Homi Jehangir Bhabha, the Renaissance Man

by Asia Pacific Mathematics Newsletter - Tuesday, May 13, 2014

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> ***Bhabha is a great lover of music, a gifted artist, a bril-liant engineer and an outstanding scientist. He is the modern equivalent of Leonardo da Vinci.***
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> ***— Sir C V Raman at the Annual Meeting of the Indian Academy of Science, Nagpur, 1941***

Homi Jehangir Bhabha was undeniably one of the most exceptional personalities in modern India. As a scientist he did path-breaking work in the field of elementary particle physics. As an institution builder he created two extraordinary foun-dations — one for fundamental science and the other for atomic energy. While shouldering the country's nuclear programme, he campaigned internationally for the peaceful uses of atomic energy. And as an artist and art connoisseur he patronised modern Indian art and went on to initiate one of the most magnificent and unique collections in India.

Bhabha was born in an aristocratic and influential Parsi family. His grandfather, Hormusji Bhabha, was the Inspector General of Education in the princely state of Mysore and was well-known in the academic circle in Bangalore. He also maintained a good rapport with prominent people like C V Raman. Bhabha's father was educated in Oxford and trained as a lawyer in England. After his marriage to Meherbai, the daughter of Framji Dorabji Panday, he moved to Bombay. Bhabha was born here on October 30, 1909.

After passing his school leaving examination from the Cathedral and John Connon School, he joined Elphinstone College and later the Royal Institute of Science. By this time Bhabha had already read Einstein's Special Theory of Relativity and was clearly interested in science and in the fundamental laws of nature. His father, though, was nurturing the hope that his elder son would become an engineer and join the well-established industrial house of the Tatas. So in 1927 Homi Bhabha joined the Gonville and Cauis College in Cambridge and enrolled in the Mechanical Tripos. However, an interest in engineering was never kindled. In 1928, he wrote to his friend Homi Seervai, "I am doing engineering now, but it is not very interesting. I am determined to do physics and astrophysics eventually. Nothing will stop me." After several arguments and settlements, the father agreed to let him pursue the Mathematics Tripos provided he did well in his engi-neering course first. Homi Bhabha did just that — in fact he passed both with firsts.

While in Cambridge, Bhabha found a very stimu-lating ground for his passion for art and music. He painted and sketched with fervour and for a while even considered giving up science for the arts. However, a strong opposition from his father and his own doubts about whether an artist could sustain life in India deterred him. He also nurtured a deep interest in music, especially western classical and attended several concerts with his college friend Arnold Cooke, the British composer.

Bhabha completed his PhD in 1934 under the supervision of R H Fowler. While in Cambridge, he worked with some of the greatest physicists like PAM Dirac, Wolfgang Pauli, Enrico Fermi and Niels Bohr.

He undertook his doctoral research during one of the most exciting periods for theoretical physics. In the 1920s the discovery of quantum mechanics, a sweeping new framework, had just revolutionised the subject. Theorists were attempting to construct quantum theories consistent with Einstein's Special Theory of Relativity. Already in 1927 Dirac had proposed his quantum theory of emission and absorption of radia-tion, a precursor to today's highly successful quantum theory of the electromagnetic field. Soon afterwards he formulated the so-called Dirac equation, a relativistic quantum theory of electrons, which predicted the exist-ence of an "anti electron" now known as a positron. The positron was experimentally discovered in 1932. At the Cavendish Laboratory, Bhabha had extensive interac-tions with Dirac. In 1935 he wrote a seminal paper in which he understood precisely how Dirac's positrons interact with and scatter off electrons. Bhabha's compu-tations were later verified in experiments. The so-called "Bhabha scattering" process is routinely used today to calibrate the beams at large accelerators using positron and other anti-particle beams.

His other important contribution was in the field of cosmic ray physics. Cosmic rays are high energy elementary particles from outer space that continually bombard the earth. Upon entering Earth's atmosphere, a cosmic ray interacts with air molecules, resulting in the radiation of a high energy photon. Bhabha and Walter Heitler, who was then in Bristol, realised that this emitted photon would itself interact with air molecules, producing electron-positron pairs in the process. The released electrons (and positrons) subsequently interact with air molecules producing new energetic photons. This process continues until the energy of the photons so produced decays below the threshold to produce an electron-positron pair. The net outcome is that a single cosmic ray produces a cascade of electrons and photons that are measured in ground based experiments. The Bhabha–Heitler cascade theory provided a satisfac-tory theoretical framework to understand cosmic ray observations, and is standard material in textbooks on cosmic ray physics.

