

## Face to Face

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This section features conversations with personalities related to science, highlighting the factors and circumstances that guided them in making the career choice to be a scientist.

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### Homi Jehangir Bhabha: A Visionary

*B V Sreekantan talks to Richa Malhotra*

Dr Homi Bhabha was an ‘institution builder’ and a scientist par excellence. His birth centenary is being celebrated from 30 October 2008 onwards. Dr B V Sreekantan was one of his first Ph D students in the field of cosmic rays at the Tata Institute of Fundamental Research (TIFR), an institute built by Bhabha. In this conversation, Sreekantan gives us an insight into the various aspects of Bhabha’s personality. He describes Bhabha’s research interests, his approach towards improving the state of science and technology in India, and also how he stood apart from the rest of the scientists. He projects his views about Bhabha based on their personal interactions. He highlights Bhabha’s inclination towards the arts, and this was no less than his passion for physics. It is our good fortune to learn about Bhabha from someone who had been closely associated with him and enlightened by his guidance.

**RM:** You worked with Dr Homi J Bhabha for 18 years. Could you share with us some noteworthy observations of Bhabha as a mentor?

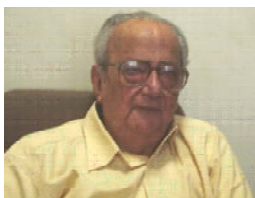
**BVS:** After I did my graduation and my master’s in Bangalore, during 1947–48, I spent a year at the Electrical Communication Engineering Department of the Indian Institute of Science (IISc). During that time, Dr Bhabha happened to be mostly in Bangalore. He had come back from Cambridge (after his PhD) for a holiday and he could not go back to Cambridge because of World War II. He was sheltered in Bangalore by C V Raman, who gave him all the opportunities for his research. During those early days when he was here in IISc (1939–45), he used to come to Central College and give lectures on cosmic rays, nuclear energy and so on. During this period he realised that the type of research that was being done in the country was not of a very fundamental nature. He also realised that the conditions were not suitable in the universities and the institutes, even in IISc at that time, for doing front-ranking research in the new areas of elementary particles, cosmic rays, nuclear physics, and so on. The type of work that



was being done here was mostly on spectroscopy, which was the legacy of Raman, and some work on X-rays and crystallography. Bhabha wanted a place where he could start more fundamental research in the newly emerging areas. So with the help of the Tatas he founded the Tata Institute of Fundamental Research (TIFR) in Bombay (now Mumbai).

I knew Dr Bhabha quite well as his student at TIFR and it was a very interesting experience because he was very sharp, and though he was a theorist, he could clearly think about what to do experimentally. In the initial years he gave us a lot of encouragement to develop radiation detectors and instruments on our own. In the 1940s and 50s our country was backward in terms of industry – practically nothing was available outside in the market and the electronics items were even more scarce. Except for some radio receivers and radio transmitters which are essentially communication electronics, nothing corresponding to pulse electronics was there, not only here in India but even in the entire world. The new electronics was not the type that people were familiar with in the 1930s and 40s. So in Bombay in the initial years we had to develop everything on our own. Also, journals from abroad were not coming on time – they would take a long time because they had to come by sea. So we had to develop all electronic instruments ourselves by trial-and-error methods. We had to go to the market ourselves and buy things because they were not readily available on order. The British had brought a lot of electronic spare parts for radars and aircraft instruments as part of the war efforts. A lot of equipment was discarded immediately after the war by the military as junk, which was cornered particularly by the Chor Bazaar market in Bombay. For us this was really precious. So we went and bought them in kilos because that is the way they were sold then. We (Raja Ramanna and myself) used to buy electronic valves, resistors, capacitors and other components. Yes, we struggled in the early years, developing new types of circuits and electronics for our experiments in nuclear physics, which was Ramanna's

Dr B V Sreekantan was born on 30 June 1925 in the town of Nanjangud, Mysore district. He graduated from the Central College, Bangalore. His research career began with a stint at the Indian Institute of Science. This was followed by a Ph D at the Tata Institute of Fundamental Research under Dr Homi Jehangir Bhabha. His research interests include cosmic rays and high-energy physics. He is a staunch supporter of communication of science to the public and believes that a scientist cannot live in isolation; considering communicating the spirit of science a scientist's duty that one can perform by giving popular lectures and writing books. He supported the Homi Bhabha Centre for Science Education when he was the Director of TIFR during 1975–87. After he retired and



joined the National Institute of Advanced Studies (NIAS), in the last 20 years, he has taken interest in the area of philosophy and written some books on philosophy of science. He has organised several conferences at NIAS as part of his efforts.

