

Reflections on My Life

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1 message

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When I reflect on my reasonably long life, I notice four distinctly different phases ,each phase influencing the succeeding one.

The four phases are :

- 1.growing up in my parents house under their care and schooling and learning in my home town (1925 -1940)
2. Higher studies in colleges at Mysore and Bangalore (1940 - 1947)
3. Forty Five years of research career at Bangalore , Bombay and foreign laboratories (all together 1947 -1992)
4. A sojourn which became a long stay at NIAS on "philosophy of science and consciousness studies " 1992 to present time

Each phase was governed by three factors : a. luck (I prefer to call it divine grace) , b. Environment , Guidance (mentoring) and c. Most importantly Effort .

* Growing up in Parents home .. Student career in Nanjangud, Mysore and Bangalore

Let me start with my early life. I was extremely lucky to have been born in a well to do , a highly religious , highly disciplined orthodox family in a small town Nanjangud (about 20 kms from the city of Myore) known for its temple on the banks of river Kapila , a tributary to the river Cauvery. My father was an ayurvedic doctor and had set up a fairly large factory for manufacturing Ayurvedic medicines which later was further developed by my brothers. There was high academic environment in the house and my father used to

arrange a lecture on the Bhagavad Gita every saturday in the house itself which had a large hall and the lecturer would be a scholar from Mysore. Though I was still very young ,I used to sit through these lectures. The schools in Nanjangud were good , had god teachers

and sports grounds. At home, I was also given tuition in sanskrit and some aspects of the kayas of Kalidas and other poets.. After completing the SSLC , I went to Mysore for the Intermediate College for two years which I did by going by train everyday for the first year and stayed in the hostel for the second year. Those days ,the Intermediate examination was the toughest with hardly 25% of the students passing the exam to get admission in the degree colleges. The teaching and the laboratories in the Intermediate Colege in Mysore were extremely good . However ,one serious problem that I had to face during my intermediate days was that the colleges Were practically closed for three months August 1942 on wards because of the Quit India movement. Anyway I dis flrly well in the exam

and got admission for BSc (hons) physics at the Central College, Bangalore.

During those days the Central College was considered to be one of the best colleges in South India . Physics Honours had a great reputation because of the rigorous teaching and Laboratory practice. Also because of the Indian Institute of Science and of presence of the Nobel Laureate Sir. C.V. Raman some of the famous foreign scientists used to come to Bangalore

As part of the Honours course , a rigorous theoretical physics course which included Special Relativity and Quantum Mechanics was given to us by Prof . Subbaramaiah . One of my colleagues Suryan and I used to spend the whole of Some Saturdays and Sundays morning to evening in Prof. Subbaramaiah's house studying the book of Heitler and of Dirac which had just been published. These studies helped me a lot in my later research work. He was deeply interested in Philosophy and made me commit all the 750 shlokas of Bhagavad Gita to memory. This became a valuable resource for me in many ways.

* Beginning of my Research careerIISc.and TIFR.

After completing my B.Sc (hons) physics in 1946 and MSc (Wireless) in 1947, I joined as a Research Scholar in the

Electrical Communication Department of the Indian Institute of Science under Professor S.K.Chatterjee. I started working with him on the generation and propagation of Ultra High Frequency Radio Waves. During this period, I learnt a lot about electronics

which was a new field that was opening up in the post second world war years. Though the work I was doing was interesting

and I was happy with the guidance by Prof. Chatterjee, my heart was elsewhere. I wanted to do research in Fundamental

Areas of physics. I expressed this to Professor Chatterjee. He encouraged me to apply to other places in India where

good theoretical physics research was going on. Immediately wrote to Prof. D.s. Kothari, Delhi University, D.M.Bose at Bose Institute,

Viram Sarabhai at PRL Ahmedabad. and H.j.Bhabha at TIFR, Bombay. I got positive responses from all of them

Prof. Kothari and D.M.Bose wanted me to join the Ph.D course and I was invited for interviews at PRL and TIFR, The PRL interview was held by Vikram Sarabhai at Chennai and after the interview, he wanted me to join PRL straight away.

