

A. P. French (ed.): Einstein: A Centenary Volume. Pp. v + 332. Cambridge, Massachusetts: Harvard University Press, 1979. Cloth, \$20.00.

Gerald Tauber (ed.): Albert Einstein's Theory of General Relativity. Pp. 6 + 351. New York: Crown Publishers, 1979. Cloth, \$14.95.

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There is much irony in the publication of memorial volumes in honor of Albert Einstein. Einstein repeatedly showed astonishment at the celebrity status his work had brought and often made gently rebuking reference to those who would complete his apotheosis. Yet with or without his consent, Albert Einstein has come to represent the highest vision of modern science. Only Copernicus has as fundamentally altered man's view of his world; only Galileo and Newton stand as his equal in rebuilding the edifice of physics. Albert Einstein has laid indisputable claim to a place among the immortals of intellectual history. Even though one can almost hear Einstein's protestations, those who stand in awe before this man will surely welcome the appearance of two outstanding volumes commemorating the 100th anniversary of Einstein's birth.

The two volumes are rather different in their aim and scope. The first of these is by A. P. French, the well-known physicist and educator from the Massachusetts Institute of Technology. This work attempts to glimpse Einstein from many different perspectives by persons as diverse as Edward Teller, C. P. Snow and Pablo Casals. It lays equal stress on Einstein as a physicist, as a social critic, and as a true savant. It avoids as far as possible the mathematical formulation of Einstein's work which forms a significant hurdle to many readers. At least 90% of this volume is accessible to the general reader with absolutely minimal formal mathematical training. It is

a tribute to the contributors and to Professor French that the significance of these articles is not diminished by their accessibility. The second volume is edited by Gerald Tauber, Professor of Physics at Tel Aviv University and director of the Israel Center for Relativistic Astrophysics and Gravitation. It is plain from the title that this volume sacrifices the scope and general accessibility of the first collection, but it more than makes up for this by the quality and breadth of the essays it contains. Professor Tauber is a contributor to the French volume with an article on "Einstein and Zionism," so it is to be assumed that the elimination of Einstein's social views from this volume reflects only the more narrow aims of this volume. It is not intended for as wide an audience as the first work. There is considerable variation with respect to the difficulty of the articles. They are never unduly technical, but the subject matter very often necessitates substantial preparation in the area of mathematical physics; however, these articles are, indeed, overviews and so do not require really advanced preparation. This book would be useful to persons with prior interest and some formal preparation, or to those with considerable ingenuity and steadfastness. With these general guidelines in mind, let me briefly describe what the reader will encounter in these works.

French's collection of essays is divided into four sections: reminiscences, commentaries on Einstein and his creations, a very brief collection of letters, and selections from Einstein's writings. It contains 38 rather interestingly chosen reproductions of documents, letters, cartoons and articles. In addition to the selection of tributes found in the first section of the book, the remainder of the work has short marginal notes, comprised of comments by or about Einstein from a variety of sources. The notes are as revealing and important as the longer essays. Two notes, from facing pages, illustrate this:

One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike--and yet it is the most precious thing we have. (p. 66)

I want to know how God created this world. I am not interested in this or that Phenomenon, in the spectrum of this or that element. I want to know his thoughts, the rest are details. (p. 67)

These notes are excellent embellishments to the work, without which it would lose a delicate, but important, flavor.

The reminiscences on Einstein are indeed varied. The chapter opens with a selection from Snow's Variety of Men and contains selections from physicists such as Louis de Broglie, John Archibald Wheeler, George Gamow and J. Robert Oppenheimer, and from such notable non-physicists as Bernard Cohen, Philippe Halsman and Paplo Casals. This section contains many interesting and amusing anecdotes, but one cannot read these selections without coming to see that Einstein was revered not just for the penetration of his intellect, but for the depth of his humanity. Virtually every author speaks of his kindness, wit, gentleness and compassion.

