Toward the Essential Einstein

Albert Einstein. Creator and Rebel. BANESH HOFFMANN, with the collaboration of Helen Dukas. Viking, New York, 1972. xvi, 272 pp., illus. $8.95.

Einstein. JEREMY BERNSTEIN. Viking, New York, 1973. xii, 242 pp. Cloth $6.95; paper, $2.75.

Of the two books under review here, one, the biographical sketch of Einstein by Banesh Hoffmann, may well go down as a classic, not only with regard to its characterization of Einstein but also with regard to its technique of popularization of science. This is not to suggest that there is anything seriously wrong with Jeremy Bernstein's book. The books are really complementary. Their content is much the same, but the arrangement is different, and some issues are raised by reading them sequentially that would not have come to mind from reading either of them alone.

The question of what constitutes a good popularization looms large as one reads these two books. Both Hoffmann and Bernstein face a formidable problem. It is the old one of dealing with the ideas of an abstract thinker in terms understandable to individuals untrained in that particular kind of abstraction and perhaps interested more in understanding the individual than his ideas. Of course the problem is that in order to understand the individual one must have some insight into the nature of his work. With Einstein, this is an especially difficult problem because so much of his work was so abstract.

The most crucial element in this kind of popularization, it seems to me, is to identify clearly the audience and, having done so, to devise a promising strategy and stick to it. Not everyone will be pleased, of course, but that's far better than leaving everyone displeased.

Hoffmann has obviously identified his audience as containing a sizable proportion of people who know almost nothing about science or mathematics. Fortunately he does not make the error Louis de Broglie made in writing his *Revolution in Physics*. In order to avoid using mathematical symbols, de Broglie wrote out the equations in words. The effect of that strategy was not to eliminate the mathematics but rather to eliminate one of its major virtues, its conciseness. In Hoffmann's book, the mathematics is all but eliminated. Unless I missed some, there is only one equation in the whole book (Minkowski's fundamental invariant).

To anyone who knows a little science, Hoffmann's technique may at first be annoying. He tells his readers not to worry if they don't understand the descriptions of scientific theories in the book but to plow on unmindful of the subtleties. Hoffmann's strategy is clear. He has set out to convey the form and flavor of Einstein's work and to show how his work compared in these respects to that of his contemporaries and predecessors. In so doing he has often used a very large brush. He makes free use of analogies and drawings. Sometimes his analogies are outlandish (for example, the use of the ratchet device in a window shade roller to represent discrete energy levels in an atom), but usually they are not. Almost always they seem to me to accomplish what was intended, namely, to identify Einstein's philosophical position and personal characteristics and to relate them to his scientific contributions.

Sometimes the unsuspecting reader is sucked in in a most charming manner. Perhaps only Banesh Hoffmann would have had the nerve to *introduce* the concept of entropy (p. 41) with the following words: "When expressed more technically, the second law of thermodynamics involves a key concept, *entropy*, whose meaning fortunately need not concern us." Sometimes the issue is explained before the reader is told not to worry about it. Thus after a careful explication of Newton's concept of absolute time, Hoffmann asks rhetorically, "How then could the flow of absolute time be other than uniform if there is only itself as a standard against which to compare its flow?" and answers, "Never mind. The foundations of science are always a morass." Hoffmann goes on to note that Newton was no simpleton. He knew what he was doing and at the time it was bold and courageous.

There are times when Hoffmann uses his strategy of popularization itself to lend power to his story. Thus in the midst of explicating Einstein's second paper of 1905, on determining the sizes of molecules, he breaks off with a remark that he realizes that the discussion has been inadequate but we must move on "if we are to keep up with the headlong pace of Einstein's discoveries. . . ."

It should not be concluded from this account that Hoffmann has failed to deal fairly with Einstein's scientific contributions. Sometimes his explications are first-class. This is the case with his explication of general relativity. His characterization of the Einstein-Podolsky-Rosen paradox and Bohr's reply is brilliant.

Bernstein likewise has taken it as his goal to transmit a sense of Einstein's contributions in the context of a sense of Einstein the man. He has been less consistent than Hoffmann with respect to the level of exposition. Often he takes great pains to explain some fundamental fact—for example, he explains that pi is the ratio of the circumference of a circle to its diameter—but then at other times he rolls on unmindful of the difficulties that the reader might have. A case in point is his reference to observers connected by "Lorentz frames" (p. 114) when he has never taken the trouble to define the term "frame of reference." But these kinds of inconsistencies are not really serious. In fact one usually expects to find them. The Bernstein book would be perfectly adequate for anyone with a modicum of acquaintance with modern physics.

