Historiographic Doubts

Physics and Beyond. Encounters and Conversations. WERNER HEISENBERG. A translation by Arnold J. Pomerans of *Der Teil und das Ganze: Gesprache im Umkreis der Atomphysik* (Piper, Munich, 1969; DM 24). Harper and Row, New York, 1971. xx, 250 pp. $7.95. World Perspectives, vol. 42.

There's nothing trickier to construe than a memoir. Now here is a memoir in the form of rationally reconstructed dialogue. And the dialogue, as Galileo well knew, is itself a most insidious literary device: lively, entertaining, and especially suited to insinuating opinions while yet evading responsibility for them. Did he, or they, really feel that way then? And if he says he, or they, said that then, and does not contradict it now, is that really his opinion now? As such interpretative complexities multiply, a reader who values the integrity of his own opinions and does not wish to be imposed upon must ask himself whether he *dares* read such a work.

Certainly the chapter titles of this example are most intriguing, and seem to promise a detailed, historical exposition of Heisenberg's scientific, philosophical, and ethical development against the background of the German political scene:

First Encounter with the Atomic Concept (1919–1920); The Decision to Study Physics (1920); "Understanding" in Modern Physics (1920–1922); Lessons in Politics and History (1922–1924); Quantum Mechanics and a Talk with Einstein (1925–1926); Fresh Fields (1926–1927) [accurately translated: "Opening up the New Territory"]; Science and Religion (1927); Atomic Physics and Pragmatism (1929); The Relationship between Biology, Physics and Chemistry (1930–1932); Quantum Mechanics and Kantian Philosophy (1930–1934); Discussions about Language (1933); Revolution and University Life (1933); Atomic Power and Elementary Particles (1935–1937); Individual Behavior in the Face of Political Disaster (1937–1941); Toward a New Beginning (1940–1945); The Responsibility of the Scientist (1945–1950); Positivism, Metaphysics and Religion (1952); Scientific and Political Disputes (1956–1957); The Unified Field Theory (1957–1958); Elementary Particles and Platonic Philosophy (1961–1965).

Placing an epigraph from Thucydides over his preface, Heisenberg there seeks to justify casting his memoirs in the form of rationally reconstructed conversations on the grounds that "science rests on experiments; its results are attained through talks among those who work in it . . . the author hopes to demonstrate that science is rooted in conversations." But the truth is that science is rooted in *communication*. Conversation is but one mode of communication, the mode which, to be sure, in the last half century has increasingly become dominant, and characteristic of the activity—first in theoretical atomic physics as Heisenberg was entering upon his career, and then in other disciplines, for example molecular biology. But where James Watson illustrated so cogently the importance of conversation for his own field and discovery, Heisenberg's memoirs conduce rather to the supposition that conversations among physicists deal only with philosophy or politics. The allusions to the specific scientific problems in atomic physics which he addressed are scant and usually so vague as to be intelligible only to a historian. In flat contradiction to his thesis, Heisenberg represents his own early scientific discoveries in highly romantic terms as occurring in complete intellectual isolation and communion with nature. He describes in detail—with, I suspect, much fanciful invention—how the idea of the quantum mechanics was found on the island of Heligoland in June 1925, but the elaboration of this idea into matrix mechanics in collaboration with Pauli, Born, and Jordan is then dismissed with one sentence: "Of this extremely intensive work which kept us breathless [!] for a few months I shall say nothing here."

On the other hand, in keeping with the predominantly philosophical concern and intent of these memoirs, Heisenberg gives considerable space to discussions of the physical interpretation and epistemological consequences of the quantum mechanics. Yet these reconstructions, too, ought not be relied upon in respect either of the substance or of the tenor. Consider, for example, Heisenberg's characterization of Bohr's demeanor during the brief visit which Erwin Schrödinger made to Copenhagen early in October 1926. Schrödinger traveled the length of Germany in order to discuss the wave mechanics—which he had recently developed as a continuous, causal, visualizable quantum mechanics—with Bohr, who declared the discontinuities to be essential and a visualization of atomic processes in space and time impossible.

Bohr's discussions with Schrödinger began at the railway station and were continued daily from early morning until late at night. Schrödinger stayed in Bohr's house so that nothing would interrupt the conversations. [Accurately translated: "Schrödinger stayed with the Bohrs in their home"—it was in fact an apartment in Bohr's institute—"so that on account of this circumstance alone an interruption was scarcely possible."] And although Bohr was normally most considerate and friendly in his dealings with people, he now struck me as an almost remorseless fanatic, one who was not prepared to make the least concession or grant that he could ever be mistaken. [Accurately translated: "he now struck me almost as a remorseless fanatic, who was not prepared to make the least concession to, or accept the least lack of clearness from, his opponent."] It is hardly possible to convey just how passionate the discussions were . . . two men were fighting for their particular interpretation of the new mathematical scheme [accurately translated: "were struggling over the interpretation of the newly won mathematical representation of nature"] with all the powers at their command.

Compare now this picture—making allowance for the way in which the translator has retouched Heisenberg's original—with the impressions which Schrödinger, who had never previously seen Bohr, took away from Copenhagen:

Despite everything that I had already heard of him [Schrödinger wrote Wilhelm Wien on 21 October 1926], the impression of Bohr's personality, that is of the purely human side, was very unexpected. It will be a good long time before a man comes again who achieves such enormous extrinsic and intrinsic success, to whom in his sphere of work the entire world pays homage almost as if to a demigod, and who through it all remains—I do not say modest and free from presumption—almost as shy and bashful as a divinity student. . . .

