ended with the defeat of the trio and their allies, transformed cosmology into a robust and highly visible specialty.

The author of this account is the versatile Danish historian of science Helge Kragh, whose *Dirac: A Scientific Biography* (Cambridge U. P., 1990) is undoubtedly familiar to a good many readers of PHYSICS TODAY. He addresses his account primarily to physicists, astronomers and historians interested in the emergence of modern cosmology. He also hopes, however, to reach a large popular audience.

Working on a broad canvas, Kragh devotes considerably more than passing attention to some 40 scientists who, in one way or another, were involved with cosmology between 1915 and 1970. His treatment of many of the lesser figures within this pantheon is provocative. For example, Kragh argues convincingly that the Russian mathematician Alexander Friedmann should not be seen, despite his discernment in 1922 of the possibility of a relativistically expanding universe, as an overlooked trailblazer of Big Bang cosmology.

But where Kragh is most captivating and successful is in dealing with his story's three central developments. He nicely delineates the articulation, between 1945 and 1953 by the American physicists George Gamow, Ralph Alpher and Robert Herman, of the Big Bang scenario for the origin of the elements. And he lays out clearly the many reasons they and their contemporaries failed to search for the residual radiation that they anticipated would be left over from the universe's initial explosion. He provides an empathetic yet balanced account of the paths the Cambridge cosmologists Hoyle, Bondi and Gold took to, and cases they made for, an unchanging universe that, on a sufficiently grand scale, should look the same no matter what one's vantage point in space or time. And he gives a satisfying portrayal of the ways in which, during the 1960s, successive lines of novel observational evidence enabled fresh Big Bang partisans, who initially knew little or nothing of the work of Gamow and his colleagues, to convert or marginalize those in the steady-state camp. Although Kragh's long narrative is not free of minor errors, its general level of reliability is high.

Kragh's stance will be congenial to most physicists. He clearly believes that cosmology has progressed in the sense that, over time, its practitioners have increased its theories' ties to both theoretical physics and observational astronomy. Moreover, he goes to considerable lengths to argue that, although religious views, aesthetic sensibilities and personal likes and dislikes intruded into the controversy between the steady-state and Big Bang theories, such extrascientific factors played at most a secondary role in the dispute's evolution and outcome. However, he may discomfit the diehard empiricists among his readers when he sympathetically recounts Bondi and Gold's initially successful campaigns against overconfident observational astronomers who thought that they had come up with facts that falsified steady-state theory.

In writing this pathbreaking book, Kragh drew mainly upon research papers, conference presentations, texts, semipopular books, memoirs and interviews. He also consulted what little germane historical and biographical literature presently exists on the topic. However, no doubt eager to complete this first reconnaissance within a reasonable amount of time, he sought out but a minuscule fraction of the letters, grant proposals, gatekeeping reports and institutional records generated by and about his protagonists and their undertakings. It will be intriguing to see the extent to which future historians, as they dig into such highly revealing materials, sustain Kragh's masterful interpretation of modern cosmology's emergence.

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The Magnetic Field of the Earth: Paleomagnetism, the Core, and the Deep Mantle

Ronald T. Merrill,
Michael W. McElhinny
and Phillip L. McFadden
Academic, San Diego, Calif., 1996. 531 pp. $89.00 hc
ISBN 0-12-491245-1

The first global geophysical topic to be examined by European scientists was geomagnetism. William Gilbert's *De Magnete*, published in London in 1600, preceded Isaac Newton's *Principia* by 87 years. Even during the first half of this century, scholars of geomagnetism thought of themselves as geomagnetists first and geophysicists second. No wonder, then, that only in 1985, at an international meeting in Prague, was the interdisciplinary program "Study of the Earth's Deep Interior" born. SEDI now embraces geomagnetism, seismology, mineral physics and other contributory disciplines. In *The Magnetic Field of the Earth*, Ronald Merrill, Michael McElhinny and Phillip McFadden have written a volume that not only is an authoritative contribution to geomagnetism *per se* but opens wide the doorway between geomagnetism and the rest of the SEDI disciplines.

The eleven chapters of the book will lead a reader from the present-day spatial and temporal variations (secular variation) of the geomagnetic field, past the record in rocks and sediments (paleomagnetism) dating back nearly 3.5 billion years, and then on to the origin of the field and its dipolar reversals in the geodynamo in Earth's fluid iron–nickel core. In spite of the long and broad-scale journey, there are very few false steps in the book that I could discern. For a rock magnetist like me, it is a treat to be brought thoroughly up to date. Thirty-nine of the 1200-plus references are from 1995 and 1996. For a geophysicist, it will be very instructive to read about the nonmagnetic dimensions of the behavior of the dipolar and nondipolar field components and the importance to magnetic field reversals and secular variation of impurities in Earth's core and of the thermal and chemical heterogeneities at the core–mantle boundary. Physicists and astronomers may find the geophysical details too many to countenance, but they will not find a similarly comprehensive—and current—account between the covers of any other single volume.

It may be asked, Does one need this new work, if one already owns Merrill and McElhinny's *History of the Earth's Magnetic Field* (Academic, 1983)? My frank answer would have to be "Yes!" The last 14 years have seen much progress in the field, including the first three-dimensional numerical solutions of the core dynamo and the merging of geomagnetic, seismological and mineral physical discoveries related to the core and core–mantle boundary. For a glimpse of the current frontier, *The Magnetic Field of the Earth* is an obvious and essential choice.

It is common to end a very positive review with a few minor criticisms, perhaps to show that the reviewer did not doze off through the 500-odd pages. Instead, I will end with a musing of mine: Some friends have said that the reference (page 17) ascribing to Albert Einstein the statement, that the origin of Earth's field is one of the five most important unsolved problems in physics, is apocryphal. However, assuming that the story is true, if geomagnetism and, of course, unified field theory are two of the five problems, what were the other three that Einstein was thinking about?

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