

Sixty years of memorable association with Prof. MGK Menon

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During the years 1946 to 49, MGK Menon (Goku for his friends and relatives) was studying for his Masters degree in physics at the Royal Institute of Science in Bombay which was just a stone throw from the Tata Institute of Fundamental Research housed at the Old Royal Yacht Club, next to the Gateway of India where I was working as a Ph.D. student. Still it so happened that Goku and I never met though perhaps he was coming to TIFR for some of the lectures and seminars. Our first meeting took place in Newyork in 1955 January under peculiar circumstances. During the year 1954-55, after I had completed my Ph.D, Dr. Homi Bhabha deputed me to visit various Cosmic Ray Laboratories in Europe and United States and spend a longer period at the Massachusetts Institute of Technology (MIT) and work under the famous physicist Professor Bruno Rossi. Accordingly, after visiting the cosmic ray laboratories in Rome, Paris, Jungfrauoch, Pic du midi, London and Manchester I reached Boston by the end of July 1954 and started working with the Cosmic ray group at MIT.

In January 1955, I went to Newyork to attend the American Physical Society meeting. In the mean time, Goku after his Masters degree had moved to the University of Bristol in UK and completed his Ph.D. working under Professor Powell and had done very exciting work in the newly emerging field of fundamental particles using the newly developed nuclear emulsion technique that had been pioneered by Professor Powell. In January 1955 Goku came to Newyork to present his exciting results on the newly discovered K-mesons at the APS meeting. Goku's talk was scheduled for presentation on the first day itself. I missed his talk because of some confusion about the location of the venue of the APS. There are two campuses for the Newyork University and by mistake I had gone to the other campus quite far away. Still it so transpired that we were destined to meet that evening for the first time. One Indian Ph.D. Student at the Columbia University in Newyork by name Ammiraju who was working under Professor Steinberger met me and invited me to join a group of scientists who had come for the APS meeting, at Dinner at the India-Ceylon Restaurant located at the Times Square. I had not known Ammiraju himself till that morning. He did not tell me who all would join the dinner.

I was pleasantly and happily surprised to meet that evening at the dinner table Goku Menon, Jack Steinberger, Lederman, and Yashpal and his wife Nirmal. Yash had been deputed by Dr. Bhabha to do a Ph.D. at MIT. It was indeed a very pleasant get together.

A few days later, Goku turned up, at MIT to meet Prof Rossi and Dr. Herb Bridge. Since I was sitting in the same room as Herb Bridge, I had the opportunity of meeting Goku again. I recall one very interesting incident during Goku's visit. He wanted to confirm his air booking to the next place he was visiting in the US. When he gave his name as M GK Menon, the girl at the air booking office, insisted that he give his full name. Goku told her that she will find it difficult to follow, but the girl still, insisted that she must have the full name as per rules. Then Goku said his name is Momballithakall Govind Kumar Menon, She just could not follow. Then Goku started spelling the full name alphabet by alphabet, the girl intercepted half way through and told him that she will manage with the short name itself!

The same evening Yash and Nirmal had invited Goku for dinner and I was also to join. That was the occasion which I had a chance to have a long conversation with Goku on his future plans. Goku told me that he had several invitations but the two important ones for him were the one from the University of Columbia in Newyork where Steinberger and Lederman worked in the field of elementary particles and the other from Dr.. Bhabha who had met him at Bristol along with Powell, He had not made up his mind yet which to accept.

Well, I returned to India in August 55 and then rushed to Ooty, where the Cosmic ray laboratory had been set up in the Raj Bhavan premises by my colleagues with two multiplate cloud chambers one one above the other for recording high energy cosmic ray interactions looking for the newly discovered K mesons. I returned to Bombay by December and was pleasantly surprised to find Goku Menon there . He had taken decision in favour of TIFR. Thus started another glorious chapter in Cosmic ray research at TIFR. Before I go into describing all the new activities in TIFR, I would like to point out that a full account of Goku Menon's contributions to the eventfull activities of the Bristol group in the Field of elementary

particles is available in an article by Dr.W.O. Lock specially written for the Festschrift volume that Prof. RR Daniel and myself brought out at the request of the Indian Academy of Sciences in honour of Goku's sixtieth birth day in 1988. The volume has also reproduction of many of the glorious tributes paid by many of his colleagues at Bristol and also by many distinguished scientists across the world.

