BOOK REVIEWS

Relativity and Experiment

Gravitation and Inertia. IGNAZIO CIUFOLINI and JOHN ARCHIBALD WHEELER. Princeton University Press, Princeton, NJ, 1995. xiv, 498 pp., illus. $49.50 or £32.50. Princeton Series in Physics.

General relativity is a peculiar physical theory. It was conceived by a single man almost in isolation, and it was grounded almost uniquely on pure speculation on the nature of space and time, with minimal inputs from experiments. The theory received some early sensational experimental corroboration, but for quite a while that was all. At the time I studied the subject, the "three classic experimental tests" of the theory (Mercury perihelion shift, solar light ray deflection, and redshift) virtually exhausted experimental relativistic gravitation. Contact with the rest of science was meager as well. For several decades, the scientific tribe of the general relativists survived rather disconnected from mainstream physics, as a kind of respected but basically ignored theoretical cult: "those who study the shape of space-time."

It is not like that any more. The field is undergoing a large-scale transition, driven by many forces. First, the intricate puzzle of particle physics has been mostly solved, with the $u(1) \times su(2) \times su(3)$ standard model. Most particle theorists now explore theories that include gravity as well, such as string theory. Second, astronomers have discovered that the universe contains plenty of regions turbulent enough to reach general relativistic regimes. Third, communication technology is getting close to the accuracy levels where general relativistic corrections must be considered. (The U.S. Army employed such corrections during the Gulf war; Einstein's main legacy lost its traditional pacifist purity.) Fourth, the unease of having two "fundamental" theories of nature—quantum mechanics and general relativity—at odds with each other has attracted an increasing number of scientists toward a major open problem of fundamental physics: "quantum gravity," the attempt to reconcile the two.

But the strongest force of all driving the revival of general relativity is an explosion of experimental activity. At the last grand meeting of the community, held in Florence, Italy, in August, observations and experiments captured most of the attention, as well as a giant share of plenary talks—a situation previously unheard of in gravity circles. Gravitational lensing observations, measurements of the cosmic background radiation revealing footprints of eons ago, apparatus getting ready to detect gravitational waves, a steady flow of cosmological data, observations of binary pulsars that fit general relativistic calculations spectacularly well—the list is impressive. Some of these novelties, such as the Cosmic Background Explorer data, reached the mass media. Some experimental programs, such as gravitational-wave detection, are gaining major financial support from various countries. A recent Nobel Prize honored experimental gravity for the binary pulsar observations. The excitement is high. Eighty years after Einstein's paper introduced general relativity almost out of pure thought, gravitational physics is returning to the right Galilean balance of theory and experiment.

In this new climate, it would be misleading to treat general relativity as a purely theoretical topic. Most classic textbooks of the subject, however, predate the experimental explosion and largely neglect experiments.

Gravitation and Inertia now fills the gap. It is a work on general relativity with major emphasis on experiments, and it covers the recent blossoming of experimental relativistic gravitation. The book can be a reference for anybody with informed curiosity, a supplementary textbook in a general relativity class, or even a main textbook, since it is introductory and relatively self-contained. To my knowledge, the only other book with extensive coverage of gravitational experiments is a very good book by Clifford Will, *Theory and Experiment in Gravitational Physics* (Cambridge University Press, 1993). The two books do not overlap much: Will's is more specialized, being based on the parameterized post-Newtonian formalism, and slightly outdated by the rapid changes in the field. For instance, it includes little on space experiments, the best-developed part of *Gravitation and Inertia*.

One of the two authors of *Gravitation and Inertia*, Ciufolini, is actively involved in gravitational space experiments and architect of the LAGEOS (Laser Geodynamic Satellite) experiment. Ciufolini's experimental expertise and his passion for space experiments, and in particular for LAGEOS, inform the book.

