Hans A Bethe 1906–2005

Hans Bethe, who died on 6 March 2005, was the last of the brilliant young theorists who entered physics right after quantum mechanics was discovered. In 1926, at the age of 20, he joined Arnold Sommerfeld’s seminar in Munich just as Erwin Schrödinger’s papers began to appear. He quickly demonstrated exceptional power and ingenuity. By 1931 his publication list included three classics: the spectrum of an atom embedded in a lattice, one of the first applications of group theory to quantum mechanics; a complete solution of the 1D Heisenberg ferromagnet using the famous Bethe Ansatz; and the first detailed quantum theory of energy loss suffered by charged particles traversing matter.

Because his mother was Jewish at birth, Bethe was dismissed from his post at Tübingen when the Nazis came to power. After two highly productive years in England, he moved to Cornell University in 1935, where he was to remain for the rest of his life.

Bethe had an unequaled ability to synthesize and elucidate complex newly developed knowledge. This was first demonstrated in the 1933 Handbuch der Physik by a long article on solid-state physics, and another on one- and two-electron atoms; and a few years later in three issues of Reviews of Modern Physics, which became known as the Bethe Bible on nuclear physics.

This mastery of nuclear physics had two remarkable consequences. In 1938, Bethe discovered the carbon cycle, the intricate catalytic mechanism that turns hydrogen into helium in massive stars. In 1967, this work won the Nobel Prize for Physics – the first one to be awarded for a topic in astronomy.

The second could not be more different: Bethe’s leadership of the Theory Division at wartime Los Alamos. The phenomena relevant to nuclear explosions were so inaccessible to experiment that theory of all sorts was indispensable, and Bethe’s intellectual powers and calm persona were needed to coordinate the stellar team that Robert Oppenheimer had assembled, consisting of people who had previously worked on whatever interested them, and usually alone.

After the war, Bethe worked intensely and simultaneously in two entirely different settings: at Cornell on pure academic physics, and as a senior advisor to – and critic of – the US government.

To an extent that was unique among the former leaders of the Manhattan Project, Bethe devoted great effort to what might appear to be contradictory ends: as a consultant to further weapons work and an opponent of such work, and as an advisor on US security policy and an opponent of central themes in this policy. This was because he held deep moral convictions and a strong pragmatic inclination.

From the start he was an outspoken advocate of arms control, and played a key part in establishing the atmospheric test ban. He publicly opposed developing the hydrogen bomb, but when it became known that such a device was possible he worked on it because he decided that the Soviets would soon have it. He worked on missile defence inside the government, concluded it would be both futile and counterproductive, and thereafter publicly opposed all attempts to deploy such systems. In a ceremony at Los Alamos on the 50th anniversary of Hiroshima, he called on scientists everywhere to desist from developing new nuclear weapons.

After the war, and thanks largely to Bethe, Cornell attracted some of the most talented physicists at Los Alamos – Richard Feynman and Robert Wilson, to name only the most famous. But Bethe always kept his own hands in front-line research until well over the age of 90. His first major post-war paper was his famous, rough-and-ready calculation of the Lamb shift, done on the train ride from the conference where Willis Lamb first announced that the Dirac equation did not account fully for the hydrogen spectrum. He then participated in virtuoso QED calculations with Feynman and their students.

During the 1950s and 1960s, he focused on nuclear matter, including the equation of state at high densities, which is important in astrophysics. After his retirement, he collaborated extensively with Gerald Brown at SUNY Stony Brook, calling himself “Gerry’s postdoc”, and worked for nearly two decades on type II supernovae. After he became convinced that the solar-neutrino problem was not a fault of solar models, he wrote a landmark paper on the implications of neutrino oscillations, and important follow-on articles with John Bahcall.

Bethe was not only a truly outstanding scientist, but also a man of legendary candour and honesty. He was a teacher and mentor to generations of young physicists. It was instructive to see him handling reporters from the Cornell undergraduate newspaper as respectfully as the Washington press corps. And he had a great sense of humour. In 1931 he published a spoof of Arthur Eddington’s claim that he had calculated the fine structure constant from first principles. Bethe and two other youngsters published a “calculation” of the absolute zero (in Centigrade units!) from the fine structure constant in Naturwissenschaften, and caused a scandal. In 1997, when World Scientific published a massive volume of selected papers, Bethe made sure this spoof was included.

When his death was announced on the front page of The New York Times, someone not at Cornell or in physics, but who knew him, wrote and asked, “Do they make them like that anymore?”

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