Hans A. Bethe

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Hans Bethe joined the Cornell faculty in 1935. Although only 28 years old, he had already achieved international renown as one of the most brilliant and productive theoretical physicists of the generation that entered the field immediately after the discovery of quantum mechanics in 1925-26. At that time, Cornell's Physics Department was ambitious and far-sighted, but it was not among the leading centers in the United States, let alone internationally. That was to change very quickly, and Hans was to be the crucial factor in that transformation.

Hans was born in Strasbourg into a German academic family; his father was a prominent physiologist and his maternal grandfather a professor of medicine. Hans became a student of Arnold Sommerfeld, the outstanding teacher of theoretical physics in Europe, joining his Munich seminar in 1926 just as Erwin Schrodinger's papers on wave mechanics were appearing. He swiftly mastered the entirely new concepts and techniques, and by 1931, his rapidly growing publication list included groundbreaking papers on atomic spectroscopy, penetration of particles through matter, and magnetism. Hans was also quick to establish himself as his era's premier synthesizer of new knowledge with two encyclopedic review articles in the *Handbuch der Physik* on atomic spectroscopy and solid-state physics.

When the Nazis came to power in 1933, Hans lost his post because his mother had been born Jewish. Before coming to Cornell, he spent two highly productive years in England, partially in collaboration with Rudolf Peierls, another émigré, brilliant Sommerfeld product, and life-long friend. Together they wrote some of the very first papers applying quantum mechanics to nuclear phenomena.

Hans felt at home very quickly at Cornell. In the fall of 1935, he wrote to Sommerfeld that when he first arrived he had felt "like a missionary going to the darkest parts of Africa [but by now] I would hardly return to Europe even if I would be offered the same amount of dollars as at Cornell."

In the years between 1935 and Pearl Harbor, Cornell became an outstanding center in both theoretical and experimental nuclear physics. Hans's presence helped to attract a number of brilliant young physicists, who built the world's second cyclotron and pioneered in cosmic ray physics. Partly in collaboration with his Cornell colleagues, he wrote the Bethe Bible, three encyclopedic articles in *Reviews of Modern Physics* that were the basic texts in the rapidly growing field of nuclear physics for a generation. And as an integral part of his research, Hans guided a succession of doctoral students and post-docs, and with his new colleagues established Cornell as an institution that attracted outstanding young physicists ever since.

Hans's prime Cornell achievement of the pre-war years was his theory of energy production in stars, published in 1939, which *inter alia* created the field of nuclear astrophysics. After nearly 30 years, he was awarded the 1967 Nobel Prize in physics for this work—the first ever on a topic in astrophysics.

Also in 1939, Hans married Rose Ewald, the daughter of his former professor at the Technical College of Stuttgart. Rose's support was crucial to Hans's later achievements, as he struggled to balance the demands of research, teaching, and advising the government.

The fall of France proved to be the second watershed in Hans's life, the first having been his emigration to America. Although he was officially still an enemy alien in 1940, he embarked on free-lance military research: first on armor penetration with another refugee at Cornell from Europe, George Winter, and then with Edward Teller on shock waves. After becoming a citizen, he joined the radar project at MIT, and after a while he succumbed to Robert Oppenheimer's entreaties to join the newly born Manhattan Project. At Los Alamos, he was selected to be the director of the Theoretical Physics Division, which was to play a key role in the bomb project. This was because so many of the processes involved in designing a nuclear explosive were not accessible to laboratory experimental physics and hinged on parameters that were still unknown. Hans's division housed a galaxy of outstanding theorists, very young and not quite so young. Hans's unique combination of technical mastery, gravitas and unimpeachable integrity allowed him to lead a team that was not predisposed to teamwork.

After the war's end, Hans returned to Cornell, and brought two brilliant young theorists with him from Los Alamos, Richard Feynman and Philip Morrison. He had grown to love Cornell and its setting in Upstate New York, for he had other attractive offers, and not only at that point. The University added a critical inducement by creating a front-line experimental physics facility, the Newman Laboratory of Nuclear Studies. A bit later, Hans and Dale Corson attracted Robert Wilson, who had headed experimental nuclear physics at Los Alamos, to leave Harvard and to become the director of the new laboratory. Together with other young Los Alamos veterans—John DeWire, Kenneth Greisen, Boyce McDaniel and William Woodward—they elevated Cornell into a world-leading center in the new field of elementary particle physics.