Both Hoffmann and Bernstein have done a superb job in painting Einstein's personal traits. Their emphases are different and the results are complementary. Hoffmann's book reflects the fact that he knew Einstein rather well and that in writing the book he had the collaboration of Helen Dukas, Einstein's personal secretary. Thus when the two authors relate the same anecdote, very often the Hoffmann account contains relevant details of which Bernstein seems unaware. On the other hand, Bernstein has a useful emotional distance from his subject that one would not expect to find in the Hoffmann book.

Both authors emphasize the simplicity of the life Einstein lived. The sense of tragedy that Einstein himself felt when privacy became a serious problem after 1919 is a common theme of the books.

Both authors dwell on Einstein's zealous commitment to a unified field theory. Here, Bernstein is perhaps the more astute. He singles out Einstein's ability to concentrate totally on the problem at hand, sometimes to the point of exhaustion, as a significant component of his genius.

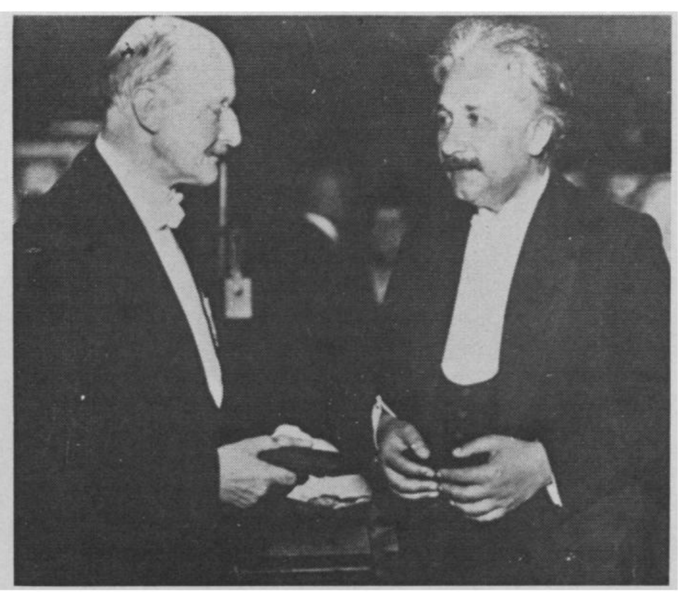
The core of the characterization of Einstein in both books has to do with his keen physical and philosophical intuitions and his ability almost instinctively to nose out the right answer. Recent research in the history of early-20th-century physics makes it more and more clear that Einstein played a pivotal role not only in the foundations of the special and general theories of relativity but in quantum mechanics as well. It was Einstein who first took Planck's formal quantization hypothesis seriously. (In this Einstein was almost alone; not even Planck took this development seriously.) For ten years he serenely waited for others to catch up to his ideas concerning light quanta, and even then, after the Einstein photoelectric equation had been verified by Millikan, there was considerable resistance to the idea.

Einstein was one of the very first physicists to welcome the radical and seemingly nonsensical Bohr theory of the structure of the atom. Never mind that it seemed to violate tried-and-true rules. Einstein sensed that it was in the right direction and what that direction was. It was Einstein who inspired and then brought to the attention of the world the work of de Broglie; it was his efforts that saved Bose's work from the likely fate of Mendel-like obscurity. Schrödinger, Heisenberg, and Dirac were all indebted to Einstein in fundamental and substantive ways and they recognized it. It was not simply that Einstein recognized that the work of all these people was important. It was much more than that. He would often immediately unravel a whole host of derivative consequences—consequences that the originator himself had not clearly foreseen. As Bernstein says, Einstein's contributions in quantum theory between 1905 and 1925 alone would have constituted a sufficient life's work for a most productive and active physicist.