*Dr B V Sreekantan in his office at the National Institute of Advanced Studies, Bangalore (19 February 2010).*



specialty, and I was doing experiments on cosmic rays. Some of my colleagues were doing balloon flight experiments in cosmic rays (*in Hyderabad?* Yes in Hyderabad later on). So the entire effort was completely indigenous till about 1980. One fall-out of this was we developed so much know-how even in the applied fields. The TIFR became a pioneer in pulsed electronics in India. The foundation for large-scale activities in many fields was laid by Bhabha at TIFR. Later, Bhabha Atomic Research Centre (BARC) became the centre for further developments in applied areas. He always wanted us to compete with the rest of the world in the best possible way and gave a lot of opportunities for us to go abroad, visit various places and participate in conferences, a feature not true of many institutions at that time.

**RM:** How was Bhabha as a person?

**BVS:** As a person there is one thing about him, he appreciated merit; he would not compromise himself for somebody who did not perform. But if somebody has to perform, he had to be given time and he would do that, but if he did not perform even then, of course Bhabha would not tolerate. Mediocrity does not help, particularly in scientific research and advancement of a country. One more very important thing he did in the early years of development was making abundant use of the international contacts he had. We had a stream of foreign visitors and experts in various fields giving lectures, participating in discussions and criticising our programmes when they were not right. All this helped in evaluating our activities and laying a pathway for the future.

**RM:** ...as an artist ?

**BVS:** As an artist he had his own personal abilities; from an early age he used to paint and do pencil sketches. He liked music and used to play on his piano, and right from his younger days he had cultivated a taste for Western music and Indian music as well. A society called 'Sharmughananda' used to arrange south Indian classical music programmes by top musicians like M S Subbalakshmi, G N Balasubramaniam and others in the 50s. Bhabha would go there for these programmes. They were in some kind of large tents and not in any buildings; sometimes he had to sit on the floor which he would not mind for listening to M S Subbalakshmi. Most importantly all the budding painters, who were not so well known at that time, but who are very famous today, were encouraged by Bhabha. I may mention among them names of Ara, Chavda, Prabha, Jamini Roy and so on and of course MF Husain, whose one painting today sells for several crores of rupees. We have in TIFR about 250 to 300 paintings by these well-known artists who were paid at that time, nearly 50 years ago, somewhere around Rs 200 to 300 per painting. There is one mural painted by Husain which is next to the library in TIFR and Bhabha paid him Rs 10,000 at that time. If Husain comes today he himself will pay 5 to 10 crore rupees to buy it back. This way he encouraged many artists – not only painters, but also other artists. For instance, there was one *daviehwala* who used to make out of scrap iron some very artistic metal works; we have



some of these in TIFR. Bhabha took personal interest in the design of buildings and also had a special eye for choosing suitable picturesque locations. TIFR is in one of the most coveted locations in Bombay right at the end of Navy Nagar. And the same is true of Trombay, Kalpakkam and other absolutely superb locations for the atomic energy institutions. He chose the Thumba site for rocket launching. He was also responsible for starting the space activities, though later on Vikram Sarabhai took over and then supported the space effort in a big way.

