Mambillikalathil Govind Kumar Menon

Ramanath Cowsik

M. G. K. Menon is more than a brilliant physicist. If we can call Homi Jahangir Bhabha the architect of modern scientific and technological India, then Menon can be considered as the builder who grasped the significance of the plans, assiduously worked on them and oversaw the construction of the first important stages of the superstructure. In this effort, he was aided by his sterling human qualities and quick and intuitive perception of the strength and capabilities in others, whom he could persuade to join in the effort to build an intellectually and technologically strong India. Apart from this, to borrow a phrase from V. Radhakrishnan, he is the most eminent 'statesman of science' we have in India.

M. G. K. Menon, Goku to friends and Goku-dada to innumerable young children, was born in Mangalore on 28 August 1928, into the family of Kizhekapat Shankara Menon who was a District and Sessions Judge. At that time, Mangalore being in the Madras Presidency, his father was transferred to various places, so that Goku's primary education took place at Kurnool and Cuddalore. Thence, the family moved to Jodhpur and he matriculated from the Punjab University in 1942. After graduating with his Bachelor of Science degree from the Agra University in 1946, while at the Jaswant College, Jodhpur, he was contemplating taking up medicine as a career. He loved science and the spark that lit his deep commitment to fundamental research was provided by none other than the Nobel laureate C. V. Raman. As Menon himself reminisces, 'I met him [Raman] in Jodhpur when my father had invited him for a meal…. For a person in the mid-teens it was quite an experience to meet someone like him. He was exuberant and completely focused. He thumped the table and said the greatest thing for me to do in life would be to do science'. Raman had insisted that Menon should do research in physics!

Menon then moved to the Royal Institute of Science, Bombay where he obtained the Master of Science in physics, under the guidance of N. R. Tawde, the noted spectroscopist. Menon, already an avid photographer, embarked on a project to develop photographic emulsion that was sensitive in the ultraviolet. As he was making significant progress in this effort, at the instance of P. K. Kichlu (Delhi University), Menon wrote to Cecil Frank Powell of the University of Bristol, UK.

Thus began in 1949, Menon's pioneering contributions to the study of elementary particles in general, and more specifically in triggering the discovery of 'parity-non-conservation' in the decay of sub-atomic particles. For several years, prior to Menon reaching Bristol, Powell was deeply engaged in the use of photographic emulsion as a detector of energetic charged particles, and had made pioneering discoveries, such as the observation of the tracks of charged pions and their decay into mono-energetic muons. The photographic plates, consisting of glass plates with a thick coating of photographic emulsion, were flown at altitudes of ~100,000 ft on large plastic balloons filled with hydrogen. The primary cosmic rays, unattenuated by the Earth's atmosphere would enter the stacks of photographic plates leaving a trail of ionization in the crystals of AgBr which could be 'developed and fixed' in the usual way, to make the track visible. Powell and Menon started using stacks of pellicles of photographic emulsion (manufactured at Ilford, UK by Clive Waller and others, and known as nuclear emulsion when used as particle detectors), without any backing by glass plates. This made it easy to follow the track over its entire length within the stack. Coming to important discoveries, by the end of 1951, Menon working in Bristol had discovered many events (see Figure 1), showing the decay of charged K particles that had been produced by cosmic rays:

$$K^+ \rightarrow \pi^+ + \pi^+ + \pi^-, \quad (1)$$

i.e. into three pions (see Figure 1). Interestingly, by 1954 they had also seen several events that could be interpreted as

$$K^+ \rightarrow \pi^+ + \pi^0, \quad (2)$$

i.e. into two pions (see Figure 2). There was no question that the parent particle in both these types of events was the same – they had same mass and about the same lifetime. How can this be? Pion is a pseudoscalar meson, with zero spin and negative parity. The decay into the three-pion final state, called the τ-mode (or τ-meson), indicates that the parity of K-meson is negative. The decay into the two-particle final state, called the θ-mode (or θ^+ or θ^- particle) indicates a positive parity for the kaon. This was called the τ–θ puzzle. How can the same particle have both a positive and a negative parity? This was resolved in 1957 by Lee and Yang by formally postulating 'parity non-conservation'. The long lifetime measured by Menon and others