The other author, Wheeler, was close to the core of that spectacular intellectual adventure that was the physics of the first half of this century, and he has introduced many striking ideas regarding general relativity (an example is the idea that space-time has a foam-like structure at short scale; and the main equation of quantum gravity, the Wheeler-DeWitt equation, carries his name). Wheeler's provocative literary style (he introduced the terms "black hole" and "mass without mass," indicating the idea—recalled in this book—of deriving mass from spatial topology) is easily identifiable in parts of the book. His visionary imagination, passion for intellectual speculation, and search for deep physical insight form part of its soul. Intertwined with the treatment of experiments is a long meditation on the meaning of the concept of inertia. Discussing the ideas of Mach, Leibniz, and Berkeley, the book continues the "philosophical" tradition of general relativity.

The conceptual and the experimental streams converge in the presentation of Ciufolini's LAGEOS experiment, which is intended to detect the Lense-Thirring ef-

Prices of Books

Average per-volume prices of books reviewed in *Science* 1990–1995. The average prices per page for the technical books in the natural sciences for the years covered were 17.8¢, 17.0¢, 17.2¢, 17.2¢, 18.3¢, and 16.7¢. (Data are for hard-cover books except where books were available only in paperback.) For earlier data from *Science* and other relevant information see *Science* **211**, 933 (1981); **235**, 95 (1986); **239**, 81 (1987); **243**, 99 (1989); and **267**, 115 (1995).

Category	Price (dollars)					
	1990	1991	1992	1993	1994	1995
All books	54.43	54.08	57.58	51.21	59.96	60.52
Technical books in natural sciences	75.57	73.19	76.78	79.00	81.93	77.37

fect, a remarkable prediction of general relativity not yet experimentally tested. According to it, an inertial frame, say, at the Earth's north pole is "dragged along" by the Earth's rotation and therefore rotates (very slowly!) with respect to the distant stars. LAGEOS is an experiment that directly addresses Wheeler's discussion on the meaning of inertia.

The book has its limits. The technical theoretical part is sometimes too simplified, and the exposition is sometimes weak. Some topics are treated in a not very convincing manner. Hawking's black hole radiance, to mention one example, is derived in a surprisingly vague fashion, without even a mention that more solid derivations exist. Altogether, the book does not have the flamboyant richness of the textbook by Misner, Thorne, and Wheeler himself, the magic concision of Landau's, the elegance and sophistication of Wald's, or the concreteness and unorthodox genius of Weinberg's. But it has plenty of useful resources and ideas and it is enjoyable. It covers, sometimes with distinctive originality, topics not easily found in other textbooks. Its charm lies in the interweaving of Wheeler's speculative quest for the physical origin of inertia with Ciufolini's experimental craft. In such interweaving lies the magic of an extraordinarily beautiful science: the science of the shape of space-time.

Carlo Rovelli
Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260, USA

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Responding to AIDS

AIDS and the Public Debate. Historical and Contemporary Perspectives. CAROLINE HANNAWAY, VICTORIA A. HARDEN, and JOHN PARASCANDOLA, Eds. IOS Press, Burke, VA, and Ohmsha, Tokyo, 1995. viii, 216 pp., illus. $70 or £60 or Dfl 160 or DM143 or ¥8900.

In this volume the editors have gathered a group of essays many of whose authors were key players in the early days of the epidemic: C. Everett Koop, the U.S. Surgeon General under President Reagan; Anthony Fauci of the National Cancer Institute; James Curran of the Centers for Disease Control; and Mark Smith of the Kaiser Foundation (who was an intern and resident in San Francisco as the first cases of AIDS were turning up). Other contributors include the scholar James Harvey Young writing of the experience of the FDA in securing faster approval of experimental drug treatments for the symptoms of AIDS, June Osborn writing of her experience in leading the National Commission on AIDS formed during the Bush Administration, and Ruth M. Kulstad, formerly of *Science*, writing of the early days when papers on HIV began to be sent to the journal and of the challenge of finding competent reviewers to evaluate the submissions. Two other authors, Allan Brandt and Richard Goldstein, comment on the impact of HIV and AIDS on American society. There are also papers on AIDS in Haiti, the United Kingdom, France, and Uganda.

