at Queens College, he transferred to Harvard, from which he graduated in physics at age 18; he was immediately recruited for Los Alamos, and he arrived there in January 1944.

At this time, the bomb fabrication laboratory was less than a year old, and weapons design was still in a state of flux. Hall helped first to determine the fission cross section of uranium-235 for the gun-type weapon and then to assess the uniformity of the implosion wave in the plutonium model. The youngest scientist on the hill thus had remarkably valuable technical details to offer the Soviets, which he did toward the end of his first year, while on leave from the lab. Even had the compartmentalization of information been imposed at Los Alamos, as the project's head, Leslie Groves, initially desired, it seems that Hall's knowledge would not have been appreciably restricted.

Soviet intelligence named Hall "Mlad," which is "young" in Old Slavonic, and it called the Manhattan Project "Project Enormoz," which needs no translation. Recently opened Soviet archives suggest that Hall's (and Fuchs's) espionage was key to the path followed by Igor Kurchatov that led to Joe-1 in 1949.

After the war, Hall earned a PhD from the University of Chicago, switched from nuclear physics to biological microphysics and conducted research in Chicago, New York and, from 1962, Cambridge, England, where he is now retired.

US Army Intelligence cracked enough wartime cable traffic from the Soviet consulate in New York for the Federal Bureau of Investigation to be convinced by 1950 of Hall's espionage. Neither surveillance nor interrogation gave the authorities any means of indicting him, however, for the US could not reveal its decryption successes. At the height of the Rosenbergs' trial (for passing relatively trivial nuclear information), Hall was frightened, and, although unrepentant, he continued to fear prosecution for much of the next four decades.

With the collapse of the Soviet Union and the end of the cold war, the intelligence services on both sides of the Iron Curtain sought to burnish their images by parading their successes, thereby justifying their budgets before a sometimes hostile public. Thus, the US National Security Agency released many once-classified decryptions that mention Hall, Fuchs, Julius Rosenberg and others, while the KGB produced "documentaries" with a large propaganda content and allowed historians into its archives and permitted its officers to give interviews. In a related domestic controversy over who played the critical role in the development of the Soviet bomb—the scientists or the spooks—Soviet nuclear physicists also have spoken openly about their work and have written articles for US journals.

The authors of *Bombshell*, Joseph Albright and Marcia Kunstel, an award-winning husband-and-wife team of veteran foreign correspondents, mined these now-open sources. They also conducted numerous interviews with Hall and his wife, Russian physicists and intelligence agents and far too many unnamed "confidential sources." They tell an exciting and credible tale, restoring respectability to espionage literature, which had been tarnished by retired spymaster Pavel Sudoplatov in his *Special Tasks: The Memo of an Unwanted Witness: A Soviet Spymaster* (Little, Brown, 1994). Despite some factual errors, a sometimes breathless style, the awkward footnoting used in trade books and an occasional peculiar phrase (bright theoreticians are called "double domes," for example, and the University of Chicago is referred to as "an academic halfway house for former Manhattan Project scientists"), Albright and Kunstel have written an interesting and important historical work. Was Hall a despicable traitor or a visionary who recognized that nuclear parity would reduce the likelihood of war? They make no judgments. Were there other, yet unnamed American spies within the Manhattan Project? Possibly.

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The Einstein Tower: An Intertexture of Dynamic Construction, Relativity Theory and Astronomy

Klaus Hentschel
Translated by Ann M. Hentschel
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The history of physics is often written as that of the singular discoveries of its outstanding heroes. Rarely does one find accounts that focus on failures or on the lesser figures, and even more rarely does history depict physics as a risky, collective enterprise that may, like the Tower of Babel, either succeed or fail. *The Einstein Tower* by Klaus Hentschel, a young but already internationally renowned historian of physics at Göttingen University, provides elements of such a contextual history of physics.

THE EINSTEIN TOWER: An effort to verify general relativity. (Courtesy of Klaus Hentschel, University of Göttingen.)

What was the significance of the Einstein Tower for the history of the theory of relativity? The answer is not obvious, even if one already knows that the Einstein Tower refers to an observatory built, according to the plans of Erich Mendelsohn, in Potsdam in the year 1921, to allow the German astronomer Erwin Finlay Freundlich to attempt to verify Albert Einstein's general theory of relativity. After all, neither the Einstein Tower nor Freundlich played a prominent role in the astronomical confirmation of general relativity.

Why then dedicate a book to such an apparently obscure subject? The subtitle, "An Intertexture of Dynamic Construction, Relativity Theory and Astronomy," is of as little help as the introduction, which announces a treatment of ten "interwoven descriptive levels." But despite such trendy terminology, Hentschel has succeeded in writing a very readable account of certain hitherto neglected aspects of the early history of general relativity, made more fascinating by the eccentric perspective that his account takes. By focusing on Freundlich, Hentschel's study reveals that the success story of general relativity depended on much more than Einstein's ingenious intuition and a few crucial observational tests.

The early history of general relativity was also a struggle against the scientific establishment. That establishment was not only peopled, as one may imagine, by conservative scientists adhering to old-fashioned ideas, but was characterized by the very organization of science and its neat intellectual and disciplinary separation between physics and astronomy. Over the years, Einstein searched essentially in vain for support from German astronomers in checking the astronomical consequences of his theory. They stubbornly refused to cooperate, with the exception of one young assistant at the Royal Observatory in Potsdam, who was himself an outsider—Erwin Freundlich.