At TIFR I was interviewed by Dr. Bhabha twice, once with a committee for selecting students for experimental research and the second time with a different committee for theoretical research. After these interviews, he called a third time and said that they had selected me for admission to the institute. He wanted to know, whether I wanted to do experimental research or theoretical research, I left the choice to him. He advised me to opt for experimental research since I had a good background in electronics which was rare in India at that time.

I joined TIFR as a research student on 10th. August 1948 and started working directly under the guidance of Dr. Bhabha.

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* My first Colloquium at TIFR

A few weeks later, Dr. Bhabha called me and said that "you will be working on an important problem in the newly developing

Particle aspect of cosmic rays and you should study all the papers that have appeared on mu-meson decay. There is a controversy

as to whether the muon decays into two particles or three and about the lifetime dependence of negative muons on the atomic number of the absorber in which it stops and decays. You should give a colloquium on the topic after a few weeks".

I went through all the papers in the Physics Review, Nuovo Cimento and the other journals available in the library. There were no projection facilities of the type we have now. On a subsequent Wednesday when I was scheduled to give the colloquium I drew all the required diagrams and circuits etc on the black board before starting the lecture. As I started the colloquium I noticed that right in the front bench Dr. Bhabha, Prof. Kosambi and several other senior members were sitting. There was so much of questioning, suggestions, mutual discussion that the one colloquium that I had planned continued for three Wednesdays and at the end I had a complete idea of what exactly I should do for the next year or so. What equipment I should build and of what dimensions, what precautions I should take and how much of data I should collect and how I should do the statistical

analysis. etc.. It was a complete lesson to a young man starting research as to how one should go about to do first rate work in a new field.

What was finally suggested to me was indeed a challenging assignment to implement in India in the late 1940s. It required development of microsecond pulsed electronics before the days of transistors and chips.

All the electronics amplifiers, pulse generators, oscilloscopes etc had to be made of Vacuum tubes which were ill suited for

Microsecond electronics because of 'rise time' effects, Some very special miniature valves known as 'acom tubes' had to be used, They were not available in India and had to be imported, Somehow, using the war disposal equipment available in the Chor Bazar,

off the Mam edali Road in Central Bombay.

road, I built over the next two years all the necessary instruments and detectors and started the decay experiment and got good results. However, some others in the US who were my competitors working on the same problems published their results ahead-of me. To some extent I lost my priority. However I was not discouraged and in fact the whole exercise had given me lot of knowledge and experience in a new field and boosted my confidence especially since I had managed to develop the entire Electronics, the detector system and the magnets for focusing the muons single handed only with little help from my seniors.

In September 1950 the institute moved to the Yacht Club building which was next to the Gateway of India. The building had been reconditioned to suit the requirements of the next phase of increased activities of the institute. In December of 1950

Dr. Bhabha organised the first International Conference on Elementary particles which was attended by leading scientists from

USA, and Europe. The eminent scientists who attended this conference were Professors PMS Blackett, Leprince Ringuet,

Wentzel, Marshak, Peter Fowler, Rosenfeld, Auger, Amaldi, C V Raman, Meghnad Saha and others. It was indeed a wonderful opportunity for young scientists like me to interact with such stalwarts.

* Starting of KGF projects

Just a couple of months before this conference, Dr. Bhabha called me and suggested that I should take my muon decay

setup down the Kolar Gold Fields and examine whether all the penetrating particles are muons only or whether other Non-muons are there in cosmic rays underground. The abstracts of the papers that had been submitted for the conference had probably indicated this possibility.

