A renowned cosmic-ray physicist

An obituary of Bernard Peters (1910–1993)

Professor Bernard Peters, a renowned cosmic-ray physicist, passed away at the age of 82 in Copenhagen on 2 February 1993. He will be remembered for his fundamental contributions in a broad range of fields[1] by his students, colleagues and friends in the US, India and Europe where he worked. The story of his life is a long list of adventures, both as a physicist and as a person. Bernard Peters demonstrated an enormous capacity to look deep into the mysteries of nature, to decide on what was really important for taking the next step, and then to transform his ideas into reality within a reasonable period of time with modesty and limited resources.

He was never held back by adverse criticisms as he had an unshakable faith in what he was doing, quite often adventuring into areas completely new to himself, e.g. refrigeration techniques, hydrogen gas mass production techniques, radiochemistry and geology.

Early life

Bernard Peters, born Bernhard Pietrkowski of Jewish heritage in 1910 in the German city of Posen (now Poznan, Poland), grew up in the Rhine Valley at Freiburg, where his father did research in pharmacology and practised internal medicine. During the latter part of World War I, when food was short, young Bernard was sent up to the Black Forest to stay with a farm family, where he herded sheep and partook of the more abundant peasant diet. As a school boy he spent more than one summer vacation rafting down the Rhine with some of his school mates and their teacher, stopping each night at some town where they set up their stage and posted their playbills for the puppet theatre performance that followed. Bernard's taste for adventure came naturally: his father, as a young medical doctor, had travelled to South America to journey up the Orinocco River and his mother, while still the young parent of two small boys in Posen, had taken part in a hot-air balloon flight that established a distance record for its time.

Bernard was a student at the Technical University in Munich in 1933, the year Hitler came to power. As a student activist in the struggle against the Nazis, Bernard was seized within the first few days of Hitler's taking over, and was taken to the concentration camp at Dachau. He escaped the camp after three months, travelled by night on a bicycle through the Alps and on to Italy. There he joined his girl friend Hannah Lilien, who had gone to Padua to study medicine and then onto

England where he remained until he obtained a visa to the US in 1934. Soon he found a job in an import firm in New York during the deepest period of the depression. Hannah moved to the US in 1934 and they were married the same year. Bernard did well in the business firm, but when Hannah finished her medical degree in 1937, he quit. They bought an old Ford car, dubbed it 'Felix', and with hardly any money in hand, the couple set out to the west coast. (Philip Morrison[2] has narrated an interesting anecdote involving Felix in his article on Bernard Peters' science.) Hannah worked as a Research Fellow in the Stanford University Medical School and Bernard as longshoreman in the San Francisco shipping docks. Then came the change which was to last. At a social occasion Bernard met Robert Oppenheimer who encouraged him to come to the University of California, Berkeley as a graduate student. Thus, in 1938, Bernard began his career in physics. He did a theoretical thesis with Oppenheimer, earning his Ph D in 1942, but then promptly engaged himself with experimental physics at the Radiation Laboratory, under Ernest O. Lawrence, for the next 3 years, working on the Manhattan project.

After World War II, Bernard was a part of the team that did the experimental and theoretical work to implement the frequency modulated cyclotron concept, using the large magnet at the Radiation Laboratory that had recently served to separate the isotopes of uranium.

Major scientific contributions

University of Rochester, USA (1946–1951)

In 1946 Bernard joined the physics faculty at the University of Rochester where he soon entered into a fruitful collaboration with Helmut Bradt, an experimentalist from Zurich. In 1947 they joined with physicists at the University of Minnesota in a two-pronged experiment to look at interactions in matter of the primary cosmic-rays near the top of the atmosphere. The Minnesota instrument was a cloud chamber while the Rochester detector was a stack of glass-mounted photographic emulsions, both carried aloft by a high-altitude 'Skyhook' balloon. The results of that experiment are now history. Both teams showed, from the density of ionization along the particle tracks, that the primary cosmic-rays include the nuclei of heavier elements along with the much more abundant protons.

The emulsions proved to be a most suitable means for studying these events and in a series of pioneering papers Peters and Bradt explored in detail the chemical composition (up to iron), abundances, energies and interactions of these newly-discovered heavy primary cosmic-rays. They considered the astophysical implications as well, including the question: 'Do cosmic-rays, the only material accessible to us from beyond the Solar System consist of matter only or do they also contain anti-matter?' This might be determined by using the E-W asymmetry in the cosmic-rays due to their magnetic deflection in the strong horizontal geomagnetic field at equatorial latitudes.