Now, let me plunge into Goku at TIFR. Before that, I would like to present the status of cosmic ray research at TIFR by the time Goku joined. Dr. Bhabha even when he was at the Indian Institute of Science during 1939 to 1945 had carried out cosmic ray experiments at air plane altitudes to study the latitude effect of the penetrating component in cosmic rays as a function of altitude by flying a Geiger telescope on a B-29 air craft with the help of a pilot by name Hoteko. He also got a cloud chamber built to study the scattering characteristics of the penetrating component of cosmic rays that had been identified as the mu meson. This cloud chamber had been moved to TIFR building at Pedder road in Bombay and Mr. A B Sahiar continued the scattering experiment on mu mesons and got his Ph.D based on this work.

At TIFR, Dr. Bhabha had organised cosmic ray research under three heads:

1. High altitude studies with Balloon Borne instruments
2. Nuclear Emulsion studies on cosmic ray interactions and search for new particles
3. Cloud chamber studies on cosmic rays

In 1949, the TIFR moved to the Old Yacht Club building next to the Gateway of India at Apolo Pier Road, after suitable modification of the building for laboratory and office purposes. Over the next five years not only activities in cosmic ray research expanded, also many new activities in other frontier area of physics got started at TIFR. In 1950 December Dr. Bhabha organised the first ever International Conference on Elementary Particles at the Institute. This conference was attended by some of the leading scientists from various countries. Prominent among them were PMS Blackett, ~~Sir~~ E. Amaldi, ^{Sir} John Cockcroft, Bernardini, Peierls, Wentzel,

Leprince-Ringuet, Rosenfeld, Fowler (on behalf Of Powell who could not come) B.Peters, Perrin, Heitler, Saha, C V Raman Mujumdar Sarabhai , Kothari mostly cosmic ray physicists, nuclear physicists and theorists. It was a unique opportunity for us who were all in the beginning of our research career to listen to them and interact with them.

This conference had many desirable side effects of relevance to the next phase of activities of TIFR. Professors Wentzel, Marshak and Rosenfeld stayed back for a few weeks and gave courses of lectures on elementary particle physics, Dr. Bhabha persuaded Bernard Peters to come and stay at TIFR for a longer period. Accordingly Peters came back in 1951 and stayed for seven years. This was indeed a great boon for the cosmic ray group especially for the Nuclear Emulsion group. Over the next few years Peters, Yash Pal and Devendra Lal made many significant contributions in the field of the newly discovered strange particles -K mesons and Hyperons.

To do full justice to the most important work of Goku Menon and focus on its importance in the field of elementary particle[^] both with Cosmic rays and high energy accelerators in the subsequent decades, I have to digress here and narrate the history of this field. There is a detailed account of it in the article of W.O. Lock which I have already referred to. I will present only a brief summary.

The year 1947, was another turning point in the history of cosmic rays and elementary particles. That year in addition, to the particles known till then- the proton, the neutron, the electron, the positron and the mu-meson, one more very important particle the pi-meson was discovered in the nuclear emulsion stack exposed at Jungfrauoch by the Bristol group. This turned out to be the parent of the muon and also the one that the Japanese physicist Yukawa was looking for as the particle whose exchange is responsible for nuclear forces..The same year was the beginning of another phase of elementary particle physics by the discovery of the first example of what came to be known as, "Strange Particle". Rochester and Butler while operating a cloud chamber with a central horizontal metal plate inside, recorded two examples