**RM:** What was Bhabha's agenda on energy programme for India and S&T in general?

**BVS:** This was a long time ago and I was not particularly interested in the atomic energy programme. Let me tell you what I know. Bhabha had envisaged the possibility of nuclear energy even before the first atom bomb was exploded in Hiroshima. In the original letters that Bhabha wrote to the Tatas, towards founding of TIFR, he had mentioned about the feasibility of nuclear energy and the necessity to train manpower for this futuristic programme in this area. Actually later he used TIFR as the 'Cradle of the Atomic Energy Programme'. I had joined in 1948 and almost simultaneously this work also started. In 1953, Bhabha suggested that I should join the team that was going to Paris to get training in this area. But I decided to continue in research rather than join Atomic Energy Programme. The first effort was to construct a small swimming pool-type reactor in Trombay called APSARA. Later with the Canadian collaboration they built one more, bigger, research reactor called CANDU – Canada–India reactor. Then the negotiation with various countries for power reactors started – this was during Bhabha's time itself. The contract for the first Tarapore reactor was more or less finalised when he was alive. But unfortunately in 1966 he died in an air crash. The rest of the power programme was carried on by others like Sethna, Ramanna, Brama Prakash, and A S Rao who had worked with Bhabha quite closely in the initial years. Bhabha had recognised that we have huge quantities of monozite sand in the Trivandrum area, which is a source of thorium. So he had envisaged a plan for Indian power reactors making use of the abundant supply of thorium. He had set up, during that time itself, a plant for processing thorium from the sand, especially because India does not have enough sources of uranium. The problem now is, with so many reactors already operating, there is a short supply of uranium. While they are trying to mine more uranium, I am told that there are political problems in mining more uranium in certain areas, because many people think that mining uranium will make the place more radioactive, which is not true; they take all the necessary care. In the long-term programme which Bhabha had envisaged in the early 1960s, fast breeder reactors, using a cycle of fuels, i.e., you first make uranium reactors, reprocess uranium fuel elements and recover plutonium, and finally get to fast breeder reactors using thorium as one of the fuel elements. They are now operating a small breeder reactor in Chennai. Bhabha was hoping that by 2010 or even earlier, at least 20% of the energy supply in India would be nuclear but it is still at the level of 2 or 2.5% and the main reason for that is not that we don't have the know-how but we lack sufficient uranium. We should have bought more reactors from other countries.



Russia had offered reactors 25 years ago at a concessional loan but the government was not prepared to accept them because of the loan of attachment and problem of radioactive wastes disposal.

**RM:** What kind of support, encouragement and political backing did Bhabha get during the establishment of the programme?

**BVS:** It is well known that Bhabha had very good relations with Pandit Nehru and Nehru inaugurated the APSARA reactor. He knew Indira Gandhi also very well. The first Atomic Energy Commission itself was constituted of Prof. K S Krishnan, who was the Director of National Physical Laboratory, Delhi at that time and Sir Shanti Swarup Bhatnagar, and some senior IAS officers whose full support he had.

**RM:** Did he face any opposition?

**BVS:** I do not know of any opposition. But some scientists in other laboratories were kind of jealous that Bhabha was getting so much support. An Atomic Energy Committee was set up at the end of 1945 by CSIR with Bhabha as Chairman and Prof. M N Saha, Prof. D N Wadia, and Prof. S S Bhatnagar as members. This committee had recommended that existing centres of atomic research in the University College in Kolkata, the Bose Research Institute and the TIFR should be strengthened and TIFR should be made the main centre. In 1948, the Atomic Energy Commission was setup with Bhabha as the Chairman and S S Bhatnagar and K S Krishnan as members. The Ministry of Atomic Energy was placed directly under the Prime Minister. The first problem was manning the new Atomic Energy Establishment with the right kind of scientists. Bhabha in his visits to various countries picked the best of the scientists of Indian origin and brought them back to TIFR and the Department of Atomic Energy (DAE) and they formed the core of the Atomic Energy Programme. It needed a different kind of commitment and expertise to build a programme like this so fast. We did get help from France because Bhabha had good contacts; he had been in Cambridge for quite a few years, and he had a lot of contacts with British scientists like Cockcroft, Blackett and others. I don't think the same thing could have happened so easily anywhere else in the country in any of the then existing institutions.

**RM:** What is your stand on the following statement made by Dilip M Salwi in his book *Homi Jehangir Bhabha – Architect of Nuclear India*: “Through his family ties with the Tatas, he (Bhabha) secured a special Reader’s post at the Indian Institute of Science in Bangalore”.

