my friends." Co-opted or not, he treats them well, while entertaining and enlightening the reader in equal measure.

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Conversations on the Dark Secrets of Physics

Edward Teller (with Wendy Teller and Wilson Talley)
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This book belongs to the genre of testament, the exposition of a worldview shaped by a lifetime of distinguished contributions to science. It is also intended to serve as a popular exposition of the core ideas of physics. Here the two goals prove to be incompatible, however, for Edward Teller's personal vision is not one that is readily grasped by anyone whose ear is not attuned to the subtle harmonies of mathematics.

For Teller, the essence of physics is the quest for unity, which he regards as a synonym for simplicity, as appears to be the case in Hungarian, his native language. He tends to find his unities on a rather formal level and shows a flair for epitomizing them in simple aphorisms. For example, he sees the crisis in classical physics that gave rise to the quantum theory as a matter of "too few degrees of freedom" in molecules, in atoms and in the vacuum. Josiah Willard Gibbs recognized this defect for diatomic molecules, and James Jeans for the blackbody cavity, but it takes a considerable measure of insight to find it in Niels Bohr's desperate *ad hoc* stabilization of the nuclear atom.

Somewhat less felicitous perhaps is Teller's characterization of the essence of relativity, which is simply that time t and distance r are not invariant, while the combination $c^2t^2 - r^2$ is, and we are left with nothing more than a simple extension of the Pythagorean theorem. Though on a formal level this is incontestable, it is unlikely to convey to the reader the magnitude of the shift in thinking about space and time that this revelation entailed. It is hard to imagine Hermann Minkowski in 1908 without Albert Einstein in 1905.

As a popular work, this book is hampered to some extent by the author's expository style, which tends to favor proclamation over persuasion. Teller seems to be aware of this tendency and tries to temper it by stepping off his exalted podium in occasional humorous asides of a distinctly Central European tone, as when he writes, "In the case of money the law is more apt to recognize the invisible flow than in the case of electrical energy."

As a further and rather unusual leavening agent, witty footnotes have been provided by Teller's daughter Wendy, a computer scientist, and by Wilson Talley, an applied physicist. These often turn into brief dialogues with the author. Many focus on Teller's personal idiosyncracies and his background as a theoretical physicist and a Hungarian. Some help to reassure the reader that he or she is not alone in failing to follow Teller's turns of argument, some of which would challenge a professional physicist, especially the argument that traces the link between Faraday's lines of force and Maxwell's equations.

Teller clearly feels more at home with the cool analytic structures of Gibbs or Werner Heisenberg than with the half-formulated intuitive flashes of Bohr. Nonetheless, he recognizes the historical importance of creative muddle. Thus in the story of gravity he dismisses Galileo as an able propagandist but not a terribly original thinker and opines that Newton, for all his analytic depth, only did what someone else would have done sooner more likely than later. But in his eyes "the man who really made the difference was Kepler," a judgment that I heartily endorse. Even after a lapse of nearly four centuries, the discovery of the ellipses hidden in Tycho Brahe's unmatchably precise but unavoidably two-dimensional data still seems almost miraculous.

Still, like many physicists, Teller can be a bit careless with history. Thus he lists Plato, one of the ancient world's more committed adherents to the atomic hypothesis, among its doubters and cites William Gladstone rather than Robert Peel as the target of Faraday's celebrated riposte on the practicality of his dynamo, "One day, sir, you will tax it." Also in this section, Teller attaches the term "dynamo" to an electric motor. And while it may be natural to imagine that Hans Christian Oersted "noticed with amazement" the response of a compass needle to an electric current, in actuality the experiment was undertaken in a passionate conviction that this would be the result. Finally, Teller's assertion that Newton "guessed that force would be proportional to acceleration" misses the mark both historically and conceptually.

Edward Teller is of course best known to the public, and even to the generation of physicists educated since World War II, as the tireless and single-minded champion of the technological arms race. Whether one finds that role admirable or reprehensible, it will assuredly define Teller's place in history. This slim volume, which barely mentions that dimension of its author's career, is unlikely to do much to alter that perception.

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Spin Glasses

K. H. Fischer and J. A. Hertz
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For more than a decade spin glasses occupied a central place in both condensed-matter physics and statistical mechanics, with dozens of conferences and colloquiums devoted to the subject and at its peak in the first half of the 1980s fueling more than 400 papers per year. The study of spin glasses also inspired much of the subsequent work on neural networks, optimization theory and related fields encompassed by the phrase "the science of complexity." But what are spin glasses, why are they so fascinating and where does the field go from here?

A spin glass is a magnetic system that exhibits a phase transition to a low-temperature state that has no magnetic long-range order. The required ingredients are randomness and "frustration," meaning that competing ferromagnetic and antiferromagnetic interactions dictate that no spin state simultaneously minimizes all the terms in the Hamiltonian. This characteristic is responsible for much of the richness of spin-glass behavior: Just determining the ground state is a nontrivial problem in optimization theory. In addition the large number of low-lying, metastable states leads to very slow relaxation—the "glassy" behavior from which spin glasses take their name.

Much of the theoretical effort in spin glasses has aimed at a complete understanding of the Sherrington–Kirkpatrick model, whose infinite-range interactions render it soluble in principle, leading to a mean-field theory equivalent to the Weiss theory of ferromagnetism or the van der Waals theory of fluids. The spin-glass mean-field theory, however, is extremely rich, yielding "ergodicity breaking" unrelated to a symmetry of the Hamiltonian and an infinite number of ordered phases organized in a