Perhaps the most notable contributions in this section would include an excerpt from L. L. Whyte's Focus and Diversions, which illustrates not only a profound admiration for Einstein, but in addition the highly sceptical attitude in which much, if not all, of Einstein's later work was held. Einstein's antipathy toward the quantum theory and his single-minded pursuit of a unified theory of fields created a gulf between him and, practically, the remainder of theoretical physicists. Einstein's status in the last three decades of his life--as a kind of antiquated god-head--lends a kind of tragic element to his life, quite apart from his quixotic views of social and international issues. Another notable selection comes from a noted photographer, Philippe Halsman. This very movingly demonstrates Einstein's view of the state of the world. Asked by Halsman "So you don't believe there will ever be peace?", Einstein replies, "No, as long as there will be man, there will be wars." A lifetime spanning the rise of National Socialism and the atomic age/cold war era had managed to erode his confidence and optimism, though not to utter despair. Yet another selection deserving special mention is one by J. Robert Oppenheimer. This article is important because only Oppenheimer has matched Einstein in sensitivity and awareness of the social responsibility of science.

Although this first section is the one about which Einstein would most loudly protest, I unabashedly admit to having thoroughly enjoyed it, probably a desire to come to know this man vicariously.

The second section of the book, which contains essays on virtually every aspect of Einstein's work and interests, is the real core of the work. It begins

with an overly-condensed biography by French. This is forgivable, however, because several bona fide biographies are available elsewhere and an adequate biography would double the size of the book. Following this is a truly outstanding piece by Silvio Bergia, entitled "Einstein and the birth of special relativity." It is, without a doubt, the finest short analysis of the development of special relativity I have seen. French then provides "The story of general relativity," which is also quite good, but not, in my opinion, quite as good as Bergia's work. Hermann Bondi, a first-rate physicist, but apparently a second-rate writer, provides a cumbersome and considerably more difficult presentation of "Relativity theory and gravitation." This was the single disappointment in the volume. Taken as a whole, however, these three selections provide an excellent introduction to relativity theory in a remarkably condensed form.

Martin Klein provides a chronicle of Einstein and quantum theory. For reasons I mentioned earlier, this is a most important aspect of Einstein's development. As much as Planck or Bohr, Einstein is a father of the quantum theory, but he remained sceptical of the fundamental truth of these insights to the end. He repeated, again and again, "God does not play dice with the universe."

Two authors of special interest include Boris Kuznetsov from the Institute of the History of Sciences and Technology in Moscow and Herbert Horz, Professor of Philosophy from the Akademie der Wissenschaft der DDR in (East) Berlin, German Democratic Republic. Kuznetsov writes on "Einstein, science and culture" and Horz on "Philosophical concept of space and time." Both pieces present some difficulties. There are problems in providing an orthodox dialectical materialist account of Einstein's theory, and some of these tensions show up in these essays. The Horz article is perplexing at a variety of points; some assertions which he makes do not seem to be particularly natural. Kuznetsov is more transparent, but still quite troublesome. He engages at one point in a discussion of econometrics on the analogy of general relativity. The analogy is loose at best (trading on the higher-dimensionality of space-time, it seems) and the conclusions are opaque. Nonetheless, these are among the most fascinating selections in this volume and may prove fruitful to the reader in a variety of unexpected ways.

French and Tauber provide two articles on Einstein and world affairs. Einstein was a man of strong political convictions and lent his name to the causes of pacifism, disarmament, world-government, socialism, a Jewish homeland, and countless other causes, all of which he supported as best as he could. To fail to take account of these views, or to minimize their significance for Einstein, is to fundamentally misunderstand Einstein as a man. Though a man of the highest ideals and motives, he was neither naive nor unbending. When the prestige of his name was required to initiate the Manhattan project, he gave it, however reluctantly, and however much he was later to have doubted the wisdom of his decision, for the menace of National Socialism left him no choice. Later he strongly urged Truman not to use the atomic bomb on Japan, and he wrote tirelessly on the necessity to renounce the use of atomic weapons--advice which, sadly, has gone unheeded.

Two last articles deserving mention concern Einstein's views on education (Arturo Loria) and methods of teaching special relativity (Geoffrey Dorling, with an appendix by French). These are somewhat surprising entries--both in the fact of their inclusion and in that both are reasonably interesting. The single entry in this section which seems gratuitous is a page of Einstein commemorative postage stamps. This was rather curious, and probably of too narrow an interest.

