

loun zones, the quantum machinery and quantized excitations—are excellently and creatively done. The chapter on real metals takes up some difficult topics like the Mott transition and makes them fairly intelligible. The author claims not to be a professional solid-state physicist, but the treatment in this text indicates the usefulness of at least occasionally listening to what an outsider has to say.

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## The Cavendish Laboratory 1874–1974

J. G. Crowther  
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In an age when name changes of laboratories are common (Oak Ridge to Holifield, JPL to H. Allen Smith), it is refreshing to note that the Cavendish Laboratory has retained its illustrious name despite a physical shift to the outskirts of Cambridge, England. Indeed, the tradition-conscious British no doubt would be appalled at the suggestion of a name change, because the laboratory (given as a gift to Cambridge University by its chancellor, the Seventh Duke of Devonshire, whose family name was Cavendish and who was related to Henry Cavendish) was for decades the most famous site of physics research and teaching in the world, and continues to be one of the foremost.

J. G. Crowther, a long-time scientific journalist for the *Manchester Guardian* and author of numerous books on British science, has written a "biography" of the Cavendish Laboratory in honor of its centennial. The first director, James Clerk Maxwell, both carried to it his own strong research orientation and established in Cambridge the then-not-universal opportunity for physics students to take experimental laboratory classes.

Lord Rayleigh (director 1879–84) systematized the teaching and concentrated research on electrical phenomena, particularly the determination of physical units. Under his successor, J. J. Thomson (1884–1919), the laboratory expanded in size and numbers and witnessed investigations of great significance: "J. J.'s" own discovery of the electron and work on positive rays, C. T. R. Wilson's development of the cloud chamber, Ernest Rutherford's first examination of radioactivity, W. L. Bragg's analysis of crystals by x-ray diffraction and F. W. Aston's early work on the mass spectrograph. By the time of Thomson's retirement in 1919, it was logical that his own pupil, Rutherford, should carry on this tradition of emi-

nence. Nuclear physics now became the Cavendish's primary research area, investigated by James Chadwick, C. D. Ellis, Patrick Blackett, John Cockcroft, E. T. S. Walton, Mark Oliphant, and others, while physics of different sorts was pursued by Peter Kapitza, Edward V. Appleton, and G. I. Taylor.

Under W. L. Bragg (1938–53) the laboratory then deemphasized nuclear physics (although Otto Frisch did arrive during this period) and encouraged the development of radioastronomy by Martin Ryle and Antony Hewish and the extension of Bragg's own speciality of x-ray diffraction to organic molecules, by Max Perutz, John Kendrew, Dorothy Hodgkin, James Watson, and Francis Crick. Solid-state physics achieved prominence under Nevill Mott

(1954–71), the next Cavendish Professor, with Brian Josephson's work being most notable. Since 1971 Brian Pippard has directed the laboratory.

Crowther's volume covers the material one would expect. He discusses the contributions not only of those named above, but of virtually every Cavendish member of at least moderate distinction, often to the point of "losing the laboratory for the scientists." He provides biographical sketches of the more distinguished figures and writes about the construction of laboratory additions, giving floor plans and dimensions of some. Crowther discusses the administration, finances, academic politics surrounding the laboratory's establishment and teaching. But, unfortunately, it does not jell into a unified





book. The problem, I feel, is one of construction and emphasis. Crowther has a reputation as a skilled science reporter, and he has known a number of people he writes about. Yet he has fashioned this book around several reports, for example those compiled by various of the professors, presumably paraphrasing them extensively, such that the text is dry. Moreover, though he endeavors to show connections between research programs, to present the logic of trends, one paraphrased report from a professor's tenure is inadequate for such purposes. The sections through Rutherford's time are more coherent, clearly because the laboratory was smaller and itself more cohesive. From Bragg onward the size and diversity tend toward industrial proportions, making organization of an overview difficult. Crowther, who is keenly interested in the social relations of science, would have done better to emphasize further the laboratory as a social institution, rather than catalog the work done in it.

The book is handsomely produced, on heavy paper and with attractive illustrations. Its complete lack of footnotes and limited bibliography reduce its usefulness for historians, but there is much information that one can find only here in a readily available form. Those interested in a distinguished institution's history, therefore, will find this volume of value.