The contribution by Koop is wonderful and insightful. Koop shows why he was such a phenomenon in Washington, a conservative physician who had difficulty winning Senate confirmation and who went on to battle the ideologues of the Reagan revolution. Only very rarely meeting with Reagan, he only had one (short) substantive conversation about AIDS with the president, and in only one press conference did Reagan seem to be directly following Koop's leadership. Koop professes mystification as to the bureaucratic politics of AIDS. Perhaps this is because, for him, his duties as Surgeon General were simply an extension of his duties as a physician: to protect and preserve life and to do so in an atmosphere of scientific truth-telling. Nonetheless, he remains a social conservative; excerpts from one week's diary he includes to show how the issue of AIDS took over his work life detail a crowded schedule of meetings with officials, experts, gay and lesbian advocates, and others, all focused on AIDS, and mentions in passing addressing a group of conservative Christians and talking about "loving the sinner" and hating the sin.

Curran's contribution, though less personal and candid, is also very valuable. Curran was a leading epidemiologist with the Centers for Disease Control when the AIDS epidemic began. Curran begins his story with a strange comment about how he will try to stick to "the facts" as admonished by the historians. He expresses admiration for Koop and for his objectivity and his refusal to act the way the newspapers expected him to. Similarly, he has praise for Admiral James Watkins and his commission on AIDS, which produced a report that resisted ideological twists. Curran details the early work of physicians and epidemiologists, primarily in New York and California, as they puzzled over the strange reports of a deadly pneumonia among young men and a surprising number of cases of Kaposi's sarcoma, a rare cancer that was turning up among gay men. The story of how rapidly the CDC, the National Institutes of Health, and state agencies began to zero in on the virus is one of the most exciting stories in modern public health.

Other contributions are equally interesting. Victoria Harden's discussion of the increased funding in the NIH for AIDS and the impact of AIDS on how clinical trials were conducted (experimental drugs were made available on a "parallel track" to potential beneficiaries who were not participants in the official trials) provides much factual background bearing on a very controversial topic. The essay by Ruth Kulstad is one of the most exciting in the book. Much of modern medicine and public health turns on public discussion and debate among scientists and other experts, and much rides on the quality and timeliness of that debate. *Science* and other leading scientific journals such as the *New England Journal of Medicine* and the *Journal of the American Medical Association* played a key role in the early days of AIDS.

Fauci's contribution includes an interesting reflection on the interaction of society, politics, and science, focusing on the rise of constituency activism on the part of gays and the transformation of that approach from one of confrontation to one of wary co-optation. As a result of a process that Fauci characterizes as "enlightening and on the whole positive and productive," activists now serve on federal advisory boards and the procedures for approval of new drugs to treat HIV and AIDS have been greatly modified to accommodate the objections of the activist community.

These are the strengths of the volume. The weaknesses stem from its origins. Apparently it is the proceedings of a meeting, but there is little discussion of the purpose of the meeting or of the rationale underlying the distribution of topics. It may be that the focus was intended to be on official or establishment participants who had not told their story, but if so it is surprising that, apart from a few leaders in the federal government, no officials from either New York or California are included. Nor is there any representation of the early experience of clinicians except for Mark Smith's contribution, and his story is part of an assessment of the impact of AIDS on the minority community. There are no contributors from the activist community.

Despite these weaknesses, I found the book exciting reading. Beginning in 1988 I myself spent some time as an official of the New York State Department of Health, and I saw how exciting public health can be, whether in contending with the AIDS epidemic or in fighting for universal health care. Many of these papers convey a sense of this too-little-appreciated sector of public service and how often it is filled with drama, conflict, accomplishment, and failure.

Dan E. Beauchamp
Department of Health Policy and Management, State University of New York, Albany, NY 12222, USA