So my next step was to explore the possibility of doing cosmic ray experiments in the Kolar Gold Fields. This turned to be another

Gold mine for cosmic ray studies. Narayan and myself started the first set of experiments in the mines in October 1951 and over the

next forty years a variety of experiments including cosmic ray neutrino detection, search for Proton Decay, extensive air showers in

association with high energy muons detected at various depths underground and so on, were carried out there some as part of International collaboration with Japanese group from university of Osaka and the university of Durham U.K.. A large number of students from India, Japan and UK got their Doctoral degrees based on the work carried out in the mines and a large number of papers published in International journals. The activities had to be stopped only in 1991 when the mines were closed down.

* Shocking, surprising offer Career changing Opportunity ?

In 1953, after completing the first phase of KGF experiments, I started writing my thesis for the Ph.D degree of the Bombay university

on "Underground Cosmic Rays" sitting in the library of the Institute. One day, to my surprise Dr. Raja Ramanna came to me and said

'Congratulations.. Get your passport ready. Dr. Bhabha wants you to join us to go to Saclay as member of the Atomic Energy team for training in Reactor Technology.' I got the shock of my life. I said 'No. I am not interested in changing my line. I came here to do fundamental research. I am happy doing cosmic ray studies.'

I immediately sought an interview with Dr. Bhabha. He called me late in the evening. I told him what I had said to Ramanna that morning. He said 'look Sreekantan. This is a wonderful opportunity for you. The Atomic Energy work is just starting and will grow. You will have great career opportunities.' I stuck to my stand. Finally, he smiled and said

'we want people for TIFR also. you carry on with your thesis work. We will find someone else to go to Saclay. I was greatly relieved.

* My first trip abroad.. Extended stay at MIT

A few months later, after I had submitted my thesis, he called me and said that he is planning to send me on a

deputation to visit all the

Important laboratories in Europe and USA doing front ranking cosmic ray research. In July 1954, I started on this deputation trip:

My first visit was to Prof. Amaldi's laboratory in Rome where I spent four days and then went to Geneva where the spadework on

The Construction of CERN laboratories had just begun. Then I went to Zurich to visit Federal Research Institute and then to go to Jung Frau Joch in the Alps where Professor Blackett's group from Manchester had set up cloud chamber experiments in search of V-particles the first examples of which had been recorded by Rochester and Butler at Manchester itself. Then I went to Paris to visit the Ecole Polytechnique group under Prof. Leprince Ringuet. They arranged my visit to the other high altitude station in Europe, Pic du Midi in southern France where the French group had been similarly looking for V particles with a magnetic cloud chamber. Then I went to England and spent two weeks between Manchester, Durham and London where a lot of activities were in progress in cosmic ray studies in which Profs Blackett, Rochester, Butler, J.G. Wilson, Elliot, and Arnold Wolfendale were involved. Thus I had the wonderful opportunity of all the centres of high cosmic ray experimental activity in Europe and got familiar with a variety of new techniques developed for unearthing the many mysterious aspects of cosmic rays.

Then on a luxury liner called 'Il de France' I sailed from Southampton to New York. I became part of Professor Bruno Rossi's cosmic ray group at the Massachusetts Institute of Technology in Boston for the next one year.

In Rossi's group at that time two different kinds of cosmic ray activities were in progress. One was on Study of Extensive Air Showers

Which was being carried out at Haystack in the area where the Harvard Optical telescope was located and the second activity was on

Strange Particles (the V particles include chambers and K-mesons and the Lambda particles in Nuclear emulsions) with

Multiplate cloud chambers that were operating at the Echo Lake Laboratory near Denver, Colorado. Since at that time my interest was in

Cloud chamber work, I immediately moved to the Echo Lake Laboratory and I spent the next three months there. For me it was a great

learning and relaxing period. From Prof. Herbert Bridge and his technical Assistant Bill Smith, I learnt a lot about operation of cloud chambers and analysis of multiplate cloud chamber pictures. When I got back to MIT, I scanned through 75,000 pictures of Penetrating Showers Produced by cosmic rays in the multiplate cloud chamber and picked up several more cases of strange particle production

which I analysed along with a graduate student of Dr. Bridge which led to several papers to be published in the Physical Review. This happened during the Christmas-New Year time. They used to call it my Christmas present to them. During those days collecting

Evidence for the 'strange particles' was like collecting rarest of rare precious stamps.