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## Laser Physics

M. Sargent III, M. O. Scully, W. E. Lamb Jr  
432 pp. W. A. Benjamin, Reading, Mass.,  
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Fifteen years ago the first man-made laser was successfully operated, and the phenomenal growth of laser devices and their applications is well known not only to physicists but also to other scientists, engineers and laymen. Numerous books about lasers have been published aimed at diverse categories of audiences. This book by Murray Sargent III, Marlan O. Scully and Willis E. Lamb Jr addresses itself to graduate students in physics and professional colleagues. It presents in a compelling form the important contributions to laser theory made by the "Lamb School." Sargent and Scully were among Lamb's graduate students at Yale University; the three authors are now faculty members at the University of Arizona. This textbook results from, and has been extensively tested in, a full-year graduate physics course conducted by the first two authors at Ari-



The first continuous organic dye laser, tunable in the 5500–6500 Å range, operated at the Kodak Research Labs in 1970. Pump light enters and is focussed into the dye-laser cavity

zona during several years. Although the book should definitely be classified as a book on laser theory, it makes sufficient connection with a few basic experimental laser configurations. In the "Lamb tradition" the basic physical ideas are stressed and the formalism is not pursued for its own sake.

The book may be divided into three parts: a review of quantum mechanics and classical oscillator theory, semiclassical layer theory, and fully quantum-mechanical laser theory with discussions on photon statistics and noise. The reader is thus introduced to laser concepts at three different levels of sophistication. Numerous cross references guide him in the early stages to more rigorous treatments later on, or conversely, from the more advanced formulations to the simplified treatments earlier in the book.

In the first part (seven chapters) the authors discuss wave mechanics, the harmonic oscillator, the two-level problem, atom-field interactions, the quantum electric dipole and the ammonia beam maser, and they introduce the notions of state vector and density matrix. All this is, of necessity, done in a rather abbreviated manner, and may be rather heavy going as a first exposure. In the preface, the authors state that a one-semester introductory course in quantum mechanics is required, but a two-semester introduction appears a more realistic prerequisite. Perusal of these chapters by the advanced specialist can give him additional glimpses of insight. Chapter 4 is of particular interest, because it contains a purely classical discussion of oscillations and frequency locking, based on the pioneering work of Balthasar van der Pol—material not usually found in laser textbooks.

The second part (chapters 8 through 13) includes a development of the semiclassical theory, first for single-mode operation with the active laser atoms or ions at rest. They discuss multimode

operation in great detail, and then present the gas laser theory with moving atoms, hole burning ("Lamb dip") and so forth. Separate chapters on the ring laser and the Zeeman laser again devote considerable attention to mode competition and mode locking. Individual steps in the calculations are indicated in sufficient detail, homogeneous and inhomogeneous (Doppler) broadening effects are always carefully distinguished. Chapter 13 deals with self-induced transparency and photon echoes. It stands somewhat apart from the laser chapters and does not delve as deeply into the subject matter.

The third part deals with the quantum theory of radiation, coherent states, density operator for the field and the Fokker-Planck equation. Noise in laser oscillations and the analogy of the threshold for oscillation with a phase-transition are discussed in a clear manner. Parallel treatments of these topics may be found in W. H. Louisell's book "Quantum Statistical Properties of Radiation" (Wiley, New York, 1973), and H. Haken's contribution "Laser Theory" in *Encyclopedia of Physics* (Vol. XXV/2c, S. Flügge, ed., Springer-Verlag, Berlin, 1970). The reservoir theory, the interaction of a mode of the electromagnetic field with a many-atom system, is treated both by the density matrix and the noise operator method. It is useful to have a well-organized and concise presentation of this difficult subject matter in the present text. The final chapter, entitled "Outlook," is too sketchy to be of much use and the section "Impact of the Laser" occupies less than three pages. The analogy with phase transitions and Josephson radiation would also require further elaboration.

The authors state in the preface that the material in the first thirteen chapters constitutes a viable alternative for a second semester quantum-mechanics course, and the remaining chapters