Bhabha's investigations led him to recognise that cosmic rays have a "hard" or penetrating component that did not seem to consist of electrons. He conjectured in 1937 that this component of cosmic radiation is actu-ally made up of a new kind of particles, whose proper-ties are rather similar to the electron, except for the fact that they are much heavier. Bhabha proposed that these "heavy electrons must have masses nearer to hundred times the electron mass". He was not alone in coming to this understanding — Neddermeyer, Anderson, Street and Stevenson had reached similar conclusions in their separate papers in the Physical Review the same year. These particles were subsequently called the muons. Thus Bhabha played a role in the discovery of a new elementary particle of nature.

In 1939 and at the peak of his scientific career, Bhabha came to India on a brief holiday. What followed next changed his life and perhaps the history of scientific research in India. Another World War broke out. He found himself unable to return to the Cavendish. He joined the Indian Institute of Science in Bangalore and went on to set up his own cosmic ray unit.

Work started with a small group of students, among them was the mathematician Harish-Chandra. In 1943 Harish-Chandra became the J H Bhabha Memorial student and by 1944 he and Bhabha had published a joint paper "On the theory of point particles". However, Harish-Chandra left India soon afterwards. The mathematician Robert Langlands writes, "Bhabha was perhaps too easy-going for Harish-

Chandra's taste. His ascetic nature did not allow him to perceive the virtues accompanying the high-living Bhabha's extravaganza. But Bhabha did recognise the young man's promise and sent him off to study with Dirac, as soon as the war-time conditions permitted, for Harish was on board the ship bound for England before the war in the Pacific had ended". It was probably on Bhabha's recommendation that Dirac accepted him as a research student in Cambridge.

In Bangalore, Bhabha slowly turned to experiments. Robert Millikan, the well-known cosmic ray physicist, visited IISc in early 1940 for experiments involving balloon flights. Soon after his visit, Bhabha decided to do balloon flights himself to measure the magnitude of cosmic rays at different latitudes.

In his first few years, C V Raman had extended full support, electing him to the Indian Academy of Sciences and also nominating him to the Royal Society of London in 1941. Over the years several disagree-ments developed and Bhabha was perhaps soon looking for other options. For a while he even considered an offer of the Chair at the Allahabad University physics department.

Around this time and on Dirac's suggestion Bhabha submitted his essay "The theory of elementary physical particles and their interactions" and won the Adams Prize in 1942.

In 1944 Bhabha wrote to S Chandrasekhar, "I have recently come to the view that provided proper appre-ciation and financial support are forthcoming, it is the duty of people like us to stay in our country and build up outstanding school of research such as some other countries are fortunate enough to possess". With this firm belief and enthusiastic encouragement from the great industrialist J R D Tata and friend Rustum Choksi, Bhabha plunged into the realms of institution building. He made an appeal to Sir Sorab Saklatvala, chairman of the Sir Dorabji Tata Trust, requesting for support. He wrote, "It is absolutely in the interest of India to have a vigorous school of research in fundamental physics for such a school forms the spearhead of research not only in the less advanced branches of physics but also in problems of immediate practical applications to industry".

With initial funding from the Sir Dorabji Tata Trust, in June 1945, the Tata Institute of Fundamental Research began functioning in the cosmic ray unit at the Indian Institute of Bangalore. In the same year, it moved to Bombay and into Kenilworth, a bungalow owned by his mother's sister Cooverbai Panday. Bhabha's own work in cosmic rays continued but most of his time was now spent in trying to find excellent scientists and mathematicians who would help his institute grow. While he wrote his last published paper in 1954, he had already made sure that the Tata Institute of Fundamental Research had every facility required to carry on world-class scientific research. The Institute flowered under the watchful eye of Bhabha and within a few years of its existence it was producing excellent research output.

His association with the greatest around the world ensured that several of them visited the institute once, if not more. During these visits he made a student write the lecture notes, creating an opportunity for interactions and enormously benefiting the young mind. He also used his connections to send researchers of exceptional promise to train with scientific leaders around the world. Several of these people returned to TIFR as the next generation faculty of the Institute.

Within a few years, the institute had shifted to 35,000 sq. ft. of hired space at the Old Yacht Club near the Gateway of India. It was only in January 1962 that it moved into the new buildings in Colaba. As Bhabha mentioned in his last speech given at the International Council of Scientific Unions on January 7, 1966,

“Work has inevitably been built up first and the permanent buildings have come afterwards, and this pattern has been followed also in the development of the whole atomic energy programme".