* The Ooty Cosmic Ray Laboratory

Before leaving for the visit of foreign laboratories, in the month of May Dr. Bhabha had suggested that he would like to construct two high altitude laboratories for Cosmic ray research, one in the south and another in the north. He asked me to

explore a suitable site in Ooty. Accordingly, I went to Ooty in the month of May and after looking around many places I selected the

Doddabetta peak would be the ideal location. Dr. Bhabha who was quite familiar with Ooty and its surroundings, agreed with me

And some time in August/September, by which time I had left on my foreign trip went to Ooty and discussed the possibility of

Buying the Doddabetta peak for setting up the cosmic ray laboratory. Sri. Sripakasha who was the Governor of Tamil Nadu then

suggested to Bhabha that there were a number of vacant houses in the Raj Bhavan area where they could start the laboratory

and later on move to Dodda Betta area. He also offered a large Bungalow called the Gate House at entrance to the Ooty Gardens

in which the Raj Bhavan was located for the stay of scientists who would be working in the laboratory. Dr. felt that this was a good proposal and thanked him for the grand gesture.

I did not know this development and when I returned from MIT in August 1955, I was pleasantly surprised that my colleagues

Naranan, subramanyan and Ramana Murthy had set up under the guidance Dr. A.B.Sahar who was the Head of the Cloud chamber group

And who had worked at Manchester and Jung Frau Joch, had set up a double cloud chamber experiment one chamber above the other

With multiple brass plates inside. The chambers were triggered whenever there was a penetrating shower due to cosmic rays was

Recorded by the GM counter telescope suitably positioned with the counters above and below the chambers.

The objective was similar to what was happening in other laboratories at that time, namely looking for strange particles.

I went to Ooty in October and introduced some change in the triggering system replacing the GM counter telescope by liquid scintillation counters. The operation was continued for a couple of years more by which time the

Bevatron at BNL at the Compton in Berkeley

Had taken over the field of particle physics by producing them in large numbers and having superior analysis capabilities.

* Development of new detectors for variety of cosmic ray experiments 1956-59

During 1956-59, I involved myself along with senior colleagues Naranan, Subramanian, Ramana Murthy, Verma Siddheswar Lal,

Rangaswamy, B K chatterjee, G T Murthy, in the development of a variety of particle detectors.... BF 3 neutron counters, liquid and plastic scintillators, Total Absorption Spectrometer, Air Cerenkov detector, large volume water Cerenkov detector, spark counters, large length proportional counters. Also data recording systems that enabled feeding the data in the form of punched tapes to the TIFRAC that had started functioning in Bombay. We also developed millimicro second electronics for measurement of millimicrosecond time intervals. All these were necessary for the next phase of our experiments lasting several decades at Ooty and KGF.

A fairly large Extensive Air Shower array with liquid scintillation detectors (replaced by plastic scintillators later) was constructed around the laboratory building. In the first instance an array of eight neutron detector piles embedded in Paraffin blocks was placed at the centre to detect low energy nuclear active component of air showers to study the variation of the number of nuclear active particles as a function of the size of air showers. This was the first air shower experiment at Ooty laboratory.

B K chatterjee's Ph.D thesis was based on the results of this experiment.

Then with a unique triple detector arrangement of a multiplate cloud chamber with an air Cerenkov counter above and a total absorption

Spectrometer below, we studied the possible differences in the characteristics of proton and Pion interactions in the energy range 10-40 GeV. This was before the CERN accelerator produced the beams of these particles of such high energy. Our cosmic ray based results were confirmed by CERN. Experiments.