In October of 1949 Bernard met H. J. Bhabha, Director of Tata Institute of Fundamental Research (TIFR), Bombay, who had an ongoing stratospheric balloon flight programme, to discuss a collaborative experiment between TIFR and the University of Rochester to study this problem. Though Helmut did not live to see this experiment, Bernard arrived in Bombay the following August with several orientation platforms, designed to hold stacks of emulsion in a fixed direction in space during a flight. A number of flights were carried out from Madras. Subsequent analysis at TIFR and in Rochester showed that not more than one heavy nucleus in a thousand is anti-matter.

Bhabha invited Bernard to come to TIFR to build what would become a world-class of cosmic-ray research. In 1951 Bernard and his family moved to Bombay and commenced a new phase in his career.

Tata Institute of Fundamental Research, Bombay (1951–1958)

Peters was already acquainted with the TIFR from his earlier visit, and no sooner had he joined TIFR, than he began a series of investigations, partly centered on analyses of nuclear emulsion plates exposed earlier to cosmic-rays at high altitudes, and partly on experiments requiring new balloon flights. The next few years marked what I believe was the most active scientific era in the history of TIFR! During this period, a great deal of new information[1] was acquired about the nature of nuclear interactions at ultra-high energies: (i) about several types of elementary particles, (ii) the property of their 'associated' production, and (iii) nature of interactions.

The success of Peters' group was a direct result of his approach to the problem, namely processing a stack of free-floating, large, thin emulsion sheets so that charged particle tracks could be traced forwards or backwards through these emulsion pellicles. The participating scientists worked round the clock with great excitement and there was electricity even in the corridors of TIFR as fundamental information was being obtained through these simple, but well-conceived experiments. The new results, particularly on the masses and modes of decay of the K-mesons, presented at the 1953 Cosmic-Ray Conference in Bagnères de Bigorre, served to put TIFR among the top laboratories in the world map of cosmic ray and elementary particle research. The rationale behind his ideas is very well summarized by Peters[4].

The years 1955–1957 marked the second period of great excitement and discoveries during the period of direction of research by Peters at TIFR. A new scientific activity was started by Peters in 1955, namely the search for the cosmic-ray-produced isotopes, ^{10}Be, and ^{7}Be. The isotope of beryllium, ^{7}Be, was detected in 1955 Bombay rains and in 1956 in Pacific marine sediments. The nuclide, ^{7}Be, was discovered by Arnold and Al-Salih earlier in 1955 rains, but TIFR scientists were then not aware of his discovery of ^{7}Be in Chicago rains during October 1953 to April 1954. The nuclide, ^{10}Be, was however discovered independently by Arnold and by Peter's group in 1956 in Pacific marine sediments. For accounts of discovery of ^{10}Be in Chicago and in India, reference is made to Arnold[5] and to Lal[6]. Two other nuclides, ^{35}S and ^{33}P, produced in the atmosphere by cosmic-ray spallations of argon were detected in Bombay rains. The capability developed at the TIFR in the field of low-level counting and radiochemistry led to the discovery of six other cosmic-ray produced radionuclides[7] during 1955–56. The work carried out at that time is still valid, and forms the basis for a wide variety of cosmic-ray geophysical studies[7].

For personal reasons, Peters left India in 1958 for Copenhagen, where he joined the Niels Bohr Institute of Theoretical Physics, first and later established the Danish Space Research Institute.

Niels Bohr Institute and Danish Space Research Institute, Copenhagen (1958–1979)

In 1958 Bernard was invited as a visiting professor and the following year accepted a permanent appointment at the Niels Bohr Institute of Theoretical Physics. There he had a small nuclear emulsion group that carried out studies of elementary particle collisions using emulsions exposed to cosmic-rays in balloons or to high-energy particles at accelerators. When the Proton Synchrotron commenced operation at CERN in 1959 Bernard spent considerable time in Geneva where he was involved, directly or indirectly, in a number of experiments using 28 GeV protons. Bernard wrote extensively, including two review articles on cosmogenic nuclides as geophysical tracers, and a detailed theoretical analysis (with Yash Pal) on the propagation of the nucleonic component of cosmic-rays through the atmosphere. The latter inspired the search for 'plutons', the heavy particles later to be identified with 'Quarks'. Bernard argued that the place to look for these particles, if they exist, is in the cores of large airshowers, looking for delayed particles. The major experimental effort at the Niels Bohr Institute, as with other Quark searches around the world, yielded no positive evidence for free Quarks.

