Heisenberg dies: Quantum pioneer

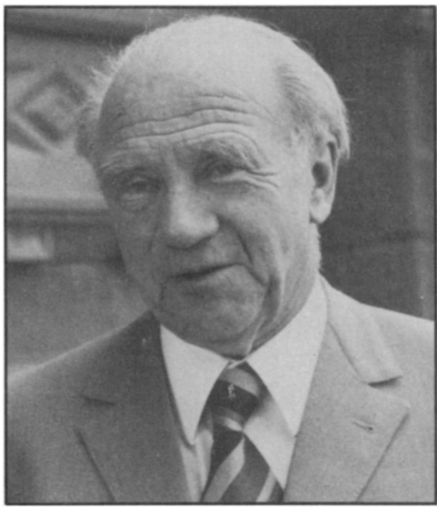
Werner Heisenberg, one of the last remaining pioneers of modern physics' Golden Age, died last week in Munich. Winner of the Nobel Prize by the time he was 31, Heisenberg formulated one of the two key principles with which physics jolted the popular intellectual consciousness of the 20th century. Together with Einstein's theory of relativity, his "uncertainty principle" ranks as one of the most far-reaching theoretical insights to emerge from a period when new scientific discoveries tumbled after one another in an unprecedented cascade.

After finishing his doctorate at age 22, Heisenberg passed quickly from one leading center of physical research to another. With Max Born at Göttingen he learned about treating electrons mathematically as waves; under Niels Bohr in Copenhagen he studied first hand the new theory that electrons in atoms occupy discrete energy levels. Then in 1925, a severe attack of hay fever forced him to seek seclusion on the North Sea island of Helgoland, where he later wrote, "I had ample opportunity to reflect on Bohr's remark that part of infinity seems to lie within the grasp of those who look across the sea."

The outcome of his gazing (and night-long calculations) was solution of the theoretical problem of discrete electron energy states and wave properties, using a methodology that became one of the foundations of quantum mechanics—the treatment of all atomic particles with the mathematics of waves and probabilities. But within two more years an even more profound assertion developed from his work: that electrons and other particles can *never* be completely defined; that the more their motion is pinned down, for example, the more uncertain their position becomes. Within this simple statement of uncertainty lay the downfall of the Newtonian conception that the universe was, at least in principle, completely knowable and predictable. There was also the implicit consequence that by the very act of observation, an experimenter inevitably alters what he's watching.

These assertions immediately brought Heisenberg into conflict with Einstein, who once warned him as they walked together, "You are moving on very thin ice, for you are suddenly speaking of what we know about nature and no longer about what nature really does. In science we ought to be concerned solely with what nature does." Their intellectual struggle continued for years, with most physicists now taking a middle view that some intimate workings of nature will indeed remain unknowable through classical causality.

During the 1930's and 40's more personal conflicts arose. Though convinced that World War II could only end in "the total destruction of Germany," he chose



1973 photo at the Smithsonian: John H. Douglas

Heisenberg: Part of physics' Golden Age.

to stay in his homeland, maintaining later that he had done so to hold together a group of young men who could reconstruct German physics after the holocaust. Some doubt still lingers over Heisenberg's role in the German government's initial consideration of developing an atomic bomb, and the project's final abandonment. Misdirected because of incorrect data that heavy water would be needed instead of graphite to moderate a nuclear chain reaction, and stifled by an isolated, heavy-handed bureaucracy, German nuclear projects progressed very slowly. The influence of Heisenberg's personal views on nuclear weapons remains uncertain.

After the war, Heisenberg's efforts to hold together a remnant of German scientists paid off—he was able to organize the Max Planck Institute for Physics and Astrophysics, where as director, he began to apply quantum mechanical analysis to the emerging problems of elementary particles. He also became more outspoken on the moral and philosophical implications of scientific discoveries, which he summarized in his intellectual autobiography *Physics and Beyond.*

The aim of current physics, he wrote, is "to construct the elementary particles, and with them the world, from alternatives in the same way as Plato tried to construct his regular bodies, and the world, from triangles. . . . It calls for thought of such abstraction as has never been used before, at least not in physics. I myself would certainly find it too hard, but perhaps the younger generation will take it all in their stride." But he also warned, "We cannot exclude the possibility that after some time the themes of science and technology will be exhausted, that a younger generation will be tired of our rationalistic and pragmatic attitude."

He produced his own "younger generation"—seven children—all of whom survive him. Just as the physicist's life reflected greater concern for science than politics or even wars, family life at the Heisenberg's displayed a certain timeless quality. The whole family frequently joined to play chamber music, with papa at the piano. It was at home, last Saturday night, that he died quietly. □

New hydrogen ion (H^{--}) discovered

Though a hydrogen atom usually consists of one electron revolving about one proton, under certain conditions, an extra electron may be picked up loosely, creating a negatively charged hydrogen ion, H^-. Now a second peculiar ion species has been detected, one with two extra electrons added to form H^{--}. Its existence may have significance to plasma physics and astrophysics, as well as to the theory of atomic structure.

Stanford Research Institute spectroscopists Michael Anbar and Rafael Schnitzer discovered the new ion in a stream of particles coming from a plasma. By lining up instruments that would select particles by weight, charge and velocity, the experimenters found that a very small number of the hydrogen ions produced in the plasma would gain twice the energy expected as they passed through an electric field—indicating they had two electronic charges. A preliminary paper is presented in the Feb. 6 SCIENCE, and a more detailed discussion will follow in the JOURNAL OF CHEMICAL PHYSICS.

Knowing concentrations of electrons and various kinds of ions is the key to modeling plasma behavior, and the existence of a new species would have to be taken into account in future theoretical calculations. Though an H^{--} lives only a short time, only 23 nanoseconds, this is still quite long compared with the time between collision of particles in a plasma; hence a sizable number of H^{--} ions might be present in equilibrium with the rest of the plasma. However, Anbar explained to SCIENCE NEWS that since all the H^{--} he measured came from near the surface of his plasma source, while H^- ions could originate anywhere in the source, he could not yet tell accurately what the equilibrium concentration of the new ion might be. This question will probably be pursued by plasma researchers.

Astronomers, too, will have a new phenomenon to look for. When an H^{--} ion is formed or broken down in interstellar space, photons of light must be absorbed or emitted. The authors suggest that photon absorption could be detected as previously unexplained lines in the astronomical infrared spectrum. They also say that an equilibrium concentration of H^{--} may exist in space. They express hope that new theoretical work will be stimulated by their discovery. □

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