And there is but one example from among the scores of technical documents written for the Manhattan Project, its descendants or other government bodies. Nor do any of these make it into the 19-page publications list.

For most of today's physicists, one attraction of the volume is that the pre-1933 papers, originally published in German, are here in English. Unfortunately, the great 1930 paper on energy loss, which Bethe singled out in a recent *Scientific American* interview as his all-time favorite, has been botched by the publisher: The equations, photocopied from the original, are almost illegible; one can discern the enormous swarms of intricate formulas, in the best style of the Sommerfeld school. But anyone who does not know German and wants to study this paper should do so with the German original at hand for the formulas. Another early gem, and very legible, is the ingenious 1931 paper on the one-dimensional Heisenberg ferromagnet, whose complete spectrum he found with the ingenious Bethe Ansatz, which lives on to this day as a whole industry in one-dimensional mathematical physics.

The brief period that Bethe spent in England before going to Cornell University in 1935 was enormously productive and is well represented in these selected works by the first analyses of the nuclear two-body problem, written with the late Rudolf Peierls, his lifelong friend; the first treatment of order–disorder transitions to go beyond the mean field approximation; and the classic Bethe–Heitler theory of energy loss by relativistic electrons, which played a central role in the debate over the compatibility of cosmic-ray data with quantum electrodynamics—until the discovery that particles much heavier than electrons formed the penetrating component of cosmic rays.

Bethe's two most famous papers are here: the Nobel Prize paper "Energy Production in Stars," from 1939; and "The Electromagnetic Shift of Energy Levels," the 1947 Lamb-shift calculation, largely done on the train from New York City to Schenectady after the Shelter Island conference. But the Bethe–Salpeter equation is missing, although it has surely given hundreds of man-years of employment to theorists, as is the recent papers on solar neutrinos, not to mention a long, long list on most nooks and crannies of physics.

On the other hand, the collection contains a remarkable and hitherto unpublished paper, coauthored with Edward Teller, one of Bethe's closest colleagues before thermonuclear weapons turned them into adversaries. It illustrates Bethe and Teller's early recognition that, when civilization is threatened, scientists should not lock themselves in an ivory tower. After the fall of France in June 1940, they wanted to contribute to the defense effort, but they were not US citizens. So they went to the famous aerodynamicist Theodore von Kármán, a friend of Teller's, and asked him to suggest a useful problem, which he did without explaining why. This soon led to "Deviation from Thermal Equilibrium in Shock Waves," the first analysis of the way the excitation and dissociation of gas molecules influence high-temperature shocks. Though it was not formally classified, because of its "importance" the Ballistic Research Laboratories, Aberdeen Proving Ground, "undertook the reproduction of this paper for limited distribution." Shock waves were to be on Bethe's mind, for very disparate reasons, for the rest of his life.

I have kibbitzed enough, but cannot refrain from reporting that Hans Bethe offers another lesson here for us all: Don't take yourself so seriously! He does this by including a marvelous hoax and two papers that turned out to be wrong. Bethe is very proud of the hoax: a spoof on Arthur Eddington's claim to have derived the fine-structure constant, 1/137, from first principles. Bethe's response was published in *Naturwissenschaften* as "On the Quantum Theory of the Temperature of Absolute Zero." In it, the 24-year-old Bethe and two young friends mimic the renowned Eddington by presenting an absurd derivation of 137 from 273 K and Dirac's theory of the electron. The "wrong" papers make up a more complicated story: The first, written with Peierls in 1935, correctly calculates the mean free path for neutrinos from nuclear beta decay and conclude that "it is therefore totally impossible to observe" such neutrinos. (The paper notes that the cross section rises with energy, which is one crucial factor in today's plethora of neutrino data, although it states that the growth is E^2, which is only true in the center of mass.) The second, from 1937, argued that the cyclotron could not produce beams of protons or deuterons above about 10 MeV, a conclusion overturned in 1945 by Edwin McMillan and Vladimir Veksler's invention of the frequency-modulated cyclotron. I learned how much controversy this paper generated in its time when Ed Purcell cited it in cautioning me to scrutinize carefully Bethe's arguments in our joint articles, in which we concluded that Star Wars would not work.

Physicists of all ages and specialties will find much here to enlighten them about the astounding growth in our understanding of the physical universe in the last 70 years, in the original words of a master contributor to that growth.

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Nonlinear Physics with Maple for Scientists and Engineers

Richard H. Enns
and George C. McGuire
Birkhäuser, Boston, 1997.
389 pp. $54.50 hc
ISBN 0-8176-3838-5

Nonlinear Physics with Maple for Scientists and Engineers: A Laboratory Manual

Richard H. Enns
and George C. McGuire
Birkhäuser, Boston, 1997.
136 pp. $26.50 pb
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Nonlinear dynamics has been slowly making its way into the standard training of physicists, but I suspect that many undergraduate physics students remain largely occupied with problems that are either linear or integrable. For example, when I was a teaching assistant for an upper-division lab course, I wanted to explain the marginal oscillator circuit that so sensitively detected nuclear magnetic resonance signals. I was both astonished and frustrated by how little my undergraduate background had to offer about circuits and systems that could become unstable to self-sustained (limit cycle) oscillation. Now, 15 years later, it seems that much of the physics curriculum is still oriented towards the linear response of systems to external driving. In this context, Richard Enns and George McGuire's *Nonlinear Physics with Maple* is a welcome change.