In the spring of 1947, Sommerfeld retired and asked Hans whether he would be willing to succeed to his chair in Munich. Hans felt very honored but declined, writing that

> *"unfortunately it is not possible to extinguish the last 14 years … perhaps still more important … is my positive attitude towards America. It occurs to me (already since many years ago) that I am much more at home in America than I was in Germany. As if I was born in Germany only by mistake, and only came to my true homeland at 28."*

The first big post-war breakthrough in basic physics came in the spring of 1947 with the discovery by Willis Lamb at Columbia of a small but critical discrepancy between the spectrum of atomic hydrogen and the prediction of Dirac's relativistic extension of quantum mechanics. There were speculations in the air that this could be accounted for by quantum fluctuations of the electromagnetic field, but that this is actually valid was first shown by Hans during his train ride from the conference where Lamb announced his result. Hans's somewhat slapdash but basically correct calculation was the opening shot in a revolutionary transformation of quantum electrodynamics in which Feynman at Cornell, and independently Julian Schwinger at Harvard, played the central roles. Hans, his students and post-docs participated in the very complex calculations that applications of the theory required. With one of us (EES), Hans developed the first fully relativistic quantum-mechanical description of the two-body problem, and later a completely new edition of his 1933 *Handbuch* article on atomic spectroscopy.

The complex technical and political controversies that surrounded the invention and deployment of thermonuclear weapons—the "hydrogen bomb"—faced Hans with a set of ethical dilemmas and perplexing decisions in which he relied on Rose for advice. Although he had no regrets about the development of the fission weapon at Los Alamos, because he had feared that Germany would do so, after the war he was deeply worried by this new means of destruction, and far more worried by the prospect of the H-bomb, a vastly more destructive weapon.

At first he publicly opposed development of the H-bomb, but after the first Soviet test of a fission weapon prompted President Truman to order a crash H-bomb project, Hans joined in the hope that he could demonstrate it was infeasible. When Teller and Ulam discovered how it could be done, he decided that the Soviets would also invent it and that the U.S. could not afford to be without. But he was always to be distressed that this development was not averted by a political bargain with the Soviets, and for decades continued to devote considerable effort to arms control.

This effort was both inside and outside the councils of government. The former was pursued as a member of the President's Scientific Advisory Committee in the Johnson and Kennedy administrations, in which setting he played a critical role in the creation of the Atmospheric Test Ban Treaty, signed in 1963. But Hans did not confine his advocacy of arms control to the "inside." Of the senior veterans of the Manhattan Project, he was the most persistent and vocal participant in the public debates about policies regarding nuclear weapons and the related issue of ballistic missile defense.

While Hans always took an active interest in planning for the Physics Department and Newman Laboratory, he rarely took part in university-wide governance. But that changed during the campus unrest following the Willard Straight student takeover in April 1969. He co-chaired a faculty "crisis" committee, which produced an important paper, "The Academic Responsibilities of the Faculty." This document appears as the first Appendix in the current Faculty Handbook. The following year, a University Senate was formed, and Hans agreed to serve in its first year.

Hans continued to teach and to supervise a large number of graduate students and post-docs, primarily on theoretical nuclear physics, until his official retirement in 1975. But his retirement was, indeed, only official. He devoted the ensuing three decades to front-line research in astrophysics, largely in close association with Gerald Brown of SUNY Stony Brook. Their work featured long sequences of papers on supernova explosions and on neutron star black hole binaries. Hans also wrote a number of important papers on neutrino emission from the sun, a topic closely related to his 1939 theory of stellar energy production.

Hans's career was unique in many ways, and we mention but two. No other physicist has ever produced front line research for over 70 years. And no other faculty member has served Cornell for fully half the entire existence of the University—an institution to which he was deeply committed, and whose surroundings, culture and ambience he loved.

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