During 1961–62 Bernard served as the scientific delegate from Denmark on the European commission set up to establish the structure of a European Space Research Organization. At Varenna he organized a two-week conference on Cosmic-Rays and Space Research and in Copenhagen, in 1962, he sponsored a symposium aimed at preparing the European cosmic-ray community for the new possibilities opening up with the creation of ESRO. In 1966 the Danish Space Research Institute was established, making use of the Ionospheric Laboratory of Denmark's Technical University in Lyngby. Bernard was appointed its first Director, a post he held until his retirement in 1979. The new Institute undertook work in two areas: 1) the Earth's magnetosphere and 2) the cosmic radiation.

In the magnetosphere area a project that Bernard pushed strongly and successfully was the first ESRO geostationary research satellite, GEOS.

In the cosmic-ray field DSRI pioneered

the use of spark chambers in balloon instruments for composition studies, making possible detectors of large area since track determination permits non-uniformities in detector response to be calibrated out. The first of several such instruments was flown in 1969 in France[8] with gratifying charge resolution. A major conceptual breakthrough came with Bernard's suggestion to use the excellent charge and velocity resolution of such an instrument's Cerenkov detectors, in conjunction with the rigidity filtering of the cosmic-rays by the geomagnetic field, to measure the *isotopic* composition of the particles relying on stopping the particles by ionization losses.

The proposal for such a satellite instrument, in a collaboration between DSRI and Centre d'Etudes Nucleaires de Saclay, France, was accepted by NASA in 1971 to be placed aboard the HEAO satellite. It had been planned to use a high-pressure gas Cerenkov detector to filter out low energy particles, but Bernard come up with a better idea — to make a Cerenkov radiator of arbitrary cut-off velocity by compressing a powder of sub-micron sized silica spheres to the desired density. Not many people believed this would work but it did. Further development took place at Saclay, resulting in a very suitable silica aerogel radiator.

In 1971 Bernard hosted an international symposium on Isotopic Composition of the Primary Cosmic-Radiation in Lyngby. The building installation of the instrument and preparing the analytical means for its use occupied the Institute until its eventual launch shortly before Bernard's retirement in 1979, but this was also a period in which Bernard continued to develop new ideas about the origins of cosmic-radiation and its confinement in the Galaxy.

Epilogue

Bernard never stopped thinking of new ideas, not just for the sake of having them, but for learning about the mysteries of nature.

He used to impress on his colleagues to think deeply before doing an experiment. He used to illustrate his thought by examples in science. He was very fascinated by a story of the Chinese Emperor and a painter. The Emperor told the painter to paint a picture of his favorite bird. The painter said alright but many months passed and no painting resulted. So finally the emperor called the artist and asked if he had the picture ready. The artist said, 'yes' and immediately executed an excellent painting with minimum of brush strokes. 'Amazing', said the emperor. The artist has spent all that time in watching the bird and all its movements and mood and the reproduction was unmistakably 'IT'. Bernard once told us how Fermi worked. Fermi always thought before designing an experiment. First he would make an assumption and write a paper on the basis of the assumed result. Then he would think if the results were totally opposite, and then he would write another paper. After careful analyses he would then design the experiment.

Peters leaves behind his wife, Dr Hannah Peters, known internationally for her researches in reproductive biology; son Tom Peters, Professor of Architecture in Lehigh University, Bethlehem; Susan Peters, histology technician in Panum Institute, Copenhagen and a sister, Mrs. Lena Kaplan in Seattle; and a large number of friends and colleagues, who will miss him for several reasons: for his collaboration and for his ferment and passionate look at the Universe.

For me, I always considered it a privilege to work closely with B. Peters, whom I revered as a teacher supreme.

Notes and references

1. A special issue of *Current Science* (vol. 61, no. 1, 1991) was recently published in honour of Professor Bernard Peters to celebrate his eightieth birthday. This issue contains several articles by his colleagues and students, which give a fair glimpse of his varied contributions. There is also an article by Peters himself in this issue giving his reminiscences of his association with Indian science for about a decade.

   For providing information on several facets of Professor Peter's early life, and for his scientific contributions in building the Danish Space Research Institute, Copenhagen, I am very thankful to Professor Bruce Dayton and Dr Niels Lund.
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