of what they called V particles at that time because of their appearance. Over the next almost a year of operation of the chamber they did not find any more similar cases..In an emulsion stack exposed at Jungfraujock in 1948 Brown et. al. of the Bristol group found just one case of a heavy particle decaying into three mesons. A similar case of three particle decay was found by Harding of Imperial college in 1950 followed by a clear cut case in 1951 in the emulsions exposed at Jungfraujock by Fowler and his collaborators of Bristol group in which Goku Menon played the most crucial role in the analysis of the event. This was the first example of the Tau meson decay into three pions. In 1951, O'ceallaigh of the Bristol group reported a case in which the primary particle of the same mass decaying into a single mu-meson. In 1954 when I was at MIT scanning through 75 thousand multiplate cloud chambers photographs recorded at Echol Lake found three examples of stopping particles decaying into a single muons. Clearly collection of data on the decay of particles during those days was like collection of rare highly valuable stamps. The particles decaying into three particles were given the name "Tau meson" and those into two particles were called "Theta", The Tau/ Theta puzzle led to the postulation of "parity violation " in weak interactions by Lee and Yang who later on got the Nobel Prize.

After this glorious and very fruitful period, at Bristol, Goku returned to India towards the end of 1955 along with his wife Indumati a student of philosophy at the Bristol University and joined TIFR.

The first major activity that Goku got involved along with Bernard Peters and Gokhale was the development of large volume plastic balloons to carry cosmic ray instruments beyond stratospheric altitudes. In a detailed article in the Festschrift volume I have already referred to, Professor Gkhale has given a full account of the various stages of this developmental work which posed serious problems because of the unsuitable plastic fabric that was commercially available in India, to stand the very low temperatures encountered at stratospheric altitudes ^h at the particular ^{ly} low latitudes. A limited success was achieved by spray painting the balloons with black paint. The paint would peel off as the balloon ascended. A lot trials and research had to be done before achieving success. This effort however paved the way for embarking on a

variety of experiments in the field of space astronomy with balloons - Infrared, X-ray, Gamma ray astronomies in the following decades.

The decade 1955-65 was also one in which TIFR expanded its activities in many directions. The new building at the Navy Nagar became ready for occupation. Several new fields of activity Nuclear Magnetic Resonance, Solid State Physics, Computer Development, Molecular Biology and Theoretical Astrophysics etc were initiated. In the field of Cosmic ray studies large scale experiments in the field of cloud chamber studies in association with extensive air showers were started in a new laboratory in Ooty. The second phase of Deep underground cosmic ray studies began in collaboration with groups from Japan and UK. Dr. Bhabha decided to organise all these diverse activities under two faculties: the physics faculty and the mathematics faculty and appointed MGK Menon as the Dean of the Physics Faculty and later as Deputy Director. Dr. Bhabha himself was getting more and more busy with equally fast developing Atomic Energy Programme. This meant that Gokul Menon had to shoulder a huge share of administrative responsibilities of TIFR as well.

Another side benefit of the International Conference organised by Dr. Bhabha in December 1950 was the following: While going through the abstracts of the papers that were to be presented by the various distinguished invitees, he got the idea that in the cosmic ray beam underground there may be other unknown particles in addition to the muons. Late one evening in October a couple of months before the conference, he called me and suggested that I should take the Meson decay experimental system that I was operating in Bombay to an underground location in Kolar Gold Fields and check whether all the charged particles were muons only. Till that time only one experiment had been carried out in Canada to determine the flux of particles underground. So I thought that before embarking on the muon decay experiment, I should get an idea of the flux and spectrum of muons. By October 1951 myself and a colleague who had just joined Narayan built a hodoscoped meson telescope system. Soon another colleague Ramana Murthy also joined, we carried out intensity and angular distribution experiments at various depths up to a maximum depth of 1000 ft. We also

set up a cloud chamber at a depth of 100 ft to study the interaction characteristics of muons. However, by the end of 1952 we were asked by the then Mining Authorities John Taylor & co to leave since they were planning to close down the mines. However, even by 1958 the mines had not been closed down and we embarked ^o in the second phase of our experiments in the mid 1958. In this phase several different types of experiments were carried out some of them in collaboration with Japanese and UK scientists. Also Goku Menon became part of some of the experiments.