There is no better example of the operation of Einstein's intuition and ability to recognize the right answer than the clock paradox in relativity. In his 1905 paper "On the Electrodynamics of Moving Bodies," Einstein devotes three paragraphs to the problem. The argument is essentially that it is obvious that if one of two identical clocks follows any closed path and returns to join its twin, it will show less time as having elapsed than the clock which has not moved. The three paragraphs conclude with the remark that therefore a clock at the equator will run slow relative to an identical clock at the pole. There are some remarkable things about this passage. First, it was not at all obvious to most people. Thrice since 1905 serious and extended debates have erupted in the literature over this question. Second, it turns out that strictly speaking it is not a problem that can be rigorously dealt with in special relativity, although in the limiting case special relativity may be used. Third, the first hint of experimental evidence on the question has come only in the last few years.

Characteristically, Einstein never once publicly remarked on the furious arguments that swirled through the physics community on this question. He knew he was right, just as he knew he was right about the relationship between the mass and speed of high energy electrons. If the data suggested (as appeared to be the case) that his formulation of the relationship was wrong, there must be something wrong with the experiment. The astounding thing was that in almost every one of these cases Einstein was right.

It was as if Einstein were wearing



(Left) Einstein in the Swiss Patent Office in Bern, where he worked from 1902 to 1909. At the Patent Office Einstein, according to Banesh Hoffmann, "soon learned to do his chores efficiently and this let him snatch precious morsels of time for his own surreptitious calculations, which he guiltily hid in a drawer when footsteps approached. Years later, long after he had become world-famous, the recollection still gave him twinges of conscience." (Right) Einstein receiving the Planck medal from Max Planck in 1929. According to Max Born, no two people could have been more different: "Einstein the homeless world citizen . . . totally unaffected by the social and cultural structure of his environment—Planck deeply immersed in the tradition of his family and . . . overflowing with patriotic pride. . . . But these differences weighed little in comparison to what they held in common: the spirit for the investigation of the mysteries of nature, the agreement about the philosophical basis for knowledge and ethics, and not the least, their joy in their music." [Pictures from *Albert Einstein: Creator and Rebel*] special glasses that made all that was irrelevant invisible. Both Hoffmann and Bernstein draw an analogy between Einstein's work and puzzle-solving. It is a good one. With regard to special relativity, for example, the pieces of the puzzle had all been turned up before 1905. (Both authors express amazement at the fact that Poincaré did not recognize the import of the ideas that he was dealing with. But recent work in the history of science makes clear that Poincaré was working on a totally different problem which precluded his discovering the theory of relativity. That problem was the unification of physical theory within the electromagnetic world view.) Einstein came along and simply took the recalcitrant pieces and plopped them together in a way no one else had suspected was possible. The analogy breaks down only because everyone else did not immediately recognize that this was indeed a solution. Also, Einstein had been thinking about the problem from his own idiosyncratic point of view for ten years.

Of course Einstein was not omniscient. He could be and sometimes was wrong. Both authors lament the fact that when Einstein foresaw the conflict that was to arise between statistical interpretations of quantum mechanics and his own views of causality and the geometrical interpretation of nature he rejected quantum mechanics as an ultimate solution, drawing more and more into his work on unified field theory. Hoffmann and Bernstein both seem to endorse Max Born's remark that it was unfortunate that the inspiration and leadership that Einstein had up to then provided had been removed.

Neither Hoffmann nor Bernstein makes the fatal error that R. W. Clark made in his unfortunate biography of Einstein several years ago. Clark mused over the fact that in middle life Einstein, having lost his sense of physical intuition, wandered aimlessly and almost helplessly down the garden path in search of a unified field theory, while everyone else kept to the high, wide, open road. Clark understood neither Einstein nor the dynamics of theoretical physics and hence redefined both into something he could understand and wrote a book about that—whatever it was. As both Hoffmann's and Bernstein's books make clear, Einstein may have slowed up a little, but the torrent of questions and hypotheses and his sharp intuitive sense never did leave him. Furthermore, as these books also make clear, theoretical physics is like a labyrinth. Just which tack will prove out is almost never dictated by which route seems, for the moment, the clearest.

Moreover, a case can be made for viewing Einstein not as a physicist as the term is commonly understood but as a natural philosopher (in the manner of Newton, Faraday, or Maxwell—three men whose portraits hung in his study) who used physics to illuminate philosophical questions. Taking this view, one does not see a gradual separation between Einstein and the mainstream of physics. He never had been (as his idol Lorentz was) in the mainstream of physics. His work was a beacon.

