static accelerators. Due to relatively low beam currents, these devices operate in the low-gain regime by means of stimulated Compton scattering. In contrast, intense electron beams can be generated at relatively low energies using pulse-line accelerators and induction linacs. In these intense beams the radiation is generated by means of a stimulated-Raman-scattering mechanism due to beam-driven space–charge waves. This distinction defines a natural divide in the free-electron laser community.

Charles A. Brau has a distinguished record in the field, having led the free-electron laser group at Los Alamos National Laboratory before leaving to head a free-electron-laser user facility under construction at Vanderbilt University. The Los Alamos effort is devoted to the short-wavelength regime based on rf linacs, and the group there has done much of the pioneering work in the field. The Vanderbilt facility is designed around an rf linac system based on the Stanford Mark III linac. Perhaps in view of this, the book is heavily weighted towards rf-linac-based free-electron lasers and deals with the entire range of issues relevant to the physics and design of this class of free-electron laser. Two chapters are devoted to rf linacs and optical resonator design.

As stated in the preface, this book grew partly out of a series of lectures delivered by the author at the 1988 Particle Accelerator School at Cornell University, and thus it retains a conversational style throughout. This is not intended a criticism; the author goes into admirable detail in the derivation of many of the fundamental properties of free-electron lasers. The conversational style relieves the otherwise dry nature of the material and results in a pleasantly readable presentation useful to novice and expert alike.

The book provides a detailed discussion of the interaction of the low-gain free-electron laser in an idealized one-dimensional model. Topics covered include incoherent emission as well as coherent emission in both uniform and tapered wiggler configurations. Incoherent radiation refers to spontaneous undulator emission, which is the prime mechanism underlying synchrotron light sources. In addition, the formalism is sufficiently general to treat emission at harmonics as well as at the fundamental frequency.

Three-dimensional effects are treated in a more qualitative fashion. The discussion is limited to the beam dynamics in a three-dimensional wiggler and to the diffraction of an optical pulse. The important question of optical guiding of the radiation is discussed in terms of a paraxial wave equation, whose solution is discussed only for Gaussian beams in the low-gain regime. The great mass of recent work on the detailed nonlinear analysis and simulation of the wave-particle interaction in three-dimensions is discussed only briefly, although references to some of the important papers on this subject are given.

There are a number of technical points that I feel are presented in a misleading fashion and should be approached with some caution. First, in regard to the Raman regime, the author states that the gain is enhanced by the beam space–charge waves. This is incorrect. The Raman regime exhibits a high gain because of the high currents required. However, the effect of the space–charge waves is to reduce the gain with respect to that for comparable stimulated Compton scattering. Second, in the discussion of harmonic radiation, the gain at harmonic frequencies is claimed to exceed that at the fundamental frequency for a sufficiently strong wiggler. This point is controversial because these estimates are usually made on the basis of a sinusoidal orbit approximation that breaks down for the wiggler field strengths required. The third point refers to refractive guiding of the radiation, which occurs if the refractive index is greater than unity. One obtains the impression from the text that this is universally true over the entire gain band, and the author states that this is justified from the analysis presented. However, a close look at the free-electron laser phase-shift function indicates that the index of refraction can also be shifted below unity.

On the whole, however, I think that the average reader will find much in this book to appreciate. It can serve as an excellent introduction to the field and as a valuable reference guide to rf-linac-based free-electron lasers.

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Moments in the Life of a Scientist

Bruno Rossi
Cambridge U. P., New York, 1990. 181 pp. $44.50 hc
ISBN 0-521-36439-6

Those of us who know and have worked with Bruno Rossi will be forever grateful that he has taken the time and devoted the energy to write this charming, succinct and, as far as I know, completely candid autobiography. Those who haven't known Bruno but are interested in understanding how experimental science is done by one of the best in the business will be richly rewarded if they are so fortunate as to happen upon this small (but expensive) book.

Doing good science is a highly personal activity, and few of those who are really good at it have the additional skills required to communicate their insight to the rest of us. An added and important dimension to *Moments* is Bruno's generous reference to those who have shared in his life, in particular, his wife, Nora, who has added a spirited chapter of her own. There are frequent reminders of the contributions and personalities of his many scientific associates and collaborators.

The science that has benefited most from Bruno's attention has been, of course, the study of cosmic rays. When he entered the picture in 1929, among the principal contributors were Walter Bothe and Walter Kohlhöster, who had recently supplied experimental evidence that the radiation had some sort of celestial rather than Earthly origin. Whether the arriving radiation was corpuscular (protons or electrons perhaps) or wave-like (gamma rays) was unsettled and confused by speculations of the revered and influential Robert Millikan. The nature and location of the celestial source was a complete mystery.

To us now, these circumstances appear to have offered an ideal setting for a 23-year-old ambitious and talented scientist to start an experimentally oriented scientific career. But beware. Part of the reason the setting looks so good to us in retrospect is that Bruno (and a few others, to be sure) asked the right questions, conceived of and did the crucial experiments—using apparatus now easily available to precocious school children but which at that time required the extremes of loving patience and ingenuity. (I was struck, for example, by Bruno's description of Geiger–Müller-counter fabrication and the photograph of the tabletop full of batteries needed to provide the high voltage for his counters.)

Cosmic rays have been central in Bruno's career, but as described in *Moments* he has been involved in an impressive number of other loosely related activities, any one of which would have established Bruno as a distinguished scientist. There was the radiation detector and weapon

implosion work at Los Alamos and the work on elementary particles, interplanetary plasmas and x-ray astronomy at MIT. During the MIT years, when most of this original scientific work was in progress, Bruno carried full teaching responsibilities and found time to write a number of primarily educational books on optics, interactions of high-energy particles, cosmic rays and space physics (with Stan Olbert). Is it possible that Bruno, perhaps joined by Nora, could be convinced to expand the subject matter of some of the chapters in *Moments*?

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Pulsar Astronomy

A. G. Lyne and F. Graham-Smith
Cambridge U. P., New York, 1990. 274 pp. $69.50 hc
ISBN 0-521-32681-8

The discovery of pulsars and the wide range of observations they subsequently made possible will always be regarded as a chapter of outstanding success in astronomy. The pulsars introduced us to a whole new world, which before then was only vaguely suspected by a few theoreticians. That world is one of enormous densities, enormous concentrations of energy and very strong gravity—a world in which Einstein's gravitation is supreme and Newton's laws would not even be a rough approximation. Unlike many other recent discoveries in astronomy, this was one that showed how far into the unknown the theoreticians had successfully penetrated. Of course the pulsars created a number of new puzzles, but what is striking is how much fell into place right away and how many predictions received observational verification.

The book is an excellent account of this chapter of astronomy. The authors have been major contributors to the field—Graham-Smith from the beginning of the investigations, following the announcement of the discovery. The great discovery, the arguments, the numerous considerations that could be brought to bear—all are clearly presented. A physicist, an astronomer or even an interested amateur will have no difficulty following the narrative and appreciating the excitement. The discussion of the astronomical applications and of the suggested mechanisms responsible for the emissions from pulsars will need a little more specialized knowledge.

The emission mechanism is not yet