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The second phase experiments in the Kolar mines were the following:

1. Intensity measurement of cosmic ray muons down to depth of 8000 ft below ground.
2. Extensive Air Shower Array at the surface in coincidence with water Cherenkov detectors at various depths
3. Detection of cosmic ray neutrinos
4. Search for proton decay

The intensity of muons at various depths down to 8000 ft underground were carried out with a specially designed hybrid telescope of scintillation counters and Geiger counters. Till then no measurements down to such large depths were done anywhere in the world. Most exciting result of the experiment was the NO COUNT registration in three months of continuous operation at the largest depth of 8000 ft. This No Count result gave us the clue that at these large depths it should be possible to detect with suitably designed particle detector Telescopes muons from Nuclear interactions of cosmic ray produced neutrinos either in the atmosphere or in the Earth below. (upward going muons).

A suitable telescope, a combination of scintillators and layers of neon flash tubes was set up at depth off 7000 ft as a collaborative project of TIFR, Osaka City University Japan and University of Durham UK. In a few months operation itself four definite cases of neutrino interactions were recorded. One of the typical cases in which the two muon tracks meet in the side wall is shown in Fig 1. The results of this astounding success (the very first example of cosmic ray

neutrino detection) was reported by Goku Menon at the International Cosmic Ray Conference held in London in August 1965.

Articles by V S Narasimhan and P V Rama Murthy and by Miyake in the 1988. Festschrift gives all the details including results on proton decay

At the invitation of Dr. Bhabha, the Cosmic Ray Commission of IUPAP, held "The Seventh International Conference on Cosmic Rays" in 1963 in India at Jaipur. Goku Menon played an extremely important role in organising this conference which was a grand success. For the first time a large number of delegates from the Soviet Union also attended the conference. It was inaugurated by Prof C F Powell. The Prime Minister of India Pandit Jawahar Lal Nehru came for the closing session and addressed the delegates.

On 1966 January 26th, a major tragedy struck India. Dr. Homi Bhabha died in an air crash over the mountains in the Alps. Four key appointments had to be made all held by Dr. Bhabha, Chairman of Atomic Energy Commission; Secretary, Department of Atomic Energy; Director Atomic Energy Research Establishment; Director, Tata Institute of Fundamental Research. Dr. Vikram Sarabhai was appointed as Chairman of Atomic Energy Commission and Secretary, Department of Atomic Energy, Dr. Homi Sethna as the Director of Atomic Energy Research Establishment (later called Bhabha Atomic Research Centre) and Professor M G K Menon as the Director of the Tata institute of Fundamental Research.

In the early 1960's Dr Bhabha initiated two major new projects in TIFR. One was Radio Astronomy and the other was Molecular Biology. The role Goku Menon played in the Radio Astronomy project is appropriately acknowledged by Professor Govind Swarup as follows in his article in the Festschrift volume referred to earlier:

"I would like to take this opportunity to express our gratitude to Professor MGK Menon for his unrelenting support to our endeavours in the field of radio astronomy at TIFR over the last 25 years. In 1961, he made a strong recommendation to Professor Homi Bhabha to start the new field of radio astronomy at TIFR ,when myself and three others working in the USA wrote to

several Organizations for initiating radio astronomy activities in India, Professor Menon's constant encouragement and fruitful advice were also crucial to the successful completion of the Ooty Radio Telescope, constructed indigenously during the 1960s. He has actively supported our plans for the construction of the GMRT which is being executed by TIFR as a National project. He has taken keen interest in the growth of at the Indian Institute of Astrophysics and the Raman Research Institute, indeed the growth of astronomy in India owes a great deal to his vision and his deep interest in the related field of Cosmic Rays".

Menon's role in the Molecular Biology activities at TIFR is available in the 2016. →

During the period 1966 to 1975. Menon supported many other new activities -- a permanent facility for manufacturing and launching of plastic balloons for experiments in the field of cosmic rays, X-ray and Gamma ray astronomies, and a building for telemetry recording and pre-launch ^{preparations} preparations and a hostel were created in a large ground suitable for launching several million ~~volume~~ cubic feet volume balloons was created at Hyderabad. International Collaborations in these areas were encouraged. In the Kolar Gold fields a large scale project on Search for Proton Decay was initiated as a continuation of the neutrino project of an International Collaboration. A project on Solid state Electronics was initiated. Theoretical Astrophysics group was expanded. A housing complex to begin with a ten storey building for scientists and a hostel for students came with up close to the Institute. These are some of the activities I recall. There must have been many more.

