Heisenberg's Path

Uncertainty. The Life and Science of Werner Heisenberg. DAVID C. CASSIDY. Freeman, New York, 1991. xiv, 669 pp. + plates. $29.95.

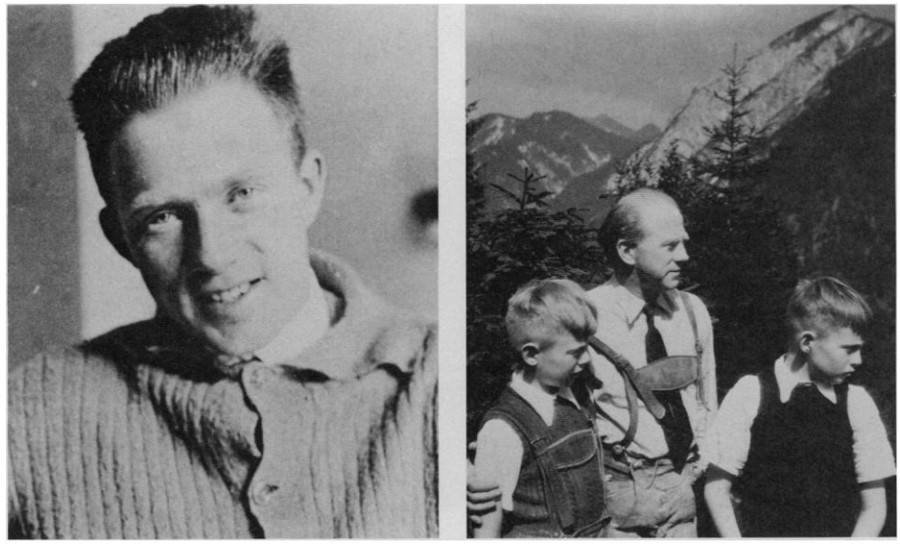
Among the dozen leading figures of 20th-century physics Werner Heisenberg stands out as the most controversial. His contributions to the creation of quantum mechanics in the 1920s have been praised as highly as his role in the "Uranium Club"—the German nuclear project in World War II—has been condemned. His most famous achievement, the articulation of the uncertainty principle, embellished his renown among physicists with an aura of philosophical profundity that has radiated far and wide in contemporary culture. In the 1930s, already crowned with a Nobel prize, Heisenberg continued to make important creative contributions in new areas such as nuclear physics and elementary particle theory, the *ne plus ultra* of modern theoretical physics. Yet at this same time Heisenberg was becoming involved in the less honorable affairs of the Third Reich. Both his discipline and he himself were attacked by a small but influential clique of ideologues promoting a "German physics." Declaring modern theoretical physics a "Jewish bluff," they insulted its non-Jewish defenders like Heisenberg as "white Jews," who would have to disappear from Germany like the "racial Jews." Heisenberg countered this onslaught by dubious compromises with the Nazi regime. Yet despite his own unpolitical ideology—in common with the great majority of German scientists and scholars of that era, he considered politics inferior to science and culture—Heisenberg involved himself in politics throughout the Third Reich. After World War II, he even intensified his political involvement, for example serving as Adenauer's adviser in nuclear policy. His performance in the political arena was as ambitious as everything in his life, but without the splendor that usually surrounded his scientific achievements.

Such a prominent career in such turbulent times did not of course pass unremarked. Heisenberg's own autobiographical essay *Der Teil und das Ganze* (*Physics and Beyond* in English translation), his wife's memoir of him—entitled by her *Das politische Leben eines Unpolitischen* (*Inner Exile* in the English)—and various other biographical accounts, of variable quality, spread the story of this life to a worldwide audience. While physicists and historians of physics examined Heisenberg's contributions to the development of quantum mechanics in elaborate technical detail, his role in the Uranium Club became a central theme in the never-ending debate over why the Nazis failed in their attempt to build an atomic bomb. At the end of the war it was suggested by Samuel Goudsmit, who headed the American mission to assess the German efforts, that Heisenberg simply did not grasp how a bomb would work. Heisenberg rejected this insulting imputation, maintaining that he had abhorred the prospect of making a bomb for the Nazis and thus had deliberately kept the project to a small scale. The ensuing debate over these issues has recently been rekindled (see *Physics Today*, January 1990 and May 1991) by Mark Walker's remarkable study *German National Socialism and the Quest for Nuclear Power, 1939–1949* (Cambridge University Press, 1989), which concluded that both sides in this dispute had retrospectively distorted the facts.

In short, a biographer of Heisenberg is confronted not only with Heisenberg's life and work but also with its subsequent interpretations by admirers and critics.

In *Uncertainty* David Cassidy addresses both challenges from the perspective of, in his words, a "physicist turned historian of science." As historian Cassidy emphasizes the social involvements and environments that make Heisenberg's life and career understandable. To this end he has scrutinized a wealth of source materials from both private and official archives and has analyzed them with the intention "neither to criticize nor to apologize but to comprehend" the "many ambiguities, dualities, and compromises of Heisenberg's life." The title of the book alludes to these as much as to the physical principle for which Heisenberg is most famous. Cassidy attempts "to make Heisenberg himself subject to a type of uncertainty principle"—whence the focus of the book on the 1920s, when this principle entered physics, and on the Nazi period, with respect to which it becomes a metaphor for Heisenberg's own ambivalent attitudes and ambiguous activities.

