as a jeweler would take in selling a diamond."

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Long-Range Casimir Forces: Theory and Recent Experiments on Atomic Systems

Edited by Frank S. Levin and David A. Micha
Plenum, New York, 1993. 357 pp. $75.00 hc
ISBN 0-306-44385-6

As Hendrik Casimir showed theoretically in 1948, the attractive force between two plane, perfectly conducting, uncharged capacitor plates can be related to a decrease in the electromagnetic vacuum energy as the plates are brought together. This Casimir force is one example of a very general phenomenon in which objects that impose boundary conditions on a quantum field experience forces. The idea of forces exerted by a vacuum is so fascinating that an enormous body of literature has grown around it in the last 45 years. This book is a recent example.

The book begins with Larry Spruch's general theoretical introduction to the subject of forces between polarizable systems. Spruch has worked for many years on this problem and writes with a marvelous physical insight and an appropriately selective minimum of technical detail about the important concepts underlying Casimir forces. The closing chapter by Joseph Sucher and Gerald Feinberg is an excellent, broad discussion of the theoretical foundations of the quantum theory of long-range forces, and it includes some interesting remarks about the role of potentials. It is, however, quite technical and may not be easily accessible to the general reader.

The remaining three chapters of the book concentrate on the interaction between the outer electron of a highly excited (Rydberg) helium atom and its singly charged inner core. Although the energy is dominated by the Coulomb interaction, a small contribution due to Casimir forces is predicted. Chapters by Gordon Drake and Richard Drachman, two leading theorists on the Rydberg states of helium, devote 165 pages to a detailed account of the remarkable progress made over the last ten years in computations of this particular system. While they cover far more than the general reader could want to know, these two chapters provide a readable and useful reference work on this subject. The single chapter on experimental matters, in which Stephen Lundeen gives a well-written account of microwave spectroscopy in the Rydberg states of helium, concentrates mainly on the very precise measurements made by his own group. I enjoyed the level of experimental detail as well as the careful explanation of how one attempts to extract the minute Casimir–Polder interaction by comparing the measured and calculated microwave intervals.

The editors describe this book as a pedagogic review that should "allow a nonexpert to grasp the underlying ideas as well as understand the technical details." They are not entirely successful in this broad aim; many important aspects of Casimir forces are either omitted altogether or touched on only briefly in Spruch's introductory chapter. It is unfortunate, for example, that there is no account of pioneering work by Gabriel Barton on long-range atom–surface interactions, by Peter Milonni on many aspects of Casimir forces and the nature of the vacuum, and by many researchers on more recent topics, such as the fluctuations of the Casimir force and Casimir forces in accelerated systems.

On the experimental side, it would have been appropriate to include some account of the long and fascinating history, starting with the work of Jan Overbeek in 1946 on colloids that stimulated the original paper by Casimir and Dik Polder. After two decades of attempts by many experimenters to study Casimir forces on macroscopic conductors, dielectrics and liquid films, a new line of research was started by Donald Raskin and Polykarp Kusch, who looked for the van der Waals force between an atom and a macroscopic conductor. This led eventually to recent experiments in which the van der Waals and Casimir–Polder forces between an atom and a conductor have been measured with high precision.

I recommend two supplements to this book: *The Quantum Vacuum, An Introduction to Quantum Electrodynamics* (Academic, 1994) by Peter Milonni, provides a brilliant and scholarly introduction to all aspects of Casimir forces; some chapters in *Cavity Quantum Electrodynamics* (Academic, 1994), edited by Paul Berman, cover recent experiments and other current topics in the field.

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Particle Accelerator Physics

Helmut Wiedemann
Springer-Verlag, New York, 1993. 445 pp. $59.00 hc
ISBN 0-540-56550-7

The Principles of Circular Accelerators and Storage Rings

Philip J. Bryant and Kjell Johnsen
Cambridge U. P., New York, 1993. 357 pp. $100.00 hc
ISBN 0-521-35578-8

In the past 15 years, particle accelerators have been transformed from an exotic research instrument into a general-purpose tool. In addition to their traditional use in particle and nuclear research, particle accelerators have been applied to research in chemistry, biology and materials science and to a wide range of industrial and medical applications, such as micromachining, x-ray lithography and radiation therapy. The studies of dynamic properties of systems having a characteristic size of about 0.1 to 100 micrometers and a time scale of a few milliseconds or microseconds find a natural match in synchrotron radiation facilities, which can generate intense x rays with tunable frequency and well-defined time structure. The explosion of particle-accelerator applications, coupled with the maturity and sophistication of beam dynamics in accelerator design and operation, has led to the formalization of the education of accelerator scientists and engineers through classroom instruction and textbooks. The two books reviewed here are an outgrowth of this trend in accelerator education.

Helmut Wiedemann holds a joint appointment at Stanford University and at the Stanford Synchrotron Radiation Laboratory. His book, *Particle Accelerator Physics*, is the first of a two-volume series. It provides an introductory survey of the fundamental principles of particle accelerators, followed by the theory of linear beam dynamics in the transverse as well as longitudinal phase space, including a detailed discussion of basic magnetic focusing units. The author tries to derive most of the equations governing particle motion in an accelerator from first principles, while retaining the intuitive and pedagogical nature of the exposition. It is an ideal classroom textbook, especially because of its complete collection of well thought-

out exercises at the end of each chapter and detailed bibliography and references. I am particularly impressed by the scope and rigor of the treatment of the motion of charged particles in an electromagnetic field, the design and function of the accelerator lattice and the synchrotron radiation issues raised by electron storage rings. The careful discussion of the interplay of machine lattice and synchrotron radiation in determining the beam parameters—such as emittance, lifetime and energy spread—is extremely useful for the design of an electron storage ring for either a synchrotron radiation facility or colliding beam research. The first few chapters survey the historical development and design principles of various types of accelerators and are of particular value for readers new to the field; overall this book will serve a generation of readers.

