

tried to turn them off, but within two minutes they would again be leaking information." Other memories attest to enormous discretion on the part of the scientists. It is possible that Dudley didn't understand as "thoroughly" as he remembers three decades later.

City Behind a Fence deals almost exclusively with this conflict between civilian workers and the Army Corps of Engineers, not at Los Alamos but at Oak Ridge, Tennessee. With its gaseous diffusion and electromagnetic separation plants, Oak Ridge was built to make the material that destroyed Hiroshima. Like Los Alamos, Oak Ridge was built in haste. Like Los Alamos, it had a population that swelled far beyond expectation. Like those at Los Alamos, the scientists had real problems. The authors of *City Behind a Fence* do not concern themselves with the scientific situation. (Indeed, they probably would not have been able to: The first page of their introduction states, incorrectly, that "nuclear physicists had long understood the structure of the atom and had believed that atomic fission was theoretically possible.") Johnson and Jackson have written a purely sociological study. They have sifted through the records and document pretty thoroughly the dilemmas facing the military in building from scratch a new city, one that within three years would be the fifth largest in the state. There never was sufficient or adequate housing. There was an alarming turnover of workers. The hope was to create a normal town, but it was, instead, "a reservation." It was a community of "civilians subject to military rule."

Johnson and Jackson are more dispassionate than the survivors who remember Los Alamos. They were not there. Soon no one who was *there*, either at Los Alamos or at Oak Ridge, will be *here*. Even those army records will disappear by trashing or shredding or chance or worms. These books are valuable records of an endeavor which affected not only the lives of the people involved in it but everyone anywhere.

* * *

Jane S. Wilson accompanied her physicist husband to Los Alamos in the spring of 1943. She is editor of *Alamogordo Plus Twenty-five Years and All in Our Time*.

Variational Methods in Electron-Atom Scattering Theory

R. K. Nesbet

238 pp. Plenum, New York, 1980. \$32.50

Atomic physics has been born again—and again and still again—since it was the frontier of physics some 50 years

ago. It was the testing ground of QED for a period starting in the 1940s. More recently, the advent of lasers provided an enormous boost, making possible entirely new classes of experiment. Very recently, atomic physicists have looked for the effects of weak currents. More to the point for present purposes is the vast increase in activity in the field that started about two decades ago and has continued unabated. That increase partly reflects developments of intrinsic interest and partly reflects the fact that atomic properties such as transition rates and cross sections, of great importance in astrophysics and in many other areas, can now be calculated with reasonable accuracy for the first time. That accuracy was made possible because high-speed computers could implement theoretical tools, such as variational principles in scattering theory, that had been developed. A leading practitioner in the field is the author, Robert K. Nesbet. He combines a strong mathematical background with computer know-how and a good knowledge of the experimental data which have been obtained and which are needed in other areas.

The material covered in the book is reasonably well described by the title, but is more precisely described in the opening paragraph: The emphasis is primarily on the scattering of electrons by neutral atoms at energies below the ionization threshold. (Some of the methods can be applied readily at higher energies and in electron-molecule scattering.) That restricted domain encompasses any number of extremely interesting processes, which would well repay study even if they did not have important applications. As a dramatic example, we note that in nonrelativistic theory there are an *infinite* number of (rather sharp) "Feshbach resonances" in electron-hydrogen scattering at energies just below the $n = 2$ (and the $n = 3, n = 4, \dots$) level of hydrogen. (The electron excites the hydrogen atom to its $n = 2$ level, forming any of an infinite number of bound states in the approximation in which the $n = 2$ to $n = 1$ transition cannot occur; the degeneracy of the $n = 2$ level gives rise to an effective potential that falls off as $1/r^2$.) Furthermore, these resonances can be calculated with high precision, the calculation being very much simplified by the fact that the projection operators that are required in the Feshbach formalism can be written down explicitly—something which cannot be done in any realistic problem in nuclear physics.

After providing some material on the quantum mechanical theory of electron-atom scattering, the author discusses a variety of variational approaches. The emphasis is very definitely on the use rather than on the

development of variational principles. (Principles that differ only trivially from the conceptual viewpoint can vary greatly in their effectiveness.) There is then a discussion of resonances and of threshold effects. Long-range interactions such as the r^{-4} polarization potential often play a decisive role in low-energy electron-atom scattering and generate a rich structure for both resonance and threshold phenomena. A is only natural for an IBM employee. Nesbet discusses computational techniques in some detail. There are two strong chapters on applications, on scattering by hydrogen atoms and by other atoms; these include a good number of figures comparing theory and experiment, with detailed discussions of who calculated what and by which method, and who measured what when. There are more than 300 references.

While I have no scathing comments, I have some criticisms.

The use of acronyms is completely out of hand. A table of acronyms would have been very useful to McLuhanian nonlinear readers who like to browse and who may not immediately know what VS, NV, EPOM, and so forth, represent.

While credits are not something anyone can discuss objectively, to this reader the references are not always the ones that would have come to mind. The author sometimes follows the not uncommon prescription of ascribing a result to the *last* person to derive it (ultimoottribution, one might call it, analog of ultimogeniture), or, in a new wrinkle, to the first person to use the result.