An Electronics Commission and the Department of Electronics were set up by the Government of India in 1971 for implementing the recommendations of the Bhabha Committee on Electronics and the Prime Minister Smt Indira Gandhi appointed Professor Menon as Chairman of the Commission and Secretary of the Department of Electronics in 1971. Till January 1975, Menon managed these additional responsibilities continuing as Director of TIFR. However in 1975 he moved to Delhi. While retiring from the Directorship of TIFR, he continued as a member of the Council for the next three decades. Till 1978 he was Chairman of the Electronics Commission and later moved on to take several responsibilities in various other departments of

→ Special ^{Volume 42} ~~lecture~~ of Biographical Memoirs of the Fellows of INSA in the article "Beginnings of Molecular Biology in TIFR" by MGK Menon and B.V. Sreenivasan

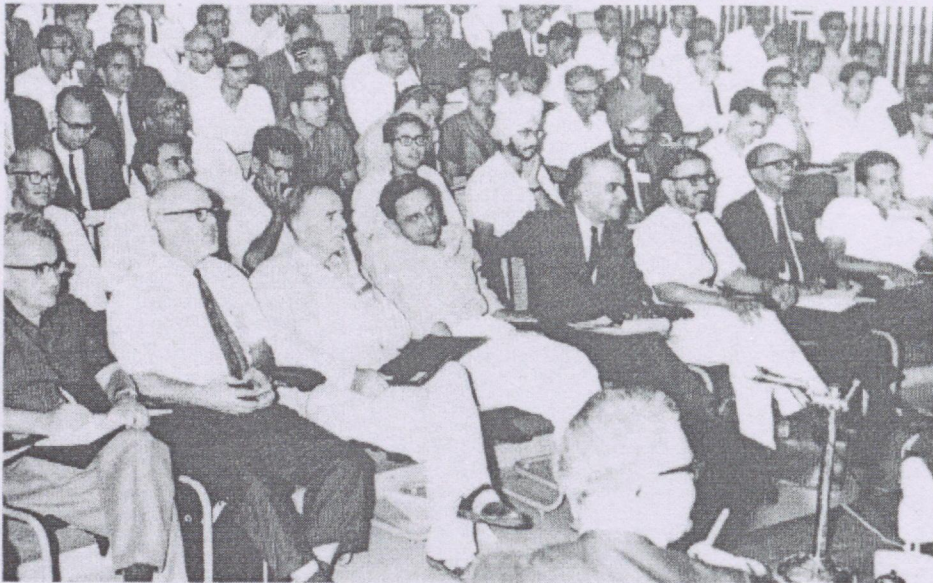
the government like DRDO, Science and Technology, CSIR , Environment etc., at the highest level. He was also Chairman of the Scientific Advisory Committee to the Cabinet. He was also Member of the Planning Commission. I am sure Menon's contributions in these areas will be highlighted by other contributors to the Festschrift. I would like to draw attention to an elegant informative article on Professor Menon in the Current Science series August 2013 on "Living Legends in Indian Science" by Ramnath Cowsik .The article also gives a full list of the various fellowships, he holds as well as the various honours and awards he has received nationally and internationally.

I have had the pleasure and privilege of interacting closely with five eminent Indian scientists- Dr. Homi Bhabha, Dr. Vikram Sarabhai, Dr. Satish Dhawan, Dr. Raja Ramanna and Dr. MGK Menon. They were of different profiles and of different personalities. However, there was one dominant goal common to all of them That was to uplift Science and Technology in India. They strived hard towards that goal and succeeded in a great measure. The country has to be ever grateful to them.



Inauguration of the international conference on cosmic rays held in Jaipur, in December 1963.

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Bombay Colloquium on cosmic ray studies in relation to recent developments in astronomy and astrophysics, November 1968.