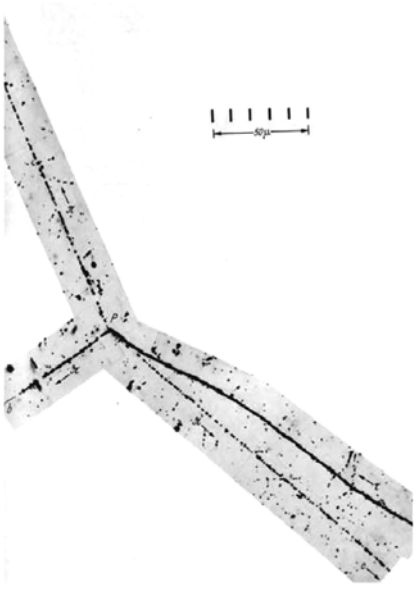

Figure 1. In this event τ_4, the length of the track of the parent particle in the emulsion is 2.1 mm and determinations of its mass gave a mean value of $960 \pm 190\ m_e$. The three secondary tracks are co-planar to within $2 \pm 2°$ and one of them has a length in emulsion of 6.4 mm. The measurements of the mass of this particle gave the value $285 \pm 20\ m_e$. The particle was moving slowly when it left the emulsion, its residual range at this point being estimated as 0.4 mm. The range–energy relation for emulsions then allowed its energy and momentum to be determined with an accuracy limited only by the errors due to 'straggling'. (Fowler, Menon, Powell and Rochat, *Philos. Mag.*, 1951, **42**, 1040). Source: Taylor & Francis Ltd.

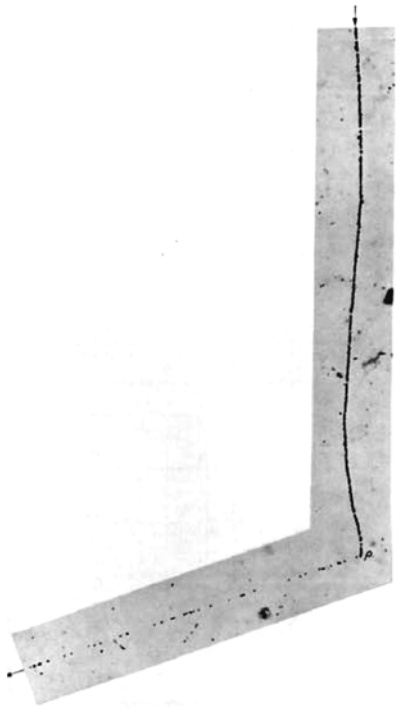

Figure 2. In this event, the track of the primary particle is only 630 μ long, and its mass was estimated to be 1380 ± 600 m_e. The identification of the particle as a X-meson was based on measurements of the faint track of the particle arising from the decay of the parent X-particle (Source: Menon and O'Ceallaigh, *Proc. R. Soc. London, Ser. A*, 1954, **221**, 292.)

Figure 3. Menon discussing Λ° decays with Michelangelo Merlin, Denis Keefe and Michael Friedlander (*Philos. Mag.*, 1954, **45**, 533).

clearly showed that 'weak interactions mediated the decay'. Menon was also responsible for coining the phrase 'associated production' to describe the fact that hyperons and kaons were always produced together in nuclear interactions, signifying the conservation of a new quantum number – the hypercharge. The production process was 'strong', but the decay was 'weak'. His studies helped in the identification of 'strangeness' as a quantum number which is conserved in strong interactions, but violated in weak interactions.

In January 1953, Menon was awarded a Ph D from Bristol and soon thereafter the Senior Award of the Exhibition of 1851, which he held for two years 1953–1955, just as Bhabha did years earlier. He met and married Indumati Patel, a student of philosophy, while at Bristol, and the two have provided hospitality and friendship to an innumerable number of students and scientists across the world. He was a key figure in Powell's fourth floor lab which was always alive with scientific discussions (see Figure 3).