**BVS:** I have not read Dilip Salwi’s book. I do not know in what context he has made such remarks. From my own personal knowledge, I can say that family ties had nothing to do with the appointment. Bhabha was an outstanding scientist by that time. What we felt was that Bhabha should have been straight away offered Professor’s position by the Tatas at that time. No doubt



at that time Tatas controlled the IISc to a great extent. It was founded by the Tatas and J R D Tata was the Chairman of the Council of IISc for a long time. Later on Choksi was there and some others from Bombay House. Though the Tatas had a lot of connection with IISc, there is no question of any special favour that was being shown. It was a great thing that C V Raman accommodated him and Bhabha stayed in India. He could have got a very good position outside in Europe or USA. In fact in his letters that he wrote to the Tatas he says, “You see my idea was to become a Professor somewhere in England or in America”. So I don’t quite agree that any such special favour was done, Bhabha published some of his best papers when he was at IISc – eight papers in all – in important journals.

**RM:** What were the main initiatives Bhabha wanted to pursue after his return from Geneva?

**BVS:** Personally I don’t know what his plans were on his return from that ill-fated air journey to Europe. At that time I was in the US at the Massachusetts Institute of Technology (MIT) doing some work in the area of X-ray astronomy. I had left in 1965. I have heard, however, that Indira Gandhi who had become the Prime Minister had persuaded Bhabha to become a Minister in her Cabinet. For this he had to give up his active roles in BARC and TIFR. And in spite of that, knowing that these institutions have still to be nurtured by him, he had agreed to help Indira Gandhi. Unfortunately, this did not happen. He had one great ambition which he used to tell us in the Faculty meetings – to put the whole issue of agriculture on a scientific basis and improve the agricultural output by orders of magnitude – which was later on done by M S Swaminathan and others.

**RM:** Do you think our country would have stood on par with the technologically developed nations if he had not died that early?

**BVS:** I think so, definitely, in many fields. It is very unfortunate that he died at the age of 56; if he had lived for another 20 years the country would have progressed very much. There is no question about it absolutely because he had the vision and he had the capacity, and the Government’s support.

**RM:** You were the Director of the Institute founded by Bhabha. What reforms did you bring about to realise Bhabha’s dreams?

**BVS:** Prof Menon succeeded Dr Bhabha as the Director of TIFR in 1966 and held that post till 1975. During this period, he had not only ensured that the research activities of TIFR had progressed at the same tempo as during the period of Dr Bhabha, but had also initiated several new programmes. Astronomy and astrophysics became major activities – radio and space astronomies, the deep underground experiments at Kolar Gold Fields (KGF) for neutrino studies and proton decay search, the air shower experiments at Ooty and KGF were all enlarged and



reached international levels. Computer facilities at TIFR and several electronics projects for Defence were undertaken by TIFR.

During my Directorship, the GMRT (Giant Metering Radio Telescope) was proposed and implemented by Prof Swarup and his colleagues. And then the establishment of NCBS (National Centre for Biological Sciences) was also one of the activities supported by me right in the beginning as part of the 7th Plan when we got some initial commitment for that. And then the Homi Bhabha Centre for Science Education which was a small initiative in TIFR, was made into a national programme by the pioneers Udgaonkar and Kulkarni and we got support for that. To provide better opportunities in the field of computers, the activities in TIFR in this area were hived off into the Department of Electronics that became the NCST (National Centre for Software Technology). The work that was going on in the field of microwaves was hived off to the Department of Electronics that became SAMEER. These new institutions are all now leaders in their own fields. Then, on the research side, the Hyderabad Balloon Facility was developed further and today we have one of the best plastic balloon fabricating and launching facility in the world where over a period of time we broke the monopoly of some companies in the US as the only manufacturers of large-size balloons for night flights. Now large-size balloons are being fabricated in Hyderabad and the expertise has been developed for making even the load tapes that such balloons carrying payloads of several tons require. A Pellatron accelerator was installed at TIFR for Nuclear and Solid State Research.

**RM:** Do you see any difference in the way research is carried out today in our country from the way it was during Bhabha's time?