The remainder of the volume is devoted to selections of Einstein's writings. These are nicely chosen, but necessarily brief. Their value is self-evident and requires no commentary. It is only regrettable that more of Einstein's correspondence could not have been included--say his rather famous exchange with Freud. But, rest assured, what is in the volume makes it worth even the rather imposing \$20 price.

Tauber's book, too, begins with a series of tributes to Einstein. There is, surprisingly, no overlap in the two volumes. French's tributes tended to be anecdotal--as reminiscences should be--where these are more reflective in nature. The same picture emerges from both. Several of these pieces seem particularly notable. Leopold Infeld, with whom Einstein collaborated to produce The Evolution of Physics, provides a very brief but moving statement concerning Einstein's appeal to the people of the world--far beyond that of any other scientist in

memory--and this is followed by a longer reflection by Cornel Lanczos on the same topic. Both combine a tribute to Einstein with an attempt at answering a really perplexing question: How did a man whose work was utterly unintelligible to the vast majority of persons earn the highest respect and honor from these persons? It does not seem to have been mere fad, or whim, or Hollywood "hype." Rather, Einstein seems to have projected directly the highest aims of science and humanity even to those for whom the realization of those aims must remain an utter mystery. It is, in fact, heartening that this should occur at all. Both of these articles are reprinted from earlier works by the authors.

Gerald Holton, the eminent historian of science, has provided a rather interesting piece on "Einstein's Weltbild" which attempts to show the common source of Einstein's commitments, both scientific and social. Holton finds six properties of Einstein's view of reality which "can be called cosmological, in the sense of being orderly, harmonious, and systematic" (p. 32). These include an insistence on completeness (consider the Einsetin-Podolsky-Rosen paper, "Can Quantum-Mechanical Description of Reality Be Considered Complete?" in this regard) and on rationality, yet with a reverence for the mysterious. Einstein's rationalism is suffused with a profound religiosity. It must encompass the non-scientific (aesthetic, moral, social) parts of reality and must be practical in its implementation in one's life. Lastly, an adequate Weltbild must clearly define its differences from other possible views. Thus Einstein's views conflict with the mechanistic, materialistic philosophies, and this is certainly reflected in the cautious treatment Einstein's work has received in Marxist nations. (Lenin denounced the theory of relativity as "idealistic physics;" the reconciliation of the undeniable fact of the success of the theory of relativity with the ideology of dialectical materialism remains an uneasy problem, an example of which is evident in the two articles mentioned earlier (by Kuznetsov and Horz).) Holton's efforts here are very interesting and promising as a way of seeing the unity of Einstein's thought and deeds.

The second section of Tauber's book is devoted to the origin of the general theory of relativity and an exposition of the theory. With the exception of a brief entry by Sir Arthur Eddington, this is entirely composed of selections from Einstein's writings, principally from Relativity, the Special and General

Theories. This is certainly appropriate, for it is quite generally agreed that Einstein is the most lucid and direct expositor of his theories, a rare phenomenon indeed. Included here is Einstein's reply to criticism raised against his theories from purely antisemitic motives. It is one of the few pieces in the work with political overtones and reminds us with a mixture of horror and pity of the notion of "Jewish physics," as Einstein's work was known, and the consequences this mentality was to have. Tauber's work is dedicated to the victims of the Holocaust, and one cannot but feel that Einstein would have joined Tauber in this dedication.

The third section is of passing interest only. It contains descriptions of tests confirming the general theory. This is not to minimize the importance of experimental verification, rather to note that the tests mentioned are rather standard and do not intend to discriminate between Einstein's theory and other modern competitors. There are points of interest here, but nothing of deep import.

The fourth section consists of a rather diverse collection. Four of the six articles are by Einstein and two are significant. "Geometry and Experience" expresses Einstein's opposition to the conventionalism of Poincare and, later, Reichenbach. It is a very important piece. Another of equal interest is "Relativity Theory and Corpuscles." Here Einstein briefly develops the notion of a "bridge," which he hoped would provide for material particles in his field-theory. He later finds that this approach will not suffice, but this article exhibits both the creativity of Einstein and depth of his desire to provide the basis for a unified theory of fields. Included in this section is a small collection of anecdotes by John Archibald Wheeler, more notable for the eminence of the collector than for the pieces themselves. Wheeler is surely the most "Einsteinian" of contemporary theoretical physicists. Of genuine interest, however, is the very short note by J. L. Synge entitled "My Relativistic Milestones." There is much to be absorbed from these pages alone.