Next, we embarked on a very important experiment to measure the time structure of the different components of air showers.

It was known that the different components namely the photons and electrons, the muons, the pions and the nucleons will arrive at the observational level at different times but there was no measurement and the Ooty experiments were the first. The analysis of the

Observed time structure with Monte Carlo simulation data led to the important result that the cross section for the production of

Nucleon-antinucleon pairs at high energies was much higher than expected from low energy data. This formed the Ph.D thesis of

Tonwar.

Another important development during this period was the construction of the world's largest multiplate chamber with the

advice and design of Professor Shiburo Miyake of the University of Osaka Japan who had been invited as Visiting Professor

at TIFR for the year 1958-59. This large cloud chamber with 8 interaction mean free path iron plates inside the chamber was operated

As part of the EAS array at Ooty. Many instances of multiple core events were recorded and provided interesting details of the core

Structure of air showers. This formed the Ph.D thesis of Vatcha.

* Deep Underground experiments at KGF ... Second phase

In 1954, we had moved out of KGF since the mining authorities had decided to close down the mines due to non-profitability of operation. The multiplate cloud chamber experiment which Naranan, Ramana Murthy and myself had set up in KGF for the study of Mu-meson interactions was moved to an abandoned railway tunnel at Khandala near Pune. Dr. A B Sahiar also participated in this cloud chamber experiment which had been set up in an air-conditioned trailer. This experiment cleared up some of the confusion that had been created by a cloud chamber experiment in the UK. Naranan's Ph.D thesis was based on the results of this experiment. However, in 1958, we came to know that the KGF mines had been closed down and the Government of Karnataka would continue its operation. Ramana Murthy who was working at Ooty and who had done experiments at KGF was very keen to pursue experiments at KGF at deeper levels. Prof. Miyake was also interested in underground experiments. A second phase measurement of intensity and angular distribution of muons with a combined Scintillation cum Geiger Counter telescope was started upto a depth of 8000 ft. Below ground. Narasimhan who was working at Ooty also joined the experiment. At the deepest level no count was registered in three months operation of the telescope. This suggested to us that at these levels, the background due to cosmic ray muons produced in the atmosphere is so low that by a suitable design of a recording system, we should be able to register the muons produced by the interaction of cosmic ray neutrinos. Through an international collaboration of the Japanese group headed by Prof. Miyake and UK group headed by Prof. Wolfendale of the University of Durham, we set up a large size detector assembly of proportional counters, neon flash tubes and scintillation counters. By the time of the London International Conference of 1965, we had recorded several clear cases of detection of cosmic ray neutrinos. This was one of the highlights of the conference. In parallel with the Ooty air shower array, we set up another at KGF which had the unique feature of being operated in coincidence with large volume water Cherenkov detectors underground which recorded simultaneous presence of very high energy muons. This was again a unique kind of experiment and was operated for several years. The analysis of the results of this experiment formed the Ph.D theses of Srinivasa Rao and Shivaprasad. Naranan and Viwanath were associated with this experiment in the early stages.

* 1965-1967. My sabbatical at MIT Participation in X-ray astronomy experiments

In 1965, I planned to go on sabbatical for a year or so and work with Brune Rossi's group work after attending the International Conference at London. It so happened that at the London conference, Vikram Sarabhai advised me that I should plan to work in Rossi's group in one of the space science areas which was futuristic and developing fast. It so happened that on the flight I was taking from London to Boston, my wife Ratna and my daughter Usha sat next to each other and in the next seat where I sat, by sheer coincidence Professor George Clark of MIT whom I had known in my earlier in '54-'55 visit to MIT, came and sat next to me. He had known that I would be joining them for a year. During the eight-hour flight, he apprised me of all the activities in Rossi's group.