**BVS:** Today there are many institutions with a very good research record; this cannot be denied but at the same time what one feels is that the quantum of high-level research is not enough for a country of the size of India. There should be several hundred times more research effort. People have asked me several times why is it that we don't have a Nobel Laureate in science after Raman. We should note that for every qualified good scientist in India there are about thousands outside, there are about 1000 in America, 1000 in Russia, and so on, thus our number of scientists is very small. As I mentioned it is true that in the last 10 years more money is available, also foreign exchange. Compared to when we started work in the 1950s the style of research has changed. Now what happens is you can do research only by using the most sophisticated instruments which we can buy now. But other countries move faster, have more resources and better facilities. One clever thing that Bhabha did was to focus attention on those areas where India with all the handicap can still function right at the frontiers with advantage. For example, cosmic ray work had a national advantage in India because we were close to the equator, we had deep mines and we have mountain stations, all within one country; and in radio astronomy, the radio telescope, which had to be parallel to the earth's axis built in Ooty by Swarup, was on



a gentle slope and this kind of a location was available in low latitude stations like Ooty. As the technical manpower improved and more finances became available we went into more sophisticated experiments and projects.

**RM:** ...and in TIFR now?

**BVS:** I can't comment much on that because I am not very familiar with what all is going on in TIFR – it is nearly 20 years since I left, but they are doing some very good work in theoretical physics. In fact, one of my disappointments was that during Bhabha's time some very good theoretical work was done; later I don't know why when theoretical physics work was booming everywhere so well TIFR did not do so well in India. I don't understand the reason though full support was given. Now again in the area of String Theory and some of the new areas like solid state theory Indians have made a name. But TIFR is suffering from a lack of manpower in experimental areas and that is because of the fact that we have lost a large number of good people who have retired, the people who developed many of the scientific programmes. And our policy of retiring people at 60 or 62 has proved detrimental and counterproductive. First of all in our country for the scientists to acquire the expertise and excel, it takes more time. Sixty is too early, it should be 70 if at all and if many of the people had continued till 70 probably TIFR would have done much better in terms of experimental work although it is still leading in many areas compared to many other institutions. Trained manpower is an asset to the country not a drain.

**RM:** To what extent did your research interest overlap with that of Bhabha?

**BVS:** It so happened that I got interested in fundamental research as a student and I wanted to join Bhabha to do theoretical research. He called me for an interview which could not take place in 1947 itself. I was interviewed in Bombay in 1948, and on Dr Bhabha's advice I started work in the field of cosmic rays and much of my early work was done in the KGF in the underground laboratories. In fact right from 1950 to 1992 a lot of experiments were done in the KGF, some of them in collaboration with the Japanese and some in collaboration with the British scientists, and most of it by ourselves. Bhabha was very much interested in cosmic rays, and had done aeroplane-based cosmic ray experiments while at IISc (1939–45). His early work was connected with particle physics and cascade theory.

My PhD work with Bhabha as the supervisor: In December 1950 Bhabha organised the first international conference in Bombay; the first such conference on elementary particles anywhere in the world for which many Nobel Laureates and future Nobel Laureates and leading scientists came. We had the opportunity to interact with them. While he was organizing this conference all by himself, one day he called me and said, "Looking at some of the papers that I have received, it is desirable for you to start work in Kolar Gold Fields and work on underground cosmic rays".





On Bhabha's suggestion I had already done an experiment on the life time of  $\mu$ -mesons stopping in various absorbers. Now he wanted me to check whether all underground particles are muons only. That is how I started work on  $\mu$ -mesons in KGF and that was followed by deeper and deeper level experiments even right up to 8000 feet below ground. Another field for which in 1965 we got good recognition is neutrino physics; we were the first to detect cosmic ray neutrinos in the KGF. It was a big effort for those days with the collaboration of Japanese and the British scientists. Also in the Kolar mines at a depth of 8000 feet, we operated a very challenging experiment to look for the decay of the proton. So these were all the fallouts of the early vision of Bhabha – we should work in areas where we have certain advantages. Today, the TIFR group in collaboration with other institutions wants to work in a very big way on neutrino physics. They are looking for a site where they can dig up a tunnel – they don't want to go to KGF because it is closed down. I am told that they proposed a tunnel in the Nilgiris which was not approved due to the opposition from environmentalists, so now they are looking for some hill near Madurai where they can dig the tunnel. We took advantage of what existed. I must mention that the entire cosmic ray research for over a period of 30 years in TIFR that fetched about thirty scientists their doctorates and several hundred papers published in journals abroad cost less than 3 to 4 crores. Now one project costs 500 crores or 1000 crore rupees. We spend 500 crores and some other country spends ten times that – such is the whole scale of operation. We worked essentially as individuals with a few collaborators but now it is not so, it is a collaboration of several institutions. The scale and type of research has changed considerably. In a recent paper by CERN collaboration the number of authors is reported as 1042!