Another insight that awaits the readers of either the Bernstein or the Hoffmann biography is that being exceedingly clever, though it may be a necessary attribute of genius, is far from sufficient. Much more important is the ability to ask the right questions. The moment Dalton asked a question that everyone before him had ignored —"What are the relative weights of the atoms?"—half the problem of building a viable chemical atomic theory was solved. In the case of Einstein, his questions often seemed so bizarre that his colleagues could take them seriously only if they had some confidence in the ability of the questioner to arrive at decent answers. The few individuals who immediately saw the import of Einstein's special theory of relativity, like Jakob J. Laub and Max von Laue, reported that no one else in physics seemed to have the foggiest clue about the ideas on which the theory was based. Laub reported being bemused by the puzzlement of colleagues at a seminar he gave on the subject at Wurtzburg in the fall of 1905.

Perhaps this helps make understandable why Einstein remained in the relatively obscure position of patent examiner from 1902 through 1909 without a hint of an academic post's being offered. Then, in four short years between 1909 and 1913, he rose meteorically to an academic position at the University of Zurich, to a more lucrative and more prestigious one at Prague, to an absolutely comfortable one at the Eidgenossische technische Hochschule in Zurich, and finally to a position at the mecca of theoretical physics, Berlin, where he essentially wrote his own ticket. Significantly, in his letter of recommendation to the German authorities Max Planck felt moved to excuse Einstein's mistake with regard to the quantization of light. After all, a productive genius like Einstein was entitled to one small mistake!

The reader may be surprised that there has been almost no comment in this discussion on Einstein's personal life, on his views on pacifism and how he forewent them in the face of what he perceived to be a greater threat during the Second World War, on his absolute disdain of convention in dress, on his seeming lack of interest in the day-to-day affairs of the world. It is not that these issues are ignored in the books. In both they are handled with taste and with a good deal of compassion and insight. With respect to Einstein's attitudes about atom bomb secrets after the war, it is left to Bernstein to note (as he does with some aggressiveness) that these simply reflected what Einstein knew to be the case—there were really no secrets, and it was only a matter of a few years before others would have such weapons. He describes Einstein's stand on the control of nuclear weapons as being anything but wishy-washy, remote idealism. Einstein's proposals were tough and realistic. When you think about it, what else would you expect?

There were at least seven biographies of Einstein published during his lifetime. Each had serious shortcomings. Einstein was against the publishing of biographies of living persons. He felt strongly that one's personal life should remain personal. These attitudes were reflected in the two biographies he not only tolerated but more or less sanctioned—Philipp Frank's and Carl Seelig's. After Einstein's death the publication of the Clark biography only revealed that his fears had been well founded. That biography was nothing short of a disaster. In treating Einstein's personal life with some distance, with grace, and in the context of his scientific work, both Bernstein and Hoffmann have shown that it is possible to be enlightening without being gratuitously damaging.

Both Bernstein and Hoffmann are moved at times to compare Einstein's work with that of Newton. There are many parallels, all of which can provide insight into the nature of scientific genius. But there is another insight to be gleaned which neither author makes explicit. Recent research into Newton's life gives strong evidence that he was, one might say, not "well adjusted"; at the very least he was more than commonly misanthropic. As both Bernstein and Hoffmann suggest, Einstein was not "very much with people." Perhaps what Einstein's life tells us is that the ultimate celebration of humanity is not being "very much with people" but rather being very much a person.

Hoffmann's book is very well illustrated with drawings and photographs. His final illustration, a Herblock cartoon done at the time of Einstein's death, perhaps best reflects the kind of intuition that Einstein himself had revealed in the course of his active life. The cartoon depicts the earth, lost in the immensity of the universe, with a sign on it, "Albert Einstein lived here."

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The Dissemination of Newtonianism

Newton and Russia. The Early Influence, 1698–1796. VALENTIN Boss. Harvard University Press, Cambridge, Mass., 1972. xviii, 310 pp. + plates. $19. Russian Research Center Studies, 69.

Historians of science concerned with the spread of Newton's thought have concentrated upon western Europe and have paid little attention to its introduction into central and eastern Europe. In this book, the first detailed study to be published on the subject, Valentin Boss examines the historical beginnings of the influence of Newton in Russia.