* Professor Patel addressing the delegates
 Seated from left to right
 Profs D. Lal, Anand Rastogi, Sankar, Hayakawa, Dobrotin
 Mehta and Bhalla

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Prof. Metan

Testing of plastic balloon.

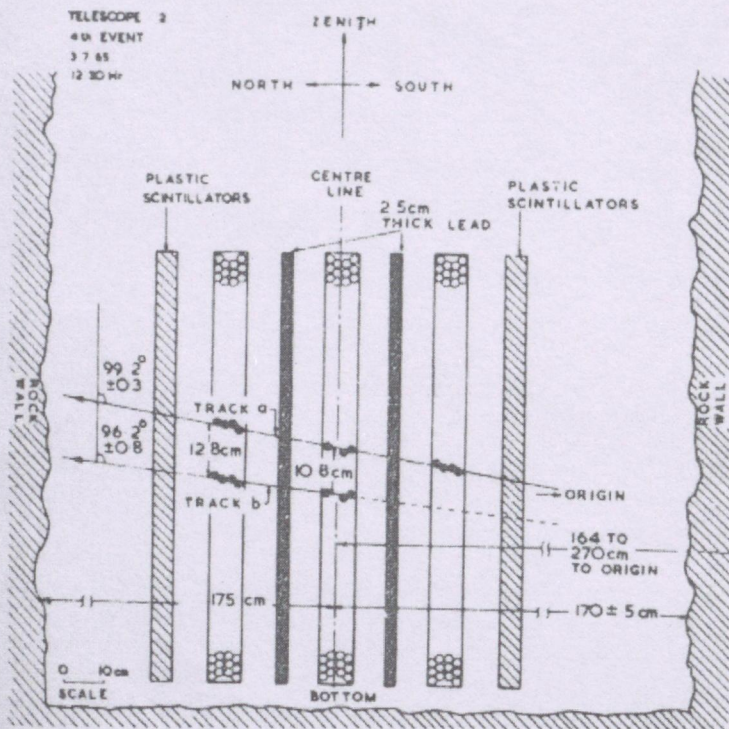
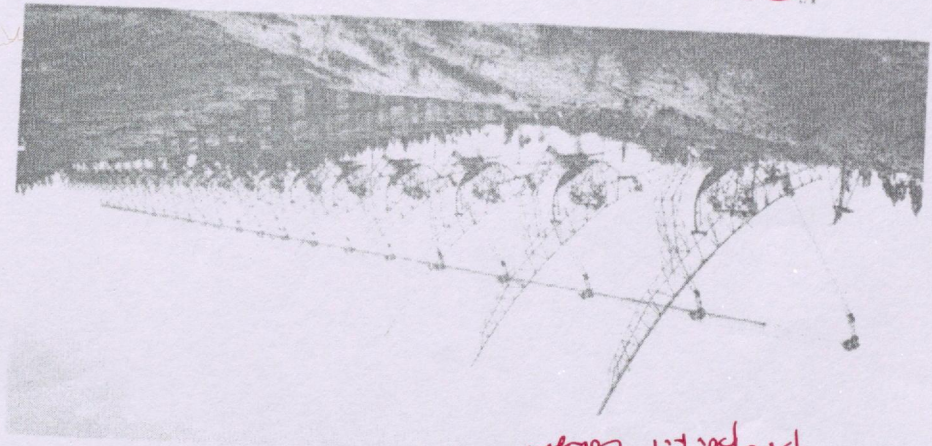


Figure 2. An expanded view of the section of telescope 2 in which an inelastic neutrino interaction was recorded.

~~Figure 1.~~

~~Figure 1~~ A view of the 530m long and 30m wide Gory radio telescope. It is placed on a suitably inclined hill so that its axis of rotation becomes parallel to that of the earth. It is mechanically steerable from -4° to $+4^{\circ}$ and electrically from about -40° to $+40^{\circ}$.



Phase I detector at 7000 hg/cm² - Photo Detector Experiment
Aftermath begins at 8000 hg/cm²
Preparation continues

