the field of nuclear weaponry, but it is unlikely that anyone could probe its real context by relying on translators, as Mould did.

The principal issue in question is personal professional responsibility.

True, Soviet society was corroded by decades of totalitarian rule. And the Soviet nuclear establishment was a part of the whole story. But the general issue of professional responsibility has quite personal dimensions. In the same society and in the same nuclear establishment, another academician with a no-less impressive career than Legasov exercised his professional responsibility more than once: Andrei Sakharov, while considering himself entirely loyal to the essential purposes of the Soviet system, personally and officially voiced his professional understanding of the problem of nuclear testing in 1958, of the nuclear moratorium in 1961, and anti ballistic-missile defense issue in 1967. And it was his feeling of personal professional responsibility that led him to break the Soviet rules and to go public in 1968—each time in order to prevent a calamity.

Musing over Chernobyl, Legasov came to the conclusion that it was "impossible to find a single culprit." Sakharov would have to have named himself a culprit, had he not taken responsibility on himself. The issue of scientists' responsibility in Chernobyl is still waiting for a definitive history.

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Introduction to Experimental Nonlinear Dynamics: A Case Study in Mechanical Vibration

▶ Lawrence N. Virgin
Cambridge U. Press, New York,
2000. \$74.95, \$32.95 paper
(256 pp.). ISBN 0-521-66286-9,
ISBN 0-521-77931-6 paper

Lawrence N. Virgin's *Introduction to Experimental Nonlinear Dynamics* is a unique book in that it treats an extremely mathematical subject from an experimental point of view. Virgin integrates the theory and the experiments very well. Novices to the field of nonlinear dynamics and chaos theory will find the book's introduction of concepts both easy to understand and presented in a physically meaningful manner. The book will also be useful for specialists in chaos and nonlinearity in the comparison of experiments with theoretical models. Virgin was trained in theoretical and applied mechanics and uses beautiful mechanical experiments as a platform from

which to investigate nonlinear behavior and mathematical models.

In chapters 1 and 2, Virgin reviews linear vibration theory, including forced oscillations and resonance. In chapter 3 he introduces the concepts of phase space, Poincaré sections, and bifurcations in the context of a simple oscillator. The mathematical model of a particle in a two-well potential and the mechanical analog of a buckled structure are presented in chapters 4 and 5. Virgin takes the reader through the world of chaotic vibrations, using his experimental model of a two-well oscillator, in chapters 6 through 10. He introduces the ideas of nonlinear free oscillations, subharmonic behavior, autocorrelation, and Lyapunov exponents, as well as beautiful experimental fractal Poincaré sections with comparisons with numerical solutions. He also discusses the idea of escape from a potential well.

In chapter 11 Virgin describes another mechanical experiment based on a hardening spring, and he discusses the Japanese attractor of Yoshisuke Ueda with a pure cubic nonlinearity. The impact oscillator under a sharp bilinear discontinuity is another experiment that is analyzed in chapter 12. Virgin ends the book with some global bifurcation issues related to quasiperiodic motions, fractal basin boundaries, Melnikov theory, and global transient motions.

Virgin does a reality check on the theory and illustrates the experimental robustness of nonlinear phenomena. At the end of his book he also describes an electrical-circuit experiment, for those who would like to explore chaos with voltages instead of mechanical motions.

Virgin's writing is clear and concise. The book contains some mathematical equations, but the general tone is toward physical explanation with visual and graphical presentations. This book is recommended for the libraries of both students and researchers in nonlinear science.

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NEW BOOKS

Astronomy and Astrophysics

Amateur-Professional Partnerships in Astronomy. J. R. Percy, J. B. Wilson, eds. *Astronomical Society of the Pacific Conference Series 220*. Proc. mtg., Toronto, Canada, July 1999. Astronomical Society of the Pacific, San Francisco, 2000. \$52.00 (414 pp.). ISBN 1-58381-052-8