The fifth part of the book involves relativistic astrophysics. It begins with a fascinating paper by the most important astrophysicist of our time, Subrahmanyan Chandrasekhar, entitled "Why Are the Stars as They Are?" This is not a difficult piece, but it does require some familiarity with the equations of gas dynamics at least. For the most part, the equations

can be ignored, however, and the exposition conveys the meaning adequately. The remaining articles are less interesting but still contain many important points, especially the short article on gravitational collapse by D. W. Sciama and J. C. Miller.

Section six is short, controversial and interesting. It concerns gravitational radiation. Considerable debate exists concerning whether such radiation exists. Joseph Weber is the only experimenter who claims to have detected such radiation successfully, and other experimenters have not as yet been able to reproduce his results. There is some question of what status we are to assign to gravitational radiation. This section begins with Einstein's paper, showing that a radiative solution to the gravitational field equations is possible. (This paper, by the way, is likely to be clear only to those with considerable sophistication in physics.) This is followed by a paper by Weber explaining the aim and methodology of his experiment, with a rather terse statement of his results and their status. Following this is a most interesting paper by Nathan Rosen (who collaborated with Einstein on the original paper on gravitational radiation) suggesting that the wave-solutions for gravitation may differ fundamentally from those of electromagnetism. The result may be that gravitational waves cannot be detected. This would be an interesting and surprising result.

The seventh section concerns the continuing search for a unified field theory. The first two pieces come, again, from Einstein and emphasize the magnitude of the undertaking, indicating the necessity to move beyond the symmetric-tensor field to a non-symmetric one. This is the most lucid of the papers in this section, but, regrettably, that does not say much. Deser's article on "Supergravity" and Ne'eman's on gauge-theories are too spare to cast much light on these developments, except to promise that they hold the best hope for Einstein's project. Unless one is rather familiar with these developments, nothing of substance is to be gleaned from these articles. It seems doubtful that there is a remedy for this; there is no really simple way to present this material. Yet it is unfortunate that a more concentrated effort to make this material less opaque was not expended. Not only was this topic the central issue of Einstein's last thirty years, but expanded interest is bound to occur as a result of the recently awarded Nobel prizes for work in this area.

Fortunately, the eighth section does not suffer from this problem nearly so severely. It concerns general relativity and cosmology. There are several articles of interest here, including articles on steady-state cosmology (the perennial Fred Hoyle) and Big Bang cosmology (Ralph Alpher and Robert Herman); also included is an excerpt from E. Hubble explaining his famous law of the relation of velocity and distance in stars and galaxies, along with an interesting paper by the astronomer Allan Sandage on the importance of ascertaining the rate of expansion of the universe (the Hubble constant) and the rate at which this expansion is slowing down. This is a rich and interesting section of the book.

The concluding section contains yet another selection from Relativity and ends with a succinct reflection on the future of research in relativity by Peter G. Bergmann. Since there is no really obvious way to close a book of this sort, this seems to be a graceful and reasonable decision.

It must be admitted that one finishes this book with the feeling that she or he has had the Grand Tour of general relativity. Certainly, one cannot but stand in awe of the edifice and the further work it has inspired. Its comparatively moderate price of \$14.95 makes it a most difficult book to pass by for anyone with interest in modern physics.

We are fortunate to have two such excellent books appear (obviously not accidentally) at this time. It should be re-emphasized, however, that Einstein neither sought nor abided idle flattery. The importance of these works lies not in their commemoration of Einstein himself, for his greatness does not require this, but in the communication of his ideals and convictions, of his genius, so completely free of vanity, to a generation of thinkers who could not learn this firsthand. I believe that these volumes do succeed in this, if in somewhat different ways, to a satisfying degree. They befit the true memory of Einstein, "der hochgelehrte Knabe."