Bryant and Johnsen's book, *The Principles of Circular Accelerators and Storage Rings*, is based heavily on their longtime experience with the construction and operation of the Intersecting Storage Ring at CERN. After introducing the basic concepts and equations of particle motion in an accelerator, the authors focus on the lattice imperfections and resonances, space-charge effects and coherent instabilities, and beam diagnostics and compensations. These subjects are all very important in achieving high-intensity and high-luminosity operation of a proton–proton collider, an area where CERN has made major contributions to the accelerator community. The chapter on diagnosis and compensation explains the making of observations on accelerator parameters and beam performance with instrumentation and provides the necessary correction and compensation to achieve the required beam behavior in an accelerator. This information is essential to the successful design and operation of particle accelerators. The treatment of the subjects is more intuitive, with plenty of hands-on graphic illustrations, trade tricks and secrets. The book will be very helpful for anyone interested in putting the abstract concepts and principles to use in making a machine work as designed. There are no homework exercises for the student, and so it may not be suitable for classroom use, but it is an excellent reference book for practitioners.

The book by Donald A. Edwards and Michael J. Syphers, *Introduction to the Physics of High Energy Accelerators*, (Wiley, 1993; reviewed in PHYSICS TODAY, February 1994, page 94) is more general, with many mathematical formulations, and is less specific in its applications than the books reviewed here. Wiedemann's book leans more toward electron storage rings; Bryant and Johnsen's book places more emphasis on proton storage rings. These three textbooks, all published in 1993, provide graduate students with a convenient place to begin their study and give practitioners a ready reference for the physics foundation of particle accelerators. As accelerator education continues to evolve, future books will be written to address more advanced subjects in beam dynamics and component-design principles to complement these introductory expositions.

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Pauper & Prince: Ritchey, Hale & Big American Telescopes

Donald E. Osterbrock
Arizona U. P., Tucson, 1993.
359 pp. $45.00 hc
ISBN 0-8165-1199-3

George Ellery Hale and George Willis Ritchey were both ambitious, driven men. Hale was (and is) famous as astronomer, builder of scientific institutions and international statesman of science. Ritchey, noted as an astronomical telescope builder and craftsman, is memorialized today mainly in a popular design for reflecting telescopes—the Ritchey–Chrétien. Hale and Ritchey share much of the responsibility for establishing the reflecting telescope as the instrument of choice for 20th-century optical astronomy.

Hale was building his first large observatory, the Yerkes Observatory, in the 1890s, when he hired Ritchey as a technician to build optical and mechanical systems. Hale moved on after the turn of the century to establish the Mount Wilson Solar Observatory in Southern California, and Ritchey moved with him to complete a 60-inch reflector there, then the largest in the world. They hardly caught their breaths upon its completion: Hale turned to plans for even larger instruments of conventional design, while his capable technician dreamed of huge telescopes using his untested hyperboloidal mirror design. Hale prevailed, and decided that a 100-inch classical reflector was the next logical step. Friction between the men escalated during the difficult process of building this instrument at Mt. Wilson, and Ritchey left Hale's employ under a cloud soon after the 100-inch reflector was completed. Hale moved on to even greater projects: the rebuilding of international science, the creation of Caltech and the construction of the 200-inch reflector on Mount Palomar.

Hale has captured the attention of many historians, including Helen Wright and Daniel Kevles. Their work is not superseded here. Rather, *Pauper & Prince* provides a contrasting vision of Hale's life and character, as they might have seemed to ambitious subordinates like Ritchey. It is a detailed, chronological narrative of the events that brought Ritchey and Hale together and of the events that soured relations between Ritchey and his superiors. The story takes Hale through his success in getting the 200-inch telescope started, but it concentrates on Ritchey's life post-Hale. It follows Ritchey to France, where he tried in vain to build his radical telescopes on a scale that would be gigantic even to a modern particle physicist. Failing completely, he was hired in the 1930s by the US Naval Observatory, where he finally built a 40-inch Ritchey–Chretien telescope, although it never worked properly until someone else was put in charge. Finally, Ritchey returned to his lemon ranch in Azusa, California, to live out his last days in obscurity and bitterness.

Osterbrock, a well-known astronomer and writer of astronomical history, works hard to resurrect Ritchey by employing the unfortunate ahistorical tactic of belittling Hale. But from the facts Osterbrock lays out, and given the standards of conduct for his day, Hale was rather generous as an observatory director and Ritchey comes off looking like a megalomaniac. Although Osterbrock is to be applauded for trying to right an imbalance in the history of science by devoting serious attention to a highly creative craftsman and instrument builder, his penchant for bashing Hale keeps him from asking really useful questions about the historical relationship between entrepreneurs and craftsmen. For example, the data cited in the book underscore the question of what made telescope builders like Ritchey possible in the first place. Would he have achieved the greatness Osterbrock bestows upon him without a man like Hale to raise the funds, set the direction and see to the completion of the project? Osterbrock's narrow focus and general avoidance of the historical literature keep him from asking such ques-