**RM:** In your Homi Bhabha Medal lecture of 2nd January 1978, you had said that the years you spent in TIFR were 'undoubtedly the best years of your life'. Could you elaborate?

**BVS:** That's the time when I had no other responsibilities. I became the Director of TIFR in 1975, the 27 years I had referred to there, was essentially the period from 1948 to 1975, that's the period when I worked full time in the laboratory in the field stations at Ooty and KGF, morning to night with lots of students and colleagues who were all working for their Ph Ds. That is the period, the best years of my life in the scientific field... and probably in my life (laughs).

**RM:** So do you still consider that period as the best years of your life?

**BVS:** Yes, naturally. I am not regretting the later years. The position of Directorship, which I did not aspire for, I don't regret but at the same time it denied me the opportunity of pursuing research in the same style. It makes a big difference whether you are a Director or you are a scientist concentrating on research without additional responsibilities.

**RM:** So do you think a scientist must continue to do research?



**BVS:** That is my view. Of course, you need good directors too but a good scientist is rare to come by and must continue his/her work to keep up the science.

**RM:** How did TIFR evolve after the tragic death of Bhabha?

**BVS:** Well I think immediately after Bhabha's demise, Prof Menon took charge of it. Menon had been there as the Deputy Director for a few years and by that time TIFR was well-established as a leading research institute in India. Gradually it got expanded under Prof Menon. He came to TIFR after finishing his Ph D in Britol University; he was also a cosmic ray physicist. Another great contribution of Bhabha was the Electronics Report where he had spelled out what the country needs to do in the field of electronics; unfortunately soon after completing the report, before submitting it to the Government, he died. Then it was taken up by Vikram Sarabhai and then Sarabhai died too within five years. But still the Government had not taken a decision on setting up an Electronics Commission. Sometime in 1972–73, the Government of India appointed Prof Menon as the first Chairman of the Commission; so Bhabha's dream in the field of electronics had to be substantiated by Menon. That is the reason why he went from TIFR to Delhi.

**RM:** You have been endowed with the INSA Homi J Bhabha Medal and also the Homi Bhabha Fellowship. Did this inspire you to participate in the centenary celebrations?

**BVS:** Not necessarily. My greatest inspiration was that I started my life in science as Bhabha's student and was with him for 18 years and I didn't need anything else for inspiration.

**RM:** The centenary period was from 30 October 2008 to 30 October 2009. However, the commemoration continues till 30th October 2010.

**BVS:** They started a year ahead. Bhabha was born in 1909 and activities started from 30 October 2008 for the centenary year and they have continued. In 2010 also activities are going on.

**RM:** And the special publications released as part of the centenary celebrations?

**BVS:** I think this is an occasion when a lot of publications have come and a lot of information is available and perhaps they are putting it all together in the form of some books and collections. I don't know what their plans are but they have already brought out quite a bit of material. TIFR has produced a diary for the calendar year 2009–10, with a large number of photographs, taken during various occasions and they have also brought out some of the speeches given by various people in conferences. They have not brought out all the publications still. I had written an article on Bhabha in *Resonance* which N Mukunda had asked me to write about 10 years ago. They have reproduced it in many publications. Special issues of newsletter *Physics News* and a collection of articles on Bhabha from these newsletters in the book *Tribute to a Titan* have been published. DAE has also brought out Bhabha Centenary special issue of



*Nuclear India*. An article on Bhabha appeared in *Frontline* magazine. The proceedings of the Homi Bhabha Centenary meeting held during 3–5 December 2009 are also available. A new edition of the book by G Venkataraman has been brought out by BARC.