The implication in a remark on page 35 that a variational bound is possible only if the trial wave function for a given energy is orthogonal to all wave functions of lower energy is not correct: Variational bounds would then be essentially impossible to obtain.

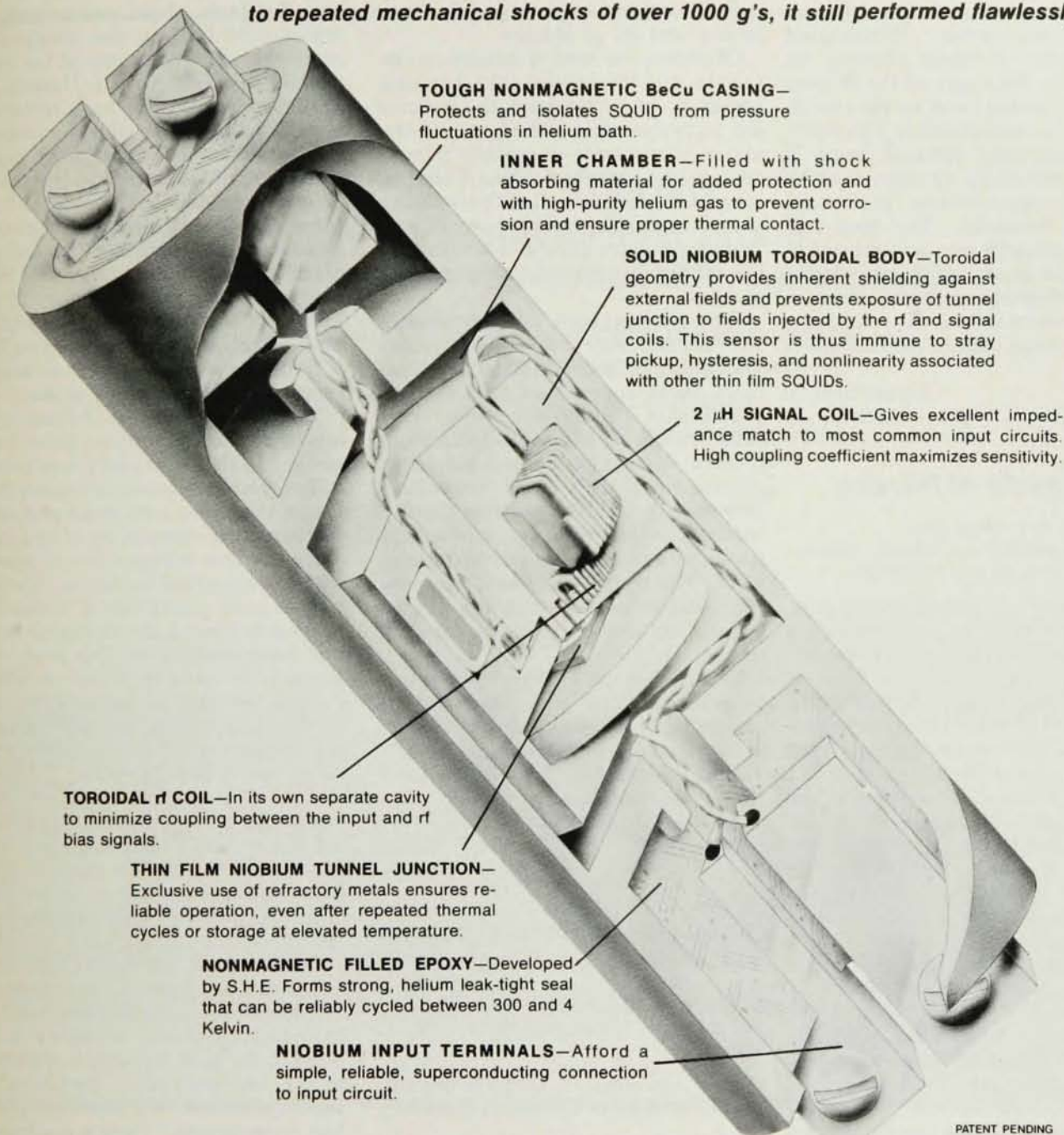
Insufficient effort is made to discuss the origin of variational principles. Thus, given two approximations, T_1 and T_2 , to $T = \tan \eta$, the Schwinger variational principle is stated to be that T_1^2/T_2 is an extremum; it is then verified that this particular ratio is indeed stationary. It would take less effort and be far more educational to show in some generality how to obtain a variational principle.

The author's emphasis on his own work does not leave enough room for the work of others. For example, there is no mention of the exceedingly beautiful series of experiments on electron-hydrogen resonances by a group led by Howard Bryant, using the Los Alamos high-energy H^- beam analyzed by means of a tunable (Doppler shifted) laser beam.

The book was not intended as a

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primer in scattering theory. For someone reasonably familiar with scattering theory, however, it can be a useful source book. In addition to its many references, it contains discussions of the relative merits of the different theoretical approaches. Interspersed are a number of useful physical remarks, as on the origin of the Wigner cusp at a threshold and on the usefulness, from a computational viewpoint, of obtaining cross sections below a threshold indirectly by extrapolating down for computations performed above the threshold. The book will serve any physicist who is interested in the concepts of atomic resonance and threshold phenomena or who seeks information on calculational techniques or experimental data in electron-atom scattering.