Although Freundlich never delivered any immediate observational results supporting general relativity, Hentschel's account admits the conclusion that his contribution to the eventual success of this theory was nevertheless quite significant.

First of all, Freundlich probed an impressive number of strategies for providing empirical evidence for general relativity. Although many of these strategies turned out to be blind alleys, his exploration of them cleared the field and identified the open questions. Unfortunately, Hentschel focuses on only a single example—the statistical investigation of gravitational redshift observations—rather than treating Freundlich's important contribution in a more systematic way.

Secondly, Freundlich's efforts to obtain data from observatories throughout the world drew the attention of numerous astronomers to Einstein's theory. These efforts thus helped to establish, on an international scale, a research program for checking the astronomical consequences of general relativity, a program that contributed much to overcoming the frictions at the disciplinary boundaries between physics and astronomy. In Hentschel's account, it was Freundlich, more than any other person, who had to carry the burden of this struggle. In comparison, Einstein appears as a mighty representative of the Berlin physics establishment on whose whims and woes Freundlich's fortune supposedly depended. Here, Hentschel's picture needs some correction. Recent research by Giuseppe Castagnetti and others, cited but not used by Hentschel, has shown that Einstein's search for a general theory of relativity did not correspond to the expectations of his Berlin colleagues and was considered by them with reserve and sometimes suspicion.

Against this background, a further contribution of Freundlich's to the history of general relativity becomes visible, one that is undervalued in Hentschel's book: Freundlich was one of the few, today mostly unknown, friends and colleagues who served as Einstein's collaborators and discussion partners in a period of intellectual isolation. An examination of Einstein's notebooks and correspondence shows that the benefit that he drew (or could have drawn) from Freundlich's intellectual partnership was indeed not small, reaching from the first calculation of the gravitational lensing effect during a visit with Freundlich to the discovery by Freundlich of a crucial flaw in a preliminary version of Einstein's theory of general relativity.

The construction of the Einstein Tower in 1921 marks what one may call a preliminary happy end to the intricate story of the emergence of general relativity. As Hentschel points out, for a short historical moment the tower represented the combined success of a new physics and a new architecture as well as of the men behind it: Mendelsohn, Freundlich and Einstein. But the moment was short; with the rise to power of the Nazis, this unique constellation was shattered: The three men were forced to emigrate, while the tower itself lost its name and temporarily became the Institute for Solar Physics—until it regained its original name after the war.

Hentschel's analysis shows that the evanescent character of the constellation represented by the Einstein Tower was a consequence not only of the impact of external forces; the constellation's transience also had intrinsic roots: In particular, the scientific instruments with which Freundlich equipped the Einstein Tower were still decades away from technology that was adequate for the intended testing of general relativity. This, of course, could not have been known to the participants in 1921. That they then hardly had the chance of recognizing the fragility of their joint success is in fact one of the lessons to be learned from this important book. The history of the Einstein Tower suggests that the stability of scientific success may be just as unpredictable as was that of the Tower of Babel.

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Rock Magnetism: Fundamentals and Frontiers

David Dunlop and Özden Özdemir
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A happy accident of nature has provided geophysicists with a remarkable record of the changing magnetic field of our planet and glimpses of past magnetic fields of the Moon and the early Solar System. This has come about because there are magnetic particles in terrestrial rocks, lunar rocks and meteorites of just the right grain size to be excellent magnetic recorders. Such particles have faithfully preserved their stable remanent magnetism over the eons. The study of the acquisition and preservation of this paleomagnetic record has become known as rock magnetism.

To understand rock magnetism, one must combine fundamental magnetic theory with specialized knowledge of the natural materials and the magnetizations they carry. The need for a separate theoretical basis for rock magnetism arises because the earlier generations of physicists who developed magnetic theory were not much interested in the topics with which rock magnetism is primarily concerned. For example, those who study rock magnetism are interested primarily in understanding remanent magnetization and only secondarily in other magnetic phenomena, such as susceptibility and coercive force; the emphasis is reversed in mainstream magnetic studies.

In *Rock Magnetism: Fundamentals and Frontiers*, David Dunlop and Özden Özdemir have successfully combined rigorous theoretical treatment of the fundamentals of rock magnetism with a necessarily more descriptive discussion of frontier areas in which all is not yet clear. In rock magnetism, one seeks to understand messy natural materials and the processes through which nature has put them. To succeed, one must have an ability to develop simple physical models and also the patience to deal with geological complexity. This combination has proved hard to come by, but is notably demonstrated by the authors in this book. Thus, there are detailed descriptions of the magnetic minerals and the chemical changes they undergo, the domain states in which they are observed and the types of remanence they carry. There is equally thorough development of the micromagnetics and models of remanence. The book is a natural successor to the classic text *Rock Magnetism* by Takesi Nagata (Maruzen, second edition, 1961) and comprehensively reflects the present state of rock magnetism.

One problem with such an encyclopedic approach is that as a subject grows, the amount of material to be covered becomes a little daunting, and organizing it into a palatable whole becomes tricky. The authors give a brief historical introduction and discussion of basic magnetic theory and then