Bohr's attitude at this moment toward the atomic problems, and you have indeed already briefly characterized it to me, is really very remarkable. He is completely convinced that understanding in the usual

sense of the word is impossible. This being the case the conversation almost always moves immediately to philosophical questions, and one soon no longer knows whether one really holds the position which he is attacking, and whether one really must attack the position he holds. . . .

It is moreover not perfectly easy to be entirely certain how Bohr actually means it, in part because he often speaks in an almost dreamlike, visionary, and really rather unclear way for some minutes at a time, and in part because he is so very considerate and is constantly inhibited by his anxiety that the other person might take his (Bohr's) unreserved expression of his own standpoint as indicating insufficient recognition of the contributions of others—that is, in this case, especially my work.

So much for the tenor of Heisenberg's account. The substance of the conversation which follows is, on the contrary, most likely roughly correct, as far as it goes. In other cases the tenor seems about right, the substance clearly wrong. In most cases it is impossible to tell. Were Heisenberg a novelist his memoirs would perhaps be read as autobiographical novel, presumed to be fiction unless proven to be fact. In that counterfactual case they would be innocuous, and the author would probably even have taken the trouble to correct the English translation. But Heisenberg being a scientist, these memoirs will generally be presumed accurate unless proven otherwise, and so are dangerous.

Finally, a word on ethics and politics. This translation is volume 42 of the series World Perspectives, planned and edited by Ruth Nanda Anshen. In her foreword, mixing 1970 code words—"environment," "planet Earth," "ecological systems"—with the traditional slogans of transcendence—"spirit," "dialectic of polarity," "primordial unitive power," "wholeness, unity, organism," "life itself"—the editor declares her intent to present the intellectual giants of natural science "chastened and humbled," endeavoring to "justify and purify" their scientific achievements by professing them to be intimately connected with "all other knowledge," artistic, intuitive, religious, or whatever. It is disturbing to find some of our most distinguished theoretical physicists as members of the editorial board—Heisenberg is among them—implicitly associating themselves with such fundamentally antiscientific attitudes and empty rhetoric. Whether a "convergence toward human and world unity" is indeed the ineluctable tendency of such slogans no one who recalls their past association with intolerant nationalisms could confidently assert. In fact it was in the Germany of Heisenberg's youth and early manhood that these slogans found their broadest popularity, and were most clearly associated with anticosmopolitanism. Many of the considerations which in these reconstructed conversations take "the whole of mankind" as the reference group or object were at that time doubtless expressed in terms of "Deutschland." And although much that is appalling has been deliberately plastered over, there remain many dicta on political matters which, though not unexpected, are nonetheless chilling.

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Research on Polymers

From Organic Chemistry to Macromolecules. A Scientific Autobiography Based on My Original Papers. HERMANN STAUDINGER. Translated from the German edition (Heidelberg, 1961) by Jerome Fock and Michael Fried. Wiley-Interscience, New York, 1970. xvi, 304 pp., illus. $14.95.

Hermann Staudinger is one of the most important figures in chemistry of this century in that he is among those who are primarily responsible for the concept of the polymer molecule, which can exist as an isolated entity in dilute solutions even if its molecular weight is of the order of 10^6. He was a pioneer in estimating molecular weights of polymers using the simple technique of viscosity measurements, which is still the simplest technique though not an absolute one. His work has therefore had unmeasurable impact on the technology of synthetic rubbers, plastics, and fibers, as well as on the study of biological macromolecules. This book is a scientific biography which summarizes his research contributions in a sequential manner. From it one can obtain the true flavor of scientific discovery, with documentation. Of side interest is the flavor of the personality Staudinger's writing reveals, which is not unlike the generally held conception of a European Geheimrat. He reminisces about the professors who influenced his early career, including Carl Engler, born in 1842. We thus span more than 100 years of chemical tradition. Staudinger won the Nobel Prize in 1953.

Hermann F. Mark has written a brilliant foreword which adds to the value of this interesting book.

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Matters of Concinnity

McGraw-Hill Encyclopedia of Science and Technology. Third edition. McGraw-Hill, New York, 1971. In 15 volumes. Approximately 10,800 pp., illus. $360; to schools, colleges, and public libraries, $295.

One would expect a world leader in the publication of scientific and technical literature, on issuing a 15-volume encyclopedia covering the area it has staked out, to aim for the production of a modern classic. If this is McGraw-Hill's intent for its *Encyclopedia of Science and Technology*, it has not yet hit the mark. The third edition, issued this year, remains spotty in quality and lacks the overall harmoniousness that would put it in the ranks of the great compendia of knowledge.

The publisher states that this edition is "far more than a thorough updating" of the original 1960 edition and the revised one of 1966. In preparation for the 1971 edition, "each article . . . was carefully evaluated. The great majority were revised and almost 1000 new articles were added" for a total of 7600. Illustrations were replaced or reworked and some 2500 new ones were prepared. Where new material was available, the bibliographies were updated, a special effort being made to include hard-cover material that would be more accessible than periodicals to high school students. The final volume is again an Index, this time with 120,000 entries. The Index volume contains as well a section on scientific notation, and at its end is a topical index which groups the articles according to about a hundred major subject areas of science and technology.

The publisher's preface sets out