portant areas completely. Furthermore, the two books mentioned above often have a level and style of presentation which is very difficult for graduate students.

Alexander L. Fetter and John D. Walecka have written a textbook that does an excellent job of filling in most of this gap. Their work contains a good introductory presentation of the field-theoretic techniques that have been developed for application to zero temperature and finite temperature problems in many-particle systems. The diagramatic and Green's function formalism is described in precisely the right amount of detail so that the novice can learn what is being done and how to do it himself. To aid the student in understanding the relationship between formalism and applications, the discussions move up and back between general theory and applications to particular cases.

The kinds of systems studied include the electron-gas weakly interacting system, degenerate Fermi and Bose systems, nuclear matter, the electron–phonon system, superconductivity, superfluidity and the atomic nucleus. Each case is considered as an illustration and application of the formalism. For this reason, the discussion of the physics of these diverse systems seems slightly superficial at times, especially in comparison with the relatively sophisticated level of formal technique. Hardly any experimental facts are presented. This text teaches the theory that underlies the calculational methods; it is not intended to give a full explanation of the physical picture of the different many-particle systems.

In short, the book is singlemindedly devoted to its job of educating potential many-particle theorists. Students will profit from the especially clear and direct presentation and from the inclusion of useful references and problems. For these reasons, *Quantum Theory of Many Particle Systems* deserves to become the standard text in the field.

LEO P. KADANOFF
Brown University

The Nature of Ball Lightning

S. Singer

169 pp. Plenum, New York, 1971.

The existence of ball lightning (Singer mentions) was recorded by Posidonius in the first century, BC but naturally Posidonius did not know its nature. Lord Rayleigh studied ball lightening early in this century and at that advanced date he was still unable to explain it. (Rayleigh made cutting note of the contempt of savants for the experiences of others, citing meteorites and ball lightning as instances. Meteorites ("thunderstones") were dismissed as pagan superstition until the 19th century. Ball lightning is just becoming respectable in our time.) And now at last Singer gives the best collection of ball-lightning observations, references and theories I have seen; but he does not tell us what ball lightning is either, for the title of this book is quite at odds with its contents.

Ball lightning. This is one of the few pictures of ball lightning. From Singer's book on the subject which is reviewed here.

I don't think anyone knows what ball lightning is. Maybe the truth lies somewhere between the dc discharge model James Powell and I worked on, and the rf one of Pyotr Kapitza, with several hundred joules stored in the ball and a few hundred watts flowing through it. Radiofrequency electric currents are suggested by some observations, but where could they come from? And while dc is provided copiously by thunderclouds, there is no ready explanation of how it can get into metal aircraft.

If it were a matter of biology the present inability of physics to cope with the phenomenon would be customary, hence tolerable. But ball lightning looks like a gaseous discharge (although Michael Faraday thought not) and we should be able to deal with it at least qualitatively from fundamental principles. We can't, and it's getting embarrassing. Nor is the reputation of science much improved by our again denying the existence of what we cannot account for.

Knowing what ball lightning is may not help much with our other problems, but it is a charming and long-standing puzzle in its own right; and while Singer is undercritical when he is presenting the many attempts at ball-lightning theories, and his prose sometimes verges on the bureaucratic, I doubt if anyone else has such grasp of the history and literature of ball lightning. He makes a great deal of work more available to us all. There is even a certain piquancy in the contrast between the lively whimsi-

cality of the actual happenings and the deadly dullness of the writing.

If you want to join the game you have to begin with this book. Here are some basic rules of serious play that I have attempted to honor and would like to promulgate:

If we use circulating currents, we estimate the electrical conductivity of our model.

If we use exotic species, we compute their lifetime and production rate.

If we draw power out of the ball, we put the power in.

So onward all to the contest, and let the cry be heard, "*Remember the Virial Theorem!*"

DAVID FINKELSTEIN
Yeshiva University
New York

Physics for Biology and Pre-Medical Students

M. Burns, S. G. G. McDonald

614 pp. Addison-Wesley, Reading, Mass., 1970. $9.50

This is one of the few physics texts at present that is specifically addressed to the large and growing audience of pre-medical and biology students. It was three years in development at the University of Dundee by Senior Lecturers Desmond M. Burns and Simon G. G. MacDonald (the latter being Dean of the Faculty of Science and author of *Problems and Solutions in General Physics for Science and Engineering Students*, Addison-Wesley.) The result is a fairly coherent, well designed book with very broad coverage.

The authors have "attempted to give a basic understanding of the relevant principles of physics, illustrating these, where possible, with current examples of their use in biology and medicine." Understanding may not be as easy to give as illustrations, but the examples themselves are worth the price of the book. There are many examples of contributions by physics to advances in biological fields and medical technology, with which many physicists are not familiar. Physicists who have adopted another text in teaching life-scientists should use this book as a reference, both for themselves and their students. Unfortunately the book contains almost no references.

Formulas are of great importance in this book. There are about 400 numbered equations plus many unnumbered ones. Most of the problems test the use of formulas. Of the 500-plus problems, 90% have numerical answers (which are given at the back), 5% are proofs and only about 5% ask for explanations. There are numerous examples worked out.

It is obviously hoped that the student will gain a reading knowledge of mathematics and develop a facility with algebra, trigonometry and perhaps calculus. Simple calculus is developed with commendable brevity, lacking only the idea of the extremum. Oddly, the derivations of formulas for the energy stored in a capacitor or inductor say nothing of integrals. Vectors are discussed, but the dot and cross products are not. Good use is made of rotor diagrams. A good chapter on statistics, complete with clinical examples of various tests, seems out of place here except for use by graduate students. There is emphasis on dimensional analysis, mainly to justify the form of equations pertaining to viscosity that are used effectively in several different sections. All of this means that the mathematical level required of students is high.

The writing is good and impressively concise, but the coverage lacks depth. The broadside approach is excellent; students meet the motion of charged particles in electric and magnetic fields as examples of dynamics twenty chapters before those fields are studied. However, the molecular viewpoint, introduced early, is not used thoughout to help interpret phenomena and to contribute to students' understanding. Too much is said to be a consequence of energy conservation (for example, even the minimization of the surface area of a liquid). At best, this adds little to one's comprehension although it does justify a formula efficiently. The style does not convey physical understanding or physical intuition, but it may appeal to students as being clear cut.

There is little humor or excitement in the book. Even when considering the possibility of wedding ultrasonics with optical holography to construct a three-dimensional image of the inside of the body, the tone is reserved. Seldom is there wonder. Experiment plays no role except as arbiter assuaging doubt.

There are 36 chapters. The first third of the book deals with mechanics and heat. Wave motion and optics constitute more than one quarter of the book. At the end of this the student is supposed to be equipped with the background necessary to understand and appreciate an electron density map as obtained by x-ray diffraction analysis. Chapters on the ear, the eye and on "specialist microscopy" make informative reading. A quarter of the book is on electricity and magnetism including conduction in solids and liquids, and ac circuits. There is much of interest on electrical effects in the body and on the use of magnetic fields in connection with blood flow. An attempt to illustrate impedance matching is a disaster, but the section ends on a sensible note of caution. The last sixth of the book treats atoms, tracers and x-rays (all well