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Encyclopedia of Physics

R. G. Lerner, G. L. Trigg, eds.

1173 pp. Advanced Book Program, Addison-Wesley, Reading, Mass., 1980. \$99.50

How does one go about reviewing an encyclopedia that runs to over 1000 pages, with a thousand words on every full page? Take a course in speed reading? Sample a paragraph every 25-50 pages? Discuss other encyclopedias, or just admire the binding? I set about in a somewhat different way. I first made a list of the articles in my field (acoustics)—there were about twenty. These I read. Then I looked for a number of fields of which I knew nothing (or within a $\delta < \epsilon$ of nothing) and read some entries to see if they could educate me. (They did.) Then I checked the authors, the references and the illustrations. And, finally, I admired the binding. (It is first class.)

From all this, what can one say? The editors have, from my samplings, chosen outstanding people to write the articles. Almost all the authors in acoustics are significant contributors to their parts of the field. Just a quick look at the pages between 937 and 1019 turned up Conyers Herring writing on solid-state physics, Sheldon Glashow on SU(3) and higher symmetries, Edwin McMillan on the synchrotron and Manuel Cardona on synchrotron radiation. Not a bad group, and there are others of note in the same sample.

The articles that I read are brief and (mainly) to the point. The numbers of equations, line drawings and photographs are adequate without being overwhelming. Every article is accompanied by a very useful set of references, including both texts on the subject and journal citations. One can start to learn a little about fiber optics, SU(3) or nonlinear acoustics by reading

the brief article on the subject, then read the related articles in the encyclopedia that are cited, and finally proceed to any of the references. Or one can quit at any level. The book is an open-ended invitation to a self-paced course in any and all of physics.

Of course, the level of articles can be uneven, and the amount of background necessary to understand the articles can be problematic. Thus, to read the article on currents in particle theory, one needs to know basic ideas of electromagnetic theory as well as the meaning of such terms as "vector bosons" and "color symmetry groups"—which send the reader to the exploration of other articles.

Who can use such an encyclopedia with profit? Any practicing physicist who needs to know a little (or a lot) more about a new field or a field of physics that is new to him or her. Any other scientist or engineer who can find it useful to get a taste of any subject in physics and a little of its vocabulary. The same usefulness, perhaps slightly reduced, is available to physics and nonphysics college and university students. The rest of the world takes its chances, just as it does on the science articles in the *Encyclopedia Britannica*.

Rita Lerner and George Trigg are to be commended for organizing such an able team of physicists, cajoling them into writing the articles, and then producing the finished product within a time span that does not render the publication hopelessly obsolete.

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Sophie Germain: An Essay in the History of Elasticity

L. Bucciarelli, N. Dworsky

147 pp. Reidel, Dordrecht, Holland, 1980. \$30.00

Sophie Germain, a French woman mathematician of the early nineteenth



Germain: a sketch of the mathematician from Stupuy that appears in the book reviewed.

century, is remembered in the history of science for her contributions to the theory of numbers and to the theory of elasticity. In many respects she was a remarkable figure: Self-educated and excluded from official institutional acceptance by her sex, she struggled to assert herself during one of the most exciting periods in the history of French science. The book under review, a collaborative effort by Louis L. Bucciarelli and Nancy Dworsky, examines Germain's research in the theory of elasticity and the context of this research within French mathematical physics of the period. The authors describe the intended audience of their book as "students and scholars in the history of science, applied mechanics, mechanical and civil engineering. It will also be of interest to those people concerned with women's studies."

The authors focus on Germain's research on the vibrations of thin elastic plates. In 1809 the French Academy of Sciences had announced a prize of 3000 francs to anyone who could provide a mathematical description of this phenomenon and indicate how it agreed with the empirical evidence. The setting of such prizes was a traditional method in France of stimulating scientific accomplishment. This particular competition was a response to a visit to Paris in 1808 by the German physicist Ernst Chladni, who had exhibited the striking patterns formed by sand scattering on vibrating glass or metal plates. The competition was reset twice, the only submission each time being Germain's, until she finally succeeded in winning the prize in 1816. She continued to work on the problem of elastic surfaces until her death in 1831.

The authors chronicle Germain's successive attempts at formulating a mathematically sound description of the vibrating plate. A central argument of the book is that the opposition to her work stemmed in part from the basic hypothesis with which she began her investigation. French mathematical physics in the early nineteenth century was dominated by the view that all terrestrial phenomena could be explained in terms of short-range forces acting between molecules. This view was championed by Simon de Laplace, the leading French scientist of the period, and was also vigorously advocated by Siméon Poisson in his work on elasticity. Germain's hypothesis, however, required no special assumptions about the underlying physical mechanism. In addition, she employed techniques of analysis developed by the French mathematician Louis Lagrange, techniques that were rejected by Poisson.

Sophie Germain: An Essay in the History of Elasticity is an interesting