**RM:** Is there any particular highlight of this book that you would like to share with us?

**BVS:** It is a very good book from the point of view of students; students must particularly read this book because that will give them an idea of how Bhabha really performed as a research scientist, as Director of TIFR and of BARC – answers the questions that you have asked about his interaction with people, how he selected them, and gave them responsibilities. I think Venkataraman has done a wonderful job.

**RM:** Bhabha initially laid stress upon building an institute for physics (and mathematics, important for theoretical physics; though over the years, molecular biology, computer science, radio astronomy, geophysics, etc., were also included). This way did Bhabha partly play a role in the balkanisation of science in India?

**BVS:** No, he did not. When he started, it was an institute of ‘Fundamental Research’, so whatever was relevant for fundamental research, he would encourage in the initial years and naturally the emphasis was on physics and mathematics. He started work on cosmic rays and then on nuclear physics in TIFR. In a speech by Bhabha at the time of inauguration of the TIFR building, he mentions how Prof A V Hill, who also was at that time the President of the Royal Society, advised Bhabha that biology is going to be the future and he should make biology as one of the important activities of TIFR. Bhabha told him, “If I find the right man then only I will start biology until then I will wait”. That’s what he did; he kept his eyes open and then when he found the right person he started biology in TIFR. In the Atomic Energy Programme he needed every kind of scientific and technical manpower; he needed mechanical engineers, electrical engineers, chemical engineers, etc., and all this was started and also chemistry, medicine, biology; so it is not that he did any balkanization he just put everything together, whatever was necessary for the growth of the programme, an integration rather than fragmentation.

**RM:** Did he find the right person for molecular biology?

**BVS:** Yes. It was Obaid Siddiqi. He doesn’t mention the name. But he says, I got this person recommended by somebody I know very well and I started. This is actually narrated in his talk at the TIFR inauguration. Later on, just before his death there is an article ‘Science and Problems of Development’ that happens to be his last speech; he narrates it there, how he went about building TIFR, how he built the Atomic Energy Programme in contrast to the Council for Scientific and Industrial Research.

**RM:** The founding ceremony of the International Centre for Theoretical Sciences was held



recently in Bangalore. Is it an act of homage to Bhabha in his birth centenary year?

**BVS:** The way this has been conceived is very beautiful. NCBS is a part of it and IISc is also a part of it. Then the TIFR Mathematics Centre in Bangalore is also part of it. It's again going to be a multidisciplinary approach. Today our institute here is a multidisciplinary institute (NIAS) because the future of science lies in multidisciplinary activities, not just in physics or biology. These were divisions that were all made once upon a time; now that division is not relevant. This year's Nobel Prize for Chemistry went to Venkatraman Ramakrishnan but his work is in the field of biology, so these are old terminologies that are no longer valid.

**RM:** You mentioned that C V Raman had good relations with Bhabha but the book *C V Raman – A Memoir* by A Jayaraman doesn't say so. Comment.

**BVS:** I don't think that they did not have good relations. When Bhabha became F.R.S., his nomination to Royal Society was recommended by C V Raman and their relations were exceedingly good but the point is that Raman, all said and done, was an old time physicist, not that this takes away his brilliance. Raman never came in the way of Bhabha. He came for the very first fundamental particle conference organized by Bhabha in 1950; Raman was there, Saha and Kothari were there. What happened was some people were jealous of Bhabha because he had access to the Prime Minister and this was misinterpreted by many other scientists. In fact, he was responsible for starting this whole area of Defence Science and Kothari was the first defence science advisor. I don't think Bhabha ever had such narrow mindedness. The point is this, what happens is when you are an administrator and you are in control of a particular programme you have your own priorities and your own style of operation. Many people might not have liked Bhabha's style of operation, but that was up to him finally; you have to judge by the results. It is not that he kept anybody out; he had his own diplomatic ways of doing things; and science at that time, particularly to build up these programmes, did require some amount of diplomacy.