Boss delineates well the transmission of the core of Newton's natural philosophy to Russia and the reaction to it there. For him this core consists of Newton's doctrines in mechanics, optics and light, and mathematics. The mathematics he refers to is not the synthetic geometry of the *Principia* but the method of fluxions, the embryonic form of the calculus. His book, which is basically an intellectual history, contains a wealth of information. It is divided into two main sections. The first probes the scientific work of Jacob Daniel (Iakov Vilimovich) Bruce, a confidant of Peter the Great; the second concentrates upon the major polemics and selected, pertinent research at the St. Petersburg Academy of Sciences from 1725 to 1765.

Boss demonstrates that Bruce played a major role in introducing Newton's thought into Russia. Bruce, who met Newton in 1698, acted as a publicist and translator at the Russian court. He participated in scientific discussions at meetings of a small group in Moscow called the "Society of Neptune" and in 1717 translated into Russian Huygens's *Kosmotheoros*, which became the first book in the Russian language to describe the Newtonian cosmology with its law of universal gravitation (attraction). Unfortunately, the printer, an Old Believer who considered the book atheistic, sabotaged its publication, and as a result only 30 copies of the first edition were printed.

Through the preparation of a catalog of Bruce's library, Boss has further found that Bruce collected all the major writings of and more important commentaries on Newton. After Bruce's death in 1736, his library was acquired by the St. Petersburg Academy of Sciences. In this period formal training in science and mathematics scarcely existed in Russia, and in the absence of established universities the St. Petersburg Academy, founded in 1725/26, was the chief scientific institution. It was through the academy that Newton's thought was originally developed and disseminated in Russia.

The early St. Petersburg Academy was a European, not strictly a Russian, institution. Its initial members were German, Swiss, and French. They knew Cartesian, Leibnizian, Wolffian, and Newtonian scientific thought. Boss describes their responses to Newton's thought as represented in the *Commentarii*, the journal of the academy, and the correspondence and other publications of the academicians. In the process he shows that they conducted some sound and substantial research in the physical sciences.

Boss relates that Newton's natural philosophy aroused acrimonious debate and found little support at the academy initially. During the late 1720's the Wolffian leaders Georg Bilfinger and Jacob Hermann criticized Newton's concept of attraction, while Daniel Bernoulli and, from England, James Jurin, the secretary of the Royal Society, defended it. From 1725 until 1737 the academicians debated whether the true shape of the earth was the Cartesian oblong configuration or the Newtonian sphere with a flattening at the poles. The Paris Academy's Lapland expedition (1736–1737), which they closely followed, confirmed the Newtonian position and ended this debate.

After the departure of Bernoulli from Russia in 1733 Cartesian ideas persisted among the St. Petersburg academicians, and for a time they fell silent on Newton's thought. Late in the 1730's the Russian poet and philosophe Antiokh Cantemir came to the support of Newtonianism. He sent the academy copies of Newton's writings and commentaries and science journals from England and France. He also unsuccessfully attempted to have published a Russian translation of the Italian Newtonian Francesco Algarotti's *Il Newtonianismo per la dame* (1737).

According to Boss, Leonhard Euler, the foremost academician from 1734 until 1741, largely determined the scientific views held by the academy at the end of the 1730's. This appears to be correct. Boss, however, seems to exaggerate Euler's power to enforce his views among his colleagues. Furthermore, his depiction of Euler as a Cartesian hostile to Newton is a dubious one.

Recently the physicist Clifford Truesdell and the historian Eduard Winter have discredited the notion that Euler was purely and exclusively a Cartesian (*1*). They have shown him, rather, to be an eclectic. An analysis of Euler's *Mechanica* (1736), which is missing in this book, could have revealed this. Boss, however, is on solid ground when he states that at this time Euler opposed Newton's corpuscular theory of light and the concept of attraction, which he apparently did not accept until 1744. Correspondence of the time and academy records substantiate his vociferous opposition to segments of Newton's thought before his departure from Russia in 1741.

From his investigation of the Richmann-Weitbrecht dispute (1744–1745) over the validity of the Leibnizian doctrine of the conservation of "vis viva" (mv^2) and the academy's research on the nature of light and electricity, Boss discerns that Newton's ideas gained considerable attention and received less criticism at the academy during the 1740's and 1750's. Indeed a Newtonian triumph occurred in 1759 when the academician Franz Aepinus published in St. Petersburg his *Tentamen theoriae electricitatis et magnetismi*, which was