The reader must be careful not to equate chaos theory with nonlinear physics. There is much useful knowledge to gain about nonlinear phenomena in addition to the part that deals with chaos. *Nonlinear Physics with Maple* correctly balances a good treatment of nonlinear, but also nonchaotic, behavior of systems with some of the exciting findings about chaotic dynamics. It also gives readers a taste of the behavior of solutions to nonlinear partial differential equations, including solitons. This last area, along with nonlinear interaction of laser beams, appears to be a specialty of the authors.

The text starts with a wide-ranging, 60-page tour of nonlinear phenomena, aided by computer explorations using the accompanying Maple software. Like Francis Moon's *Chaotic and Fractal Dynamics* (Wiley, 1992), one of the book's strengths is the diverse selection of examples from mechanical, chemical, electronic, fluid and many other physical systems. As one who does research in fluid instabilities and chaos in mechanical systems, I recognized many old friends. Another strength of the book is the diversity of approaches that the student is encouraged to take.

The text, software and accompanying laboratory manual allow the reader to examine nonlinear physics in complementary ways. In the text, three chapters create a foundation of qualitative, analytical and numerical tools before the rest of the book focuses in turn on limit cycles, forced oscillators, chaotic systems, iterated maps and nonlinear waves. The laboratory manual is perhaps the first freestanding book to accompany a text on this topic, and its 28 relatively simple experiments provide benchtop verification of the behavior of nonlinear systems.

The thoroughly annotated Maple files accompanying the text provide a parallel track, reinforcing concepts and encouraging further explorations. Indeed, this text simultaneously serves as an excellent, structured introduction to Maple V release 4. I found the Maple environment to be efficient and the commands surprisingly intuitive. For example, I easily adapted the authors' examples to use of Maple in exploring the dynamics of particles in a Paul trap, gaining several useful insights to this problem. This is just the sort of tool I wish I had found during my initial readings on nonlinear dynamics. Readers who wish to pursue more specialized computations on, say, the properties of chaotic attractors, will want to supplement this environment with software such as the package provided by Helena Nusse, James York, Eric Kostelich and Brian Hunt, in the second edition of Nusse and York's *Dynamics: Numerical Explorations* (Springer-Verlag, 1997).

One drawback of the Enns–McGuire book is its rather limited treatment of bifurcations. The topic is not dealt with at any length until late in the book and then mostly in the context of iterated maps. Many research experiments in nonlinear systems proceed by variation of a control parameter, and a book such as this could convey the excitement and insight gained from watching new physical behavior result from a succession of bifurcations. The important topic of Hopf bifurcations—perhaps a suitable model for my old friend the marginal oscillator detector—is not even mentioned in the text. Also, the linear stability analysis of singular points in two-dimensional flows seems a bit restricted: In this context, the Jacobian matrix is not mentioned, and the student may wonder how to generalize the stability analysis to higher dimensional systems. I prefer the treatment of stability and bifurcations in Steven Strogatz's *Nonlinear Dynamics and Chaos* (Addison-Wesley, 1994). Finally, it is surprising that a book seeking to give a wide-ranging introduction to nonlinear physics omits treatment of Hamiltonian systems.

Choices of coverage must, of course, be made to keep a book like this of reasonable length and accessibility. On the whole, the authors have chosen well, and the trio of text, Maple-based software and lab manual gives the newcomer to nonlinear physics quite an effective set of tools. Basic ideas are explained clearly and illustrated with many examples. There is an ample set of problems and suggestions for further exploration. Thus, this text–software–manual trio will serve well for both undergraduate senior-level lecture courses and independent study, perhaps alongside or closely following a reading of the second edition of Gregory Baker and Jerry Gollub's *Chaotic Dynamics: An Introduction*, (Cambridge U. P., 1996). I recommend that students also get a taste for ongoing research through a multiauthored survey like *The Nature of Chaos*, edited by Tom Mullin (Oxford U. P., 1993). For readers wishing a more thorough grounding in chaotic dynamic systems, I would strongly recommend follow-up study of the above-mentioned book by Strogatz or, at a more advanced level, Edward Ott's *Chaos in Dynamical Systems* (Cambridge U. P., 1993). This is clearly an extended course of study, and one for which *Nonlinear Physics with Maple* provides a good, balanced start.

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An Introduction to Active Galactic Nuclei

Bradley M. Peterson
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ISBN 0-521-47348-9

Quasi-stellar objects, or quasars, were first identified through radio astronomical techniques in the early 1960s.