What new insights do we gain from such scrutiny? Most revealing is the first detailed exposition and extensive documentation of Heisenberg's affiliation with the German youth movement after the First World War. As a model on which the young could build their own lives, prewar bourgeois society seemed to have collapsed in the turmoils of war and revolution. "A gaping hole opened up for us young people," recalled one member of the "Gruppe Heisenberg," a group of newly independent "Boy Scouts" under Heisenberg's leadership, whom Cassidy quotes. Such groups became hotbeds for the creation of new value-orientations. Heisenberg's group sought their new orientation in romantic enthusiasm and love for their country, enforced by tribal rituals such as the criticism sessions known by the Germanic name *Thing*. Dedication to a "Gemeinschaft" (community) under a charismatic



Werner Heisenberg in Göttingen about 1924 and in the late 1940s with two of his sons. [From *Uncertainty: The Life and Science of Werner Heisenberg*]

"Führer" became their cherished ideology. They considered themselves a new spiritual aristocracy and longed for a social, moral, and aesthetic order in which the "part" would be mystically fused with the "whole."

For Heisenberg the youth movement became "a vehicle for his adolescent rebellion, adventurous impulses, and budding leadership qualities" (p. 65). Far more than a teen-age fancy, "pathfinding" (a phrase Cassidy takes for the title of his chapter on these activities) was a significant factor in Heisenberg's career. He had few friends outside his circle of Neupfadfinder, and even after his student years "Altmann" Heisenberg found relaxation from his quantum research in the company of his Jungstamm (the youngsters of the tribe) around the campfire. More than his own family, this circle was his true emotional home. Here he developed the attitudes he would display as an intellectual revolutionary and leader of a progressive school of modern physical theorists—and a compromising and compromised physics leader under the Nazi regime, which had no difficulty in exploiting the nationalist tendencies nurtured in this environment for its own propaganda purposes.

Heisenberg's intellectual development as a theoretical physicist and quantum mechanist is likewise illuminated by Cassidy's tracing it through a series of academic environments charged with a spirit of emulation: first, Arnold Sommerfeld's seminar in Munich, from which so many first-rate theorists sprang as if, like Argonauts, "stamped out of the ground" (to quote Einstein's admiring characterization of Sommerfeld's accomplishments as a teacher); and then the institutes of Max Born in Göttingen and Niels Bohr in Copenhagen, which were the focal points of the quantum revolution. In each of these institutes Heisenberg made his appearance following in the footsteps of Wolfgang Pauli, his Munich fellow student, friend, and competitor. Competition and rivalry, common in scientific careers, were probably nowhere so prominent as in these centers. Cassidy's account of the social and intellectual interactions among the quantum pioneers in these centers corrects the widespread romantic picture of a genial and carefree scientific comradeship. The recounting of Heisenberg's collaboration with Hendrik Anthony Kramers, who preceded him as Bohr's assistant, amply illustrates fierce rivalry between prima donnas.

Another legend Cassidy dispels has to do with the creation of matrix mechanics, commonly attributed to a stroke of genius that hit Heisenberg in summer 1925 on a barren rock in the North Sea during a recuperation from a severe attack of hay fever. Seen against the background of the enormous collaborative and competitive efforts during the preceding years in Copenhagen, Göttingen, Munich, and elsewhere, this inspiration in splendid isolation appears as just one step in a long and complicated social process that led finally to matrix mechanics. Cassidy resists the temptation to trace this process (as he did in his 1976 doctoral dissertation) in exhaustive technical detail but instead provides just enough physics to convey the main lines of thought. Readers without the competence to follow the intricate theories will be grateful for this compromise between readability and technical precision; for others the references indicate the pertinent publications. This is also the case with the treatment of other technical matters such as Heisenberg's struggle with quantum field theory and elementary particles. Here, too, readers are guided at sufficient height over a jungle of exotic physics that they can perceive the main contours without having to stumble through an impenetrable theoretical thicket.

Thus social and intellectual developments are carefully balanced and woven together into a coherent portrayal of Heisenberg's "life and science"—to the end of the Second World War, when Heisenberg was 44. The last three decades of Heisenberg's life are squeezed as a kind of epilogue into the last of the book's 27 chapters. But in view of the author's undertaking to comprehend Heisenberg from the perspective of his formative environments, such a chronologically skewed biography is a tolerable compromise. The same scrutiny of sources could not readily have been extended with the same degree of accuracy to all periods of Heisenberg's life, and the context of German science changed so much after the war that another volume would be needed to embed Heisenberg in this new environment as neatly as is done here for the earlier periods. The thoroughness with which Cassidy has approached the earlier periods, in particular with regard to the Third Reich, was necessary in view of the "profound failure by Heisenberg and others to be completely candid about their attitudes during Hitler's rule and especially during the war" (p. 521). Given the controversies that have surrounded Heisenberg's attitudes during the Nazi period, Cassidy's judicious account is most welcome as an authoritative and reliable reference.

Beyond the interest attaching to Heisenberg himself, this biography deserves attention for yet another reason. Biographers of scientists usually portray their subjects more from the perspective of scientists or scientific journalists than of historical scholars. Cassidy's *Uncertainty*, bringing a professional historical approach to its subject, is a powerful demonstration of the potential of social history in scientific biography.

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"Nobelists and family members at the Stockholm train station, 1933." From right, Erwin Schrödinger, Werner Heisenberg, Paul Dirac, Dirac's mother, Schrödinger's wife, Heisenberg's mother. [From *Uncertainty: The Life and Science of Werner Heisenberg*]

Italians on Evolution

Darwin in Italy. Science Across Cultural Frontiers. GIULIANO PANCALDI. Indiana University Press, Bloomington, 1991. xvi, 222 pp. $35. Translated with revisions from the Italian edition (Bologna, 1983) by Ruey Brodine Morelli.

Italy was an important meeting place for mid-19th-century writers and thinkers from all parts of Europe. After unification it offered an opportunity for scientists in exile from Germany, France, and Russia, as it had