Volume 2 provides far more than merely facsimile reproductions. The editors have rendered at least three further services to its users. First, they have included a substantial introduction and a set of eight "editorial notes" that place Einstein's writings within their immediate scientific context, relating them both to Einstein's own developing work and to the work of his contemporaries. The introduction and the accompanying "editorial notes" are virtually independent historical articles and serve as useful guides both to the secondary literature on Einstein and to the scientific literature of Einstein's day.

Second, the editors have provided footnotes to Einstein's texts designed to illuminate the sources of the scientific problems that Einstein confronted and the ideas and techniques with which he addressed them and to point out occasional errors. Third and finally, they provide a comprehensive index to Einstein's early writings. The reader who wants to know where Einstein used or referred to a certain problem, theory, concept, or instrument—the second law of thermodynamics, electrons, fluctuation phenomena, molecules, quanta of action and of energy, time dilation, the ultramicroscope—now need only consult the excellent indexes, which also provide references to all institutions and individuals cited by Einstein or the editors.

Volume 2, along with the already published and equally handsome volume 1 and the forthcoming volume 5 (the "Correspondence" for 1902 to 1914), constitutes an essential scholarly tool for the continuing study of the intellectual and social context of the young Einstein and his work.

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New Examinations

Einstein and the History of General Relativity. DON HOWARD and JOHN STACHEL, Eds. Birkhäuser Boston, Cambridge, MA, 1989. xii, 445 pp. $69. Einstein Studies, vol. 1. From a conference, North Andover, MA, May 1986.

As recently as 15 years ago there was very little serious historical study of Einstein's work after 1905, or of the development of field theory and cosmology by Einstein and his contemporaries. Before 1975, historical studies were usually confined to argument over the sources of Einstein's ideas in physics and philosophy; the details of paths to discovery were left mysterious. A more ambitious historical enterprise has been under way for the last decade or so. It undertakes to reconstruct the details of the work that led Einstein and his contemporaries to their views, to reconstruct in modern mathematical form the arguments and exchanges that were of historical importance but appear in retrospect to be opaque or confused, and to give scientific readers a real sense of the intellectual struggles of historical figures. The change in historical writing is due in part to John Stachel, a physicist turned historian and the original editor of the Einstein papers. In 1975 Einstein's papers were available only on microfilm at Princeton University; scholars were forbidden to make photographic copies of any of the film, and no transcriptions were available. Today, thanks to Stachel there are readable photocopies available at Princeton, Boston, and Jerusalem, as well as the two volumes of Einstein's papers that have been published. This collection of essays on a variety of aspects of the historical development of the general theory of relativity attests that physicists, historians, and philosophers from around the world are making good use of these sources.

Einstein and the History of General Relativity is not an easy book. It is a book about work and scientific opinion, not about character or personal relations. Almost the only indication of an assessment of Einstein as a person occurs in an essay contributed by Peter Havas, who gives a not altogether flattering picture of aspects of Einstein's character in his mature years. Readers without a good knowledge of differential geometry and the elements of the general theory of relativity will find none of the essays rewarding. Those with an adequate background should find the collection very valuable. The essays are not uniform in quality, but all of them are worth reading and several of them are extraordinary pieces of scholarship and writing.

The first four essays, two by Stachel and two by John Norton, explore Einstein's passage from the special theory through a sequence of gravitational theories to the discovery of the field equations of the general theory in November of 1915. Norton's second essay is concerned with the sequence of gravitational theories Einstein offered between 1912 and 1915 and the reasons for the succession of conjectures. Stachel's second essay covers the same period, paying special attention to Einstein's shifting views about the possibility of a generally covariant theory. These pieces are among the best "internal" intellectual history to be found anywhere.

Two essays by Carlo Cattani and Michelangelo De Maria discuss Einstein's public and private exchanges with Max Abraham and Tullio Levi-Civita in 1913 and 1914. The authors' discussion of Levi-Civita's correspondence with Einstein and his criticism of Einstein's attempts at proofs using the calculus of variations is detailed and interesting. Their discussion of Abraham is less satisfying: Abraham's own work is scarcely described, and he is discussed chiefly as an example of Italian hostility to the theories of relativity. He deserves better and deeper study. A. J. Kox offers a sympathetic picture of H. A. Lorentz's reaction to the general theory of relativity and of his attachment to the aether. Jean Eisenstadt has contributed a careful and insightful essay on the early understanding of the Schwarzschild-Droste solution to the field equations of general relativity. Eisenstadt has also contributed a paper on the state of the enterprise of general relativity between 1925 and 1955, and Peter Bergmann has written a short essay on the history of steps toward quantum gravitation through canonical quantization.

The relationship between the field equations and the equations of motion is part of the special explanatory unity of the general theory, and, I suspect, one of the fundamental reasons Eddington and Weyl found the theory attractive. The essay by Havas is a refreshingly blunt account of the history of derivations of the geodesic equation of motion from the field equations and conservation laws of the general theory, focusing on issues of priority. Einstein, Leopold Infeld, and H. P. Robertson do not fare well.

Vladimir Vizgin contributes an extremely interesting essay on the early history of geometrical unified field theories, beginning with David Hilbert's work. The essay is regrettably brief, and reminds me of how much we need a thorough study of the idea of unifying physics through geometrical field theory, beginning no later than with the work of Gustav Mie. The volume also includes an essay by Michel Biezunski on an exchange between Eli Cartan and Einstein in the 1930s and two essays on relativistic cosmology. One, by Pierre Kerszberg, focuses on Einstein and De Sitter; the other, by George Ellis, is an astonishingly compact overview of cosmological theory and evidence between 1917 and 1960.

The book is handsomely bound and printed. The absence of figures (save in Eisenstadt's essays) is regrettable, especially in Norton's essay on the equivalence principle, as is the failure to give addresses and affiliations of the contributors.

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