Towards the end of 1955, at the invitation of Bhabha, Menon joined the Tata Institute of Fundamental Research (TIFR), which had by then moved from Bangalore to Bombay and was well established at the Kenilworth and the Old Yacht Club.

At TIFR, Menon started a programme to develop plastic balloons which could carry scientific payloads to stratospheric heights – a harbinger of India's programmes in space. He also seamlessly integrated himself with the studies of particle physics and cosmic rays with detectors deployed deep underground, which was already moving forward vigorously, under the dedicated efforts of B. V. Sreekantan, one of the pioneers of Indian science, handpicked by Homi Bhabha himself. At TIFR, Menon also immersed himself in the studies of cosmic rays and particle physics with nuclear emulsions which was being led by Bernard Peters and Roy Daniel, also a Ph D from Bristol. Bhabha found in him a kindred spirit, and asked him to shoulder progressively greater responsibility in the affairs of the Institute. While this helped Bhabha devote more time to the growth of atomic energy in the country and conceptualize a broad framework for the growth of electronics, computer science and information technology, defence capabilities and space activities in India, it brought Menon into closer contact with Bhabha and, equally importantly, with J. R. D. Tata, under whose joint influence the innate qualities in Menon matured. These influences were also responsible for his deep resolve to dedicate all his life to the development of our country. It was thus, he took up all responsibilities that were thrust upon him in an unassuming and selfless manner. Menon was indefatigable and soon became known for his attention to detail and meticulousness with which he assessed all the background material before taking a decision. He was soon made the Dean of the Faculty of Physics immediately followed by elevation to the position of the Deputy Director (Physics). TIFR grew rapidly in areas as diverse as biological sciences, radio astronomy, solid state electronics and geophysics, and to quote Sreekantan 'Menon was the guiding spirit behind these developments'. It was during this period that Menon and his associates, Sreekantan and others recorded the first event ever of a cosmic-ray neutrino interacting deep underground and generating a muon. This was reported at the International Cosmic Ray Conference in 1965 held in London, during which Fred Reines and his team from the University of California at Irvine, USA also reported a similar event. This triggered the growth of neutrino physics, and scientists across the world dedicated considerable time, effort and finances to build larger detectors collecting such rare events in large numbers. It is indeed one such effort in Japan, by a team led by Masatoshi

Koshiba that discovered the phenomenon of neutrino oscillations, recognized by the award of the Nobel Prize.

It was soon after this that a great tragedy befell the Indian scientific scene: 24 January 1966, Bhabha was killed in an air crash over Mount Blanc. The Chairman of the Governing Council of TIFR, J. R. D. Tata while appointing Menon as the New Director of the Institute, must have well recognized that the mantle of responsibility they were placing on his shoulders carried with it not only the burden of responsibility of guiding an internationally famous Institute to greater heights, but also the more challenging one of capturing the dream J.R.D. had shared with Bhabha of a scientifically advanced and technologically capable India. 'It goes to the credit of Menon that during the crucial period following Homi Bhabha's death, he was not only able to maintain and further the high standards of basic research at the Institute but also encourage the Institute to undertake major projects of national relevance in the fields of electronics, computer science and material science… The Institute became much more broad-based and the expertise that had been developed as a part of the research programme became available for national use and development' – to quote Daniel and Sreekantan.

