P. K. Iyengar (1931–2011)

Padmanabha Krishnagopal Iyengar passed away on 21 December 2011. A pioneer of neutron scattering research in India and initiator of pulsed fast reactor at the Bhabha Atomic Research Centre (BARC), Trombay, Mumbai, he was also an inveterate innovator and motivator of people. Starting his scientific career as a young research assistant at the Tata Institute of Fundamental Research (TIFR), Mumbai in 1952, he retired in 1993 from his formal scientific, technical and administrative responsibilities as Chairman of the Atomic Energy Commission (AEC). He was the first Chairman who was trained within the country, except for a short stint of 18 months at Chalk River Nuclear Laboratories, Canada. He was committed to the cause of Indian science and in particular, to atomic energy till his last days.

Iyengar was truly a product of his times. He was 16 years old at the time of Indian independence, and had absorbed the pre-independence ethos and spirit and transformed it into a guiding principle for his life: people's utter dependence on foreign goods and technology made Iyengar believe that if India has to survive, it has to provide for itself through its own science and technology.

Iyengar obtained his M Sc degree in physics (1952) from Thiruvananthapuram and joined TIFR under Raja Ramanna. A 1 million volt accelerator of charged particles had been installed at the Institute at that time. This is where Iyengar got his initial grounding in detecting nuclear radiation and in building the electronics required for counting nuclear particles and in fabricating other advanced electronic units for measurement of the slowing down of fast neutrons in different media. This period of about five years of learning and experimentation instilled in him a style of working which moulded his personality in the years to come.

The neutron measurements at TIFR were a preparation for the utilization of neutrons from Apsara, India's first nuclear reactor, which became critical on 4 August 1956. However, even before the starting of Apsara, India had signed an agreement with Canada for building a bigger reactor, Cirus, at Trombay, similar to their NRX reactor at Chalk River. A team of several engineers and a few scientists was sent to Chalk River for training in 1956. Iyengar had the good fortune to be chosen to work with B. N. Brockhouse – an extraordinary scientist who won the Nobel Prize for physics (with C. G. Shull) in 1994. Brockhouse had an intuitive approach and could get to the heart of a problem without being embroiled in the details of mathematical tools, necessarily used in physics. Iyengar was a complete match for Brockhouse in his approach to science; the 18 months during 1956–58 that Iyengar spent with Brockhouse turned out to be a period of great value as it consolidated his belief in himself and kindled his innovative spirit for developing newer methods and devices for experimentation and study.

Impressed by Iyengar's abilities, motivation and independent nature, Brockhouse asked him to stay longer at Chalk River's expense. However, Iyengar had different plans. He explained to Brockhouse that he had obligations to his institution, his parents and siblings in India. While at Chalk River, Bhabha had provided for his living expenses there and salary in India. He had impressed upon the team members that it was they who had to establish new science and technology in the Atomic Energy Establishment Trombay (now BARC). Therefore, for Iyengar it was a duty and an obligation to stand up to the expectations reposed in him. Brockhouse appreciated his deep commitment to India and Iyengar returned home in March 1958.

Iyengar was full of confidence and ideas about starting a full-fledged neutron scattering programme at Trombay. He was encouraged and supported by Raja Ramanna in this. Satya Murthy and I joined Iyengar in August 1958. An automatic neutron diffractometer, a major piece of equipment, was the first to be built and installed at Apsara in less than two years. This was soon followed by an inelastic scattering spectrometer. Measurements on the magnetic structure of an alloy of iron and tin, and lattice vibrations in iron crystal were the first to be reported in less than three years from the start. In parallel, more instruments were built for using neutrons from the Cirus reactor. When Cirus produced its first neutrons, spectrometers from Apsara were shifted there and some new ones were installed and ready for experiments; inelastic scattering measurements on magnesium and ammonium chloride were reported in 1962 at an international meeting at Chalk River. By 1962, the Trombay group for studying condensed matter with neutrons had more than a dozen scientists and technical personnel.

In recognition of this growth and scientific output of the BARC group, the International Atomic Energy Agency (IAEA) accepted India's invitation to hold the next international meeting on inelastic scattering of neutrons by solids in the winter of 1964 at Bombay; by the time of the meeting several new instruments, including a window-filter spectrometer and a multi-arm spectrometer which had interesting innovative features introduced by Iyengar, were in place. From then on, Iyengar and his group contributed extensively to measurements of lattice vibrations and other inelastic scattering studies in several materials. In the area of magnetism the contributions included studies of antiferromagnetic alloys and dynamics of magnetic spins by neutron scattering. The group was well established and many of Iyengar's colleagues were recognized in their own right as leading workers in the field. Meanwhile, Iyengar got a Ph D and also the Bhatnagar Award. He expanded his area of investigations in the late sixties to studies of magnetic alloys and spin relaxation in ferrites using the Mössbauer effect; this led to some innovations in instrumentation and a number of publications. Had the Trombay group depended on importing instruments, it would have been nowhere near to being as competitive as it became later.

Following the 1964 IAEA meeting, a programme for introducing neutron scattering at nuclear reactors in the South East Asian countries was initiated by IAEA at the suggestion of Ramanna and Iyengar. India initially built a neutron diffractometer for the Philippines and a number of physicists from the Philippines, South Korea, Thailand, Indonesia and Taiwan were trained. Some of them visited BARC for further advanced training. Under the Regional Cooperation Agreement (RCA) of IAEA, BARC supplied spectrometers to most of these countries and neutronic study of condensed matter was started. This RCA became a template for other regional collaboration programmes of IAEA. This initiative substantially contributed to establishing the field of neutron scattering for the study of condensed matter in South East Asia.

The next phase in Iyengar's scientific career was concerned with the development of the country's first fast reactor assembly, PURNIMA 1 (Plutonium Reactor for Neutron Investigations in Multiplying Assemblies).

Internationally, the sixties saw the development of pulsed neutron sources with a view to using them for neutron scattering experiments; USSR had built a pulsed fast reactor in the early sixties and Italy was contemplating one; accelerator-based photo-neutron and spallation sources were also being developed. A team of scientists under Iyengar, who was by then Head, Nuclear Physics Division, BARC, was sent to Italy and USSR in 1967 to learn about their programmes. It was felt that a pulsed fast reactor could be a possibility for installation at the then proposed reactor research centre for fast reactors at Kalpakkam. However, there was no experience