**RM:** When the tragic death of Bhabha was announced, how did the scientific community throughout the world react?

**BVS:** Unfortunately, I was not in India, so what happened in India I don't know much. But I have seen quite a lot, a whole collection of tributes that were paid in India and outside. And everybody was shocked and very unhappy. This happened at such a time when Indira Gandhi had just come to power as Prime Minister, and Bhabha and Indira Gandhi together could have built science in a much bigger way. Unfortunately, this tragedy happened and there was a vacuum created. At the same time there were people like Sarabhai, Menon, Sethna, Ramanna and others who took charge and carried on. One always felt that with Bhabha it would have been different.



On the day Bhabha died, 24th January 1966, I was at MIT and was scheduled to give a talk on a topic in which Bhabha was very much interested – ‘anti-matter’. Bhabha’s work was connected with cascade theory and anti-particle production and I was to give a colloquium at MIT on anti-matter. Early morning that day, one of my colleagues Prof George Clark telephoned me and asked, “Have you been following the news?”. I said “No”. He said, “Look Sreekantan, a tragic thing has happened, an Air India flight has crashed near Geneva and it is suspected that Bhabha was on that plane”. Then I started tuning up the TV and also the radio. Very soon it was confirmed that Bhabha was on that flight. Then immediately after that I rushed to MIT and met Prof Phil Morrison, a great physicist, who was in charge of the Colloquium, and told him “Sir I am in such a mood that I can’t give this talk today, it has shocked me beyond control”. He said, “Look Sreekantan, you don’t give up the talk, dedicate the talk to his memory. I am sure you will do well” to which I replied, “Well in that case I will try”. So that day I gave the talk and it was quite successful. Then I rushed home, my wife and daughter were at home, I had a very quick dinner and went to bed, tears were rolling down my eyes... and then something happened, in the night: I got a fantastic dream; the dream was probably based upon my association with *Bhagwad Gita*. The dream was that Bhabha was driving away in a Golden Chariot drawn by four white horses high above in the sky; he was dressed like a Parsi in a white closed-collar coat and Parsi cap, so it was a fantastic dream. That brought immediate relief to me...I woke up my wife and told her about the fantastic dream.

**RM:** Are there any other thoughts or observations of Bhabha that you would like to share with our readers?

**BVS:** Honestly, I have met so many scientists all over the world and I have spent a lot of time with them; I have not come across anybody else with the same kind of qualities as Bhabha. Of course, there are so many people who are very knowledgeable. We all look upon Bhabha as a theoretical physicist most of the times or as a cosmic rays physicist where he has done very original work in the early days of particle physics. If he had continued in that area he definitely would have got the Nobel Prize; there is no question about it, he was of that calibre and the work that he was doing at that time was of that nature basically, right in the area of fundamental particles. He was exceedingly lucky to have been in Cambridge at that time when this entire new field of particle physics was just blooming and to which he had contributed quite a lot. It so happened that he was destined to stay back in India and build an institution which is today respected by the world, and was so even during his time. In a very short time TIFR got an international fame both in physics and mathematics and then later on in radio astronomy, biology, and so many areas. Also he built up the entire Atomic Energy Programme right from scratch and those who know what is required to build such a programme, realise that it could have been done only by Bhabha, that is what most people have said and I completely endorse



that it could not have been done by anybody else in such a short time. And also later on we had the activities of the Department of Space, DRDO, etc., that were all patterned after Bhabha's model of DAE functioning and the way he managed things.

One of the first things that he started, compared to earlier times, was having the headquarters of the DAE in Bombay. Till then the headquarters of any government department was always in Delhi. Prof Dhawan followed the same pattern; he said that the Department of Space headquarters will be in Bangalore. So, I think Bhabha set a kind of pattern for many things, one is how to start new activity and secondly how to get the right kind of people for the various activities. Most importantly I would say Bhabha had a clear cut picture of what he wanted to achieve, that many people don't have; they just carry on with their research. He was a very good artist, good scholar, engineer, that's why C V Raman, while making him a fellow of the Indian Academy of Sciences told the academicians, "Here is a Leonardo da Vinci" – that's how he introduced Bhabha. We have been exceedingly lucky in the country to have had a man like Bhabha.