During the early years of his directorship, Menon was invited by C. V. Raman to play a central role in the Board of Trustees of the Raman Trust. It was thus that when Raman died after a brief illness in November 1970, the responsibility of the future of the Raman Research Institute (RRI) at Bangalore fell on his shoulders. During a couple of years prior to Raman's death, the research activities had become limited by the meagre funds obtained from the sales of Raman's personal property. How to rejuvenate RRI befitting its founder, an incomparable experimentalist, who had brought fame and visibility to Indian science, by working entirely within India and whose students had occupied high academic positions across the world? Menon decided that the only way this could be done was to identify the right person as Director and provide him with full support and freedom to rebuild the institute according to his own vision. With the advice and help of S. Chandrasekhar (of the University of Chicago) and S. Ramaseshan (Indian Institute of Science (IISc), Bangalore), Menon got in touch with V. Radhakrishnan, Rad, to everyone, who had ever met him, even once, student, professor, aviator or sailor. Rad had acquired international renown in the field of radio astronomy, especially because of his pioneering work on Pulsars which had been discovered just a couple of years earlier. Today Rad is no more with us; his glorious multifaceted life came to an end just a couple of years ago. But RRI is doing extraordinarily well, thanks to the phenomenal efforts of Rad and the magic that only Menon could wield.

Menon's perspicacity in identifying and persuading the right person to give up his own personal trajectory and dedicate his efforts to national development was phenomenal: Bhabha had been responsible for the commencement of space research activities in India. Upon Bhabha's death in 1966, Vikram Sarabhai had been appointed as the Chairman of the Indian Space Research Organisation (ISRO). Upon the sudden and tragic death of Sarabhai in December 1971, Menon, who was already holding the position as the Chairman of the Electronics Commission and Secretary to the Government of India, Department of Electronics, concurrent with the Directorship of TIFR, was asked by the then Prime Minister Indira Gandhi to shoulder the additional responsibilities as the Chairman of ISRO and Director of Physical Research Laboratory (PRL), Ahmedabad. While agreeing to hold these additional responsibilities briefly, until a successor could be appointed, Menon prevailed upon Indira Gandhi and P. N. Haksar (her Principal Secretary) to call upon Satish Dhawan (IISc) to be appointed as the Chairman of ISRO. The success of the space programme in India and the formation of the Space Commission owe as much to Dhawan's tremendous abilities and human values as to Menon's perspicacity and persuasiveness to make Dhawan accept this major responsibility. Menon also persuaded U. R. Rao to accept the Director's position at PRL. Amidst all this nation-building activity, Menon never lost his focus on science. He helped establish close collaboration in the field of cosmic rays between TIFR and groups at University of Durham led by Arnold Wolfendale and at Osaka University led by S. Miyake. Menon was elected Fellow, Royal Society (London) in 1970, in recognition of his outstanding contributions to particle physics and for the studies in cosmic rays.

By mid-seventies, the electro-weak unification of forces pioneered by Glashow, Salam and Weinberg was being accepted by the scientific community and the possibility of the unification of strong interaction as well with the electromagnetic and weak interactions. In this context Pati and Salam envisaged the possibility that matter may decay away, in particular proton might decay to mesons and electrons or muons. Menon, a close friend of Salam, and always well informed of key problems in physics, launched a major experiment in the deep mines of the Kolar Gold Fields to test this exciting possibility. A large team from TIFR joined hands and in record time the huge instrument was assembled, deep in the Kolar mines, where a special vault 15 m high had been excavated for the purpose. This experiment set the best limits on the stability of matter available at that time.

Menon's creative approach to science and elegant management skills projected him rapidly to the higher echelons of academia across the world. He has occupied the position of the President of the three academies of sciences in India – the Indian Academy of Sciences (IAS), the Indian National Science Academy (INSA) and the National Academy of Sciences (India) (NASI). During his presidency and, indeed, through his continued association with them, these academies have vastly increased their scope and engagement with society in general. This remark may be exemplified by noting that soon after he was elected President of the Indian Academy of Sciences, the fellowship was significantly enlarged to bring in scientists from new and emerging fields of study. Menon was also responsible for vastly increasing the publications of the academy. C. V. Raman, the founder of the Academy, started with the publication of the 'Proceedings', in 1934, with monthlies in Physical Sciences, to which, in the very next year, he added a monthly devoted to other branches of science and mathematics. Menon, with the association of leading scientists in India, was responsible for the rapid growth of the publications: *Pramana*, to start with, in 1973, and a significantly larger number of others covering various fields in 1977. This growth has continued ever since (including the rejuvenation of '*Genetics*', the