In the field of Solar Particle physics. He welcomed me to work with him on hard X-ray astronomy with balloons. He also told me that Prof. Minoru Oda, Hale Bradt and Garmire were planning an experiment with rocket to determine the exact location of the X-ray source Sco X1. The extensive air shower experiments were being continued by John Linsley at Valno Ranch, New Mexico. Next day my old friend Minoru Oda invited us for dinner. It was Sunday. We had long chat about the status of X-ray astronomy and he explained to me his idea of Modulation Collimator for determining the exact location of X-ray sources. It was a very novel idea. He wanted me to work with him on the project which was to be carried out as a joint Project with AS&E. It was an experiment to be flown on a rocket. After consulting Prof. Rossi and Herb Bridge who were my mentors during my earlier stay at MIT in 1954-55, I decided to work on X-ray astronomy projects. The Modulation Collimator was a simple and elegant idea. It turned out to be very difficult to implement. Particularly the alignment of the system of parallel wire grids. Our attempts to align them with optical beams failed because of the interference of Moiré fringes. Finally, Hale Bradt and myself did the alignment using an x-ray beam itself and a special type of Poloroid camera that had been just developed. The Rocket flight was successful. The modulation device worked perfectly and the location of Sco X1 revealed that it was a 12th magnitude star with no special optical features. In the same flight, the second X-ray source in the Crab Nebula was also identified and its location in the Nebula identified. It turned out to be the fastest pulsar that had been known till then.

* search for quarks in cosmic rays

Another experiment which Prof. Gordon Garmire and myself set up in the basement of MIT, was a large telescope of proportional counters was to record in cosmic rays the presence of fractionally charged quarks that had been predicted by Gellman. There was no evidence for such particles. Later Gellman himself pointed out that quarks are confined within the nucleons and there are no free quarks to be found in cosmic rays or at accelerators.

* Dr. Homi Bhabha's Death

On 26th. January 1966 I was scheduled to give a physics colloquium at MIT. In the evening. The topic I had chosen was "Status of Anti Matter search". That morning around 6 am. I got a call from my friend George Clark to tell me that The Air India Flight from Bombay had crashed near Geneva in the Alps and it was suspected that Dr. Bhabha was on the flight. It was shattering news for me. I switched on the TV and soon the news that Dr. Bhabha was on the plane confirmed. Around 10 am I went to MIT and called on Prof. Philip Morrison who was in charge of the colloquia and told him that I am in a too disturbed mind to give the talk in the evening. He said "we are all saddened to know that Dr. Bhabha is no more. He was such a great Physicist. I advise you to give the talk in memory of him. I am sure you will be able to do that". With a heavy heart I agreed and gave the talk which went off well.

* Starting of X-ray Astronomy programme in TIFR
the news

We returned to Bombay by mid April of 1967. Immediately I started discussions with the Director Prof. Menon and the senior members of the High Altitudes Group headed by Prof. Gokhale, Prof. Daniel and others. They all enthusiastically supported the idea. Development work on Orientation platform on which the x-ray telescope

could be mounted for the collimated telescope to look at specific sources and an aluminum Gondola in which the entire instrumentation namely the xray detector, the collimator, the electronics, telemetry, telecommand systems could be mounted, was started. A young group of research students and research scholars Agarwal, Manvhanda, Damle, joined the programme. We had to import the Sodium Iodide Crystal to serve as the hard Xray detector and most importantly, the large size plastic balloon that could stand the night tropo pause temperatures of equatorial latitudes. The first flight was made in . The balloon could not stand the tropospheric temperature and burst. However the payload safely and the instrument recovered and was not damaged.

A second flight made a few weeks later was successful. Results were obtained on Sco x1 and cyg X3 in the energy range

20 to 100 kev. The balloon Xray astronomy programme continued for several years.