At the same time as he was living his dream of building a school of world-class research in India, Bhabha was also setting up the atomic energy programme of the country. Soon after the Atomic Energy Act was passed in 1948, the Atomic Energy Commission began functioning with Bhabha as chairman. The initial work on atomic energy began in the Old Yacht Club and then in the hutments that existed on the Colaba campus. The MeV Cockcroft– Walton generator was set up in one such hutment. This was followed by setting up of the Atomic Energy Estab-lishment in Trombay. By now Bhabha was wearing many hats — as AEC became a separate government department, he became the secretary to the Depart-ment of Atomic Energy. At the same time he became director of the Atomic Energy Establishment even as he continued to be chairman AEC and director TIFR. By now he strongly believed, “The administration of scientific research and development is an even more subtle matter than the administration of industrial enterprises, and I am convinced that it cannot be done on the basis of borrowed knowledge. It must necessarily be done, as in the technologically advanced countries, by scientists and technologists themselves".

While the atomic energy programme in India had taken off beautifully, the world was getting increasingly concerned about a repeat of the horrors of Hiroshima. People like Einstein were convinced that nuclear weapons were capable of ending a civilisation. The first Geneva Conference for the Peaceful Uses of Atomic Energy was held in 1955 with Bhabha as the president. He considered the conference as a platform to “discuss the peaceful uses of atomic energy and to exchange scientific and technical knowledge connected with it".

His contribution to Indian science encompassed several different areas. In 1962, he focussed on the Electronics Committee Report, working towards a nation with larger technological capabilities that would ensure national security. He was a member of the Scientific Advisory Committee to the Indian Cabinet and became its Chairman in 1964. He also played a key role in setting up of the Indian National Committee for Space Research thereby introducing the Indian space Bhabha programme.

Through all of his endeavours, be it the Tata Insti-tute of Fundamental Research or the atomic energy programme, Bhabha got full-hearted support from his close friend Prime Minister Jawaharlal Nehru. In 1968, Indira Gandhi said, “The life of a politician seems to be full of glamour from the outside, but it lacks many of those warm moments of sensitivity that other people take for granted in their everyday life. I know that Homi Bhabha opened one such “window” for my father, and he always found that no matter how tired my father was, no matter how late it was at night, he always found time for Dr Bhabha, not only because the problems which Dr Bhabha brought were important and he wanted to give them urgent atten-tion, but because he found at the same time it was relaxing and it was an entirely new world".

One of the cherished legacies of Bhabha is a very special collection of Indian contemporary art that adorns the walls of the institute buildings in Colaba even today. An artist himself, Bhabha wanted to build up a magnificent collection for the magnificent build-ings. In a bid to do so he sought out the best works of the Progressive Artists Group (PAG).

The PAG, founded in 1947, heralded a new movement in Indian art. The people associated with them included most of the significant artists working in Bombay in the 1950s. The founding members included K H Ara, Sadanand Bakre, H A Gade, M F Husain, S H Raza and F N Souza. One can also count among

associated members V S Gaitonde, Krishen Khanna, Akbar Padamsee, Tyeb Mehta, Ram Kumar and Bal Chavda. The group was dissolved in 1956.

The Gallery Chemould started holding special previews for Homi Bhabha. Mortimer Chatterjee writes in the recently published The TIFR Art Collection, “a single-minded focus on the idea of the contemporary marks the TIFR art collection. Bhabha was drawn inexorably to the youthful energy of the art scene as he experienced it at exhibitions in Bombay during the 1950s and 60s. His desire was to reflect this moment in the context of a museum-quality collection".

On January 24, 1966 on his way to Vienna, an Air India aircraft in which Bhabha was traveling crashed into the Mont Blanc. There were no survivors. Homi Bhabha was 56. Forty five years later, his legacy lives on.

> ***"On a sudden there is a gaping void, and men are left masterless, their sense of direction lost, their purposes reduced to nothingness; for in that whole world of atomic energy and fundamental research “presiding everywhere upon event was one man’s character”. The mood must change. To indulge in lamentation or feel that everything is over were poor tribute to his strong, confident, masterful spirit."***
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> ***— Rustum Choksi,***
> ***A World without Homi Bhabha, January 31, 1966***

Author : Ananya Dasgupta.

Source:- ***Asia Pacific Mathematics Newsletter****, Volume 1 No. 4 (October 2011).*

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