Box 1. Selected highlights thus far of M. G. K. Menon's accomplishments

Important positions held

- Faculty Member, Tata Institute of Fundamental Research (1955–66)
- Director, Tata Institute of Fundamental Research (1966–75)
- Chairman, Electronics Commission and Secretary, Department of Electronics (1971–78)
- Chairman, Indian Space Research Organisation (1972)
- Scientific Adviser to the Defence Minister, Secretary, Department of Defence Research, and Director-General, Defence Research and Development Organisation (1974–78)
- Secretary, Department of Science and Technology (1978–82)
- Director-General, Council of Scientific and Industrial Research (1978–81)
- Secretary, Department of Environment (1980–81)
- Chairman, Commission for Additional Sources of Energy (1981–82)
- Chairman, Science Advisory Committee to the Cabinet (1982–85)
- Member, Planning Commission (with the rank of Minister of State) (May 1982– December 1989)
- Scientific Adviser to Prime Minister (February 1986–December 1989)
- Prof. Sir C. V. Raman Professor of the Indian National Science Academy (1986–91)
- Minister of State (Government of India) for Science & Technology (December 1989–November 1990); and as also for Education
- Member of Parliament (1990–1996) – Rajya Sabha
- M.N. Saha Distinguished Fellow of the National Academy of Sciences (India) (1994–99)

Fellowship of societies and academies

- Fellow of the Royal Society (1970)
- Foreign Honorary Member, American Academy of Arts and Sciences (1970)
- Fellow of the Indian Academy of Sciences (President 1974–76)
- Fellow of the Indian National Science Academy (President 1981–82)
- Member, Pontifical Academy of Sciences, Rome (1981)
- Honorary Fellow, National Academy of Sciences (President 1987–88)
- President, Indian Science Congress Association (1981–82)
- Honorary Foreign Member, Russian (earlier USSR) Academy of Sciences
- Honorary Member, The Institution of Electrical and Electronics Engineers (IEEE)
- Honorary President, Asia Electronics Union
- Honorary Fellow, Tata Institute of Fundamental Research, Bombay
- Honorary Fellow, Indian Institute of Astrophysics, Bangalore
- Honorary Fellow, Indian Institute of Science, Bangalore
- Fellow of the National Institute of Education, New Delhi
- Founding Fellow of Third World Academy of Sciences, Trieste
- Honorary Fellow, The Institute of Physics, London, 1997.

National Awards by the President of India

- Padma Shri (1961)
- Padma Bhushan (1968)
- Padma Vibhushan (1985)

National and international honours

- Senior Award of the Royal Commission for the Exhibition of 1851 (1953–55)
- Shanti Swarup Bhatnagar Award for Physical Sciences of CSIR (1960)
- Cecil Powell Medal of European Physical Society (1978)
- Durga Prasad Khaitan Memorial Medal of Royal Asiatic Society (1978)
- Kerala State Committee for Science and Technology Prize (1979)
- Pt. Jawaharlal Nehru Award for Science (1983) of Madhya Pradesh State Government
- G.P. Chatterjee Award (1984) of Indian Science Congress Association
- Fourth J.C. Bose Triennial Gold Medal of Bose Institute (1984)
- C.V. Raman Medal (1985) of the Indian National Science Academy
- Om Prakash Bhasin Award for Science and Technology (1985) – Electronics
- First Sir Asutosh Mookerjee Gold Medal of Indian Science Congress Association (1988)
- 'Health for All' Medal of WHO given on its 40th Anniversary
- Shiromani Award
- Abdus Salam Medal (1997), Third World Academy of Sciences
- Shatabdi Puraskar (1999), Indian Science Congress Association, for overall contributions to the development science.

oldest journal on the subject of the English language).