In parallel we also started soft Xray studies with rockets flown The balloon Xray from Thumba, Several of my colleagues in the Xray programme Naranan, Damle, Agarwal, Manchanda, K. p. Singh, had the opportunity to be associated with Xray satellite programmes later. They were also the crucial members of the very successful Indian Astrosat which has been successfully operating with various astronomical instruments for Xray and Gamma ray astronomies for several years now.

* ultrahigh energy gamma ray astronomy with Air Cerenkov Telescopes Ooty and Pachmari

The famous Russian astrophysicist Shlovsky had suggested in 1955 that Supernova remnants could be sources of high energy

Cosmic rays which could give rise to high energy gamma rays which should be looked for through the showers they produce in the atmosphere. The Russian scientists Chudakov and collaborators used the night air Cerenkov detectors and could set only upper limits

To the intensity of high energy gamma ray emission from several of the supernova remnants. These negative results were first reported at

The Jaipur International conference on Cosmic rays in 1963. In 1967 Anthony Hewish reported on the discovery of radio frequency pulsars. Some of these turned out to be Supernova remnants like the Crab nebula.

Since we were familiar with air Cerenkov technique, we immediately set up a four mirror air Cerenkov detector for looking at

Pulsed high energy gamma rays from supernova remnants. Later a much larger assembly of detectors was set up at

Pachmari in Madhya Pradesh since the sky conditions were better there. Prof. Ramana Murthy, Prof. Viswanath, and Prof. Acharya and Prof. Bhat initiated this activity at Pachmari and continued the observations for several years.

* As Director of TIFR January 1975 - August 1987

In January 1975, I was appointed as Director of TIFR. Despite high administrative responsibilities, I was able to keep up

close involvement with the research activities at Ooty and Hyderabad though I could not spend long times at the field stations. This was feasible since I got excellent support from the two Deans of the Physics and Mathematics faculties and the Chairperson of the Applied Sciences Committee. The Registrar and other officers were there right from the time of Dr. Bhabha and had become part of a smooth administrative system.

We also had excellent relations with DAE which was the funding Department of the Government for us. Sri. J. R. D. Tata was the Chairman of the Council and the other members of the Council were Prof. Rustom Choksi, the Finance Secretary of the Government of India, the Secretary DAE, and the Education Secretary of the Government of Maharashtra, Prof. M. G. K. Menon, the previous Director of TIFR continued as member of the Council. With the support and appreciation of such an enlightened Council, I was able to initiate several new programmes proposed by the senior faculty members of TIFR, which over the years have become National

- programmes and institutions by themselves..Among these I might mention the National Radioastronomy centre at Pune, (NRAC) , the National Centre for Biological Studies (NCBS)at Bangalore, the Society for Microwave Engineering Research at Mumbai (SMPU) , The National Centre for Software Development and Computing Techniques (NCST)Mumbai. These were activities initiated by Dr. Bhabha and grown and nurtured by eminent scientists of TIFR Prof. Swarup, Prof. Siddiqi, Prof. Narasimhan . Some of them like NRAC, NCBS, have remained as part of TIFR and others like SMPU, NCST have become part of Department of Electronics.

I retired from the Directorship, of TIFR, on 31 st. July 1987 with a sense of great satisfaction and continued there for the next five years as Indian National Academy, Ramanujan Professor till end of 1992 .

* My sojourn at IAS which became a long stay .

* Typical Topics on which I have given lectures at IAS and other places relating to Consciousness Studies

1. Nature of Consciousness
2. Scientific Explanations and Consciousness
3. Science , Reality and Consciousness
4. Role of Basic Sciences in Human Culture and Philosophy
5. The Mysterious Universe (Deep Revelations over the Centuries)
6. Reality and Consciousness - Is vacuum Quantum Biology the future of life sciences ?
7. Conceptual Revolution of the 20th Century leading to One Grand Unified Concept -- the Quantum vacuum
8. The Quest for Ultimate Reality
9. It is all matter of Scale
10. Scientific Challenges to philosophy and Philosophical challenges to Science
11. Science , spirituality and consciousness

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