J. Natn.Sci.Foundation Sri Lanka 2005 33(1): 57-58

COMMENTARY & NOTES

HANS BETHE (1906-2005)

Hans Albrecht Bethe who died on 6 March 2005 at the age of 98, was one of the most influential and innovative theoretical physicists of our time.

Bethe was born in Strasbourg, Alsace-Lorraine (then part of Germany) on 2 July 1906. His father was a University physiologist and his mother Jewish, the daughter of a Strasbourg professor of Medicine. Bethe moved to Kiel and Frankfurt from where he went to Munich to carry out research in theoretical physics under Arnold Sommerfeld, who was not only a great teacher, but an inspiring research supervisor as well. Bethe received his doctorate in 1928, for the work he did on electron diffraction. He then went to the Cavendish laboratory in Cambridge on a Rockefeller Fellowship, and Rome, before accepting an appointment in Tubingen, where he was a faculty member with Hans Geiger until 1933. Bethe moved to England where he worked for sometime at the University of Manchester with fellow physicist Rudolf Peierls, on nuclear physics. They both got started by chance after meeting James Chadwick, the Cambridge physicist who discovered the neutron. Bethe once remarked that he considered everything before 1932 "the prehistory of nuclear physics, and from 1932 on, the history of nuclear physics". The difference, according to him was the discovery of the neutron. Bethe and Peierls also enjoyed collaborating on some work on the neutrino, the hypothetical particle invented by Wolfgang Pauli. From Manchester Bethe moved to Cornell University, Ithaca, NY in 1934 where he became Professor of Physics in 1937. He was working on radar but was regarded as one of the world's leading nuclear physicists. At Cornell, Bethe was joined by Richard Feynman and Freeman Dyson, two brilliant minds. Bethe retired in 1975, however he continued to stay at Cornell as Professor Emeritus.

It was while working at Cornell that Bethe began to study the energy source of stars. A young English woman named Cecilia Payne found that over 90% of the sun's core was hydrogen and not iron as it was previously believed (for which she was ridiculed at first by her scientific peers, but subsequently was vindicated when independent research by others backed her findings). The fuel within the sun is hydrogen which is available in tremendous volume. Near the centre of the sun, hydrogen nuclei can be squeezed under enormous pressure to become the element helium. If the mass of hydrogen nucleus can be written as 1, Bethe showed that each time four nuclei of hydrogen fused together as helium, their sum was not equal to 4. The helium nucleus weighs about 0.7% less, or just 3.993 units of weight. It is this missing 0.7% that comes out as a burst of explosive energy. The sun is so powerful that it pumps 4 million tons of hydrogen into pure energy every second. Einstein's famous equation, $E = mc^2$, provides a clue to the massive energy that reaches the earth from the sun, when 4 million tons of hydrogen are multiplied by the figure c^2 (square of the speed of light). Bethe identified a cycle of thermonuclear reactions involving hydrogen, nitrogen and oxygen that are catalyzed by carbon culminating in the creation of helium. He calculated the sun's energy production which results in the fusion of four hydrogen nuclei into helium. He proposed the carbon cycle in 1938 in which carbon acts as a nuclear catalyst promoting, at very high temperatures, a process in which the fusion of hydrogen nuclei into helium results in the loss of mass accompanied by the release of enormous, billowing, explosive energy, while the carbon itself remains unchanged.

Hans Bethe became a US citizen in 1941, and in 1942 began working on radar in the radiation Laboratory at MIT. It was here that he came to the notice of J. Robert Oppenheimer, who invited him to join a small group of theorists – nine in all – to discuss bomb physics in Berkeley. When the Manhattan Project began at Los Alamos in 1942 to produce the first atom bomb that was later dropped on Hiroshima, Oppenheimer enlarged this team to include several other brilliant scientists, many of whom subsequently were awarded the Nobel Prize. By the time Bethe was working in the Manhattan project, he was already married to Rose Ewald, the intelligent and attractive daughter of his Stuttgart physics professor Paul Ewald who was well known for his work on crystallography. Bethe had met Rose as a young girl earlier in Germany when he was working for Paul Ewald as a young assistant. The Ewalds left Germany and came to England, and

Rose went to America to study. Bethe had met her again in America and married her. Their two children were born in Los Alamos.

When Bethe heard over the loudspeaker that on 6 August 1945 the atom bomb had been dropped on Hiroshima, his first reaction was one of relief. He was at first elated and had a sense of satisfaction that something he had worked on had helped to win the war. Later however he was troubled and would ask "What have we done? What have we done?". Since then he did everything possible to see that such a disaster would not happen again. He firmly believed that the power of the atom bomb should have been demonstrated to the Japanese before it was dropped on Hiroshima and Nagasaki. After the war, he and Oppenheimer campaigned for international control of all nuclear developments. He was the leader in emphasizing the social responsibility of science. Bethe was against the development of the hydrogen bomb. While the atom bomb that destroyed Hiroshima had a blast power equivalent to 15,000 tons of TNT, the first successful U.S hydrogen bomb which was tested on the Eniwetok atoll on 31 October 1952 had a blast power equivalent to about 10 million tons of TNT - enough power to destroy an area about a thousand times larger than what was devastated by the Hiroshima bomb. Between 1946 and 1958, there were 67 nuclear bomb tests that were carried out in Bikini and Eniwetok atolls in the northern Marshall Islands in the Pacific.

Bethe was awarded the Max Planck Medal in 1955, and received the U.S Atomic Commission's Enrico Fermi award in 1961. He was awarded the Nobel Prize in 1967 for unraveling the mystery of how stars continue to generate such prodigious amounts of energy over long periods of time without burning out. The discovery of neutron stars led him to fundamental research in astrophysics in 1970.

Bethe loved the outdoor and often went on hikes and mountain climbing with friends. He scaled the Lake Peak across the Rio Grande with Enrico Fermi. Both would sit in the sunshine at 12,500 feet discussing physics problems. As a student in Germany, Bethe had the peculiar habit of numbering all his letters consecutively, starting with the first one he wrote when leaving home. He also numbered the pages consecutively! Bethe was a tall heavily built man who spoke in a slow drawl. He was a very warm, amiable and thoroughly easy-going physicist devoid of pride or pretense. By force of intellect and personality, he exerted a profound influence on everyone who was fortunate to get to know him at Cornell University. In his passing, the scientific community has lost one of the last of the giants who contributed so brilliantly to the advancement of theoretical physics. He is survived by his wife Rose, a daughter and a son.

Charles Santiapillai
Department of Zoology, University of Peradeniya.