There are not many scientists who are deeply committed to the concept that it is only through the growth of science, not only within one's own country but worldwide, even in the poorest of nations, that the major problems facing humanity could be solved. Abdus Salam was certainly one of them. He had dedicated his incomparable charisma, energy and the high standing he had in the academic world to establish the International Centre for Theoretical Physics in Trieste, Italy. Any scientist from the developing world, almost by right could go and work there and interact with other scientists across the world. Powell was a great internationalist, and this trait had been imbibed by those working in his laboratory. Menon was similarly committed to achieving human progress through science. Both Salam and Menon had been admitted into the Pontifical Academy of Sciences in 1981. On this occasion, over a quiet dinner, Menon broached the possibility of setting up an international academy, and on how this could energize the scientists in these countries and confirm their academic credentials, allowing them to spread science and scientific method in their respective countries. Also such a body 'could assume responsibility for the advocacy of science, establish standards of excellence, and promote social, cultural and economic development'. At Menon's instance, distinguished scientists from across the world, including C. N. R. Rao met to discuss and flesh out how this could be achieved. It was thus the idea of Third World Academy of Sciences was born, with these luminaries as the Founding Fellows of the Academy. It is the deep concern that Menon feels for the well-being of others, that gives him the energy and drive to accomplish so much.

Figure 4. Indu and Menon (photograph taken by Michael Friedlander at the railway station in Bristol).

In the long list of his outstanding achievements, one must include the key role he played in saving the 'Silent Valley' from ecological disaster. Silent Valley is a dense tropical forest, occupying about 30,000 ha in the Western Ghats of Kerala. This area is rich in rare flora and fauna, and constitutes an important reserve of diverse life forms and a large gene pool. Such rainforests are believed to be the highest form of vegetation and the evolutionary peak of plant life. Primitive nomadic tribes live along its outskirts. The threat to the Silent Valley came in the form of a resolution by the Kerala Assembly, circa 1976, to dam the Kunthipuzha River, which will flood a significant fraction of the Valley, but will provide the opportunity for generating about 250 MW of hydroelectric power and also irrigate some 10,000 ha of land in Palghat district, Kerala. The environmentalists across India launched strong opposition to the project, supported by international groups and scientists. The Kerala Government was equally committed to the project and a veritable war between the two raged on. During this time the nation saw its Prime Minister change from Charan Singh to Morarji Desai and then to Indira Gandhi. To resolve this impasse, Indira Gandhi appointed a committee of eight persons, four chosen by the Kerala Government and four by the Government of India with Menon in the chair. The committee was to send its recommendations speedily, say, in about three months. This is where Menon's statesmanship came to the fore. Three months was too short a time to fully assess all the pros and cons of the issue, and, more importantly for the rigid stance taken by the two sides to thaw. During his careful and extended hearing of the arguments, both sides felt that his decision will go in their favour; such was his objectivity, while assessing the problem. The decision came slowly but surely, with carefully drafted evaluation, in favour of the environmentalists, and the Silent Valley is there for us all to enjoy, a repository of plant and animal wealth. These are sensitive ecosystems that tourists and even environmentalists and scientists should tread with caution.

Such sterling human qualities, coupled with high intellect and administrative judgement in Menon was recognized widely in the form of awards, election to the fellowship of several national and international bodies, and also in appointments to high-level administrative and advisory positions such as the Member of Planning Commission, Chairman of the Scientific Advisory Committee to the Cabinet and Scientific Advisor to the Prime Minister of India. It has not been possible to touch upon several aspects of Menon's many-faceted personality and his wide-ranging contributions to India and to science and scientists across this world (see Box 1). He continues to serve the nation and international community of scientists with distinction in many ways, shouldering responsibilities that are thrust on him. We now wish Indu and Menon (see Figure 4) all the very best and many happy returns on the occasion of his birthday which falls on 28 August.

RAMANATH COWSIK

McDonnell Center for Space Sciences,
Department of Physics,
Washington University,
1 Brooking Drive,
CB 1105, St Louis,
MO 63130-4899, USA
e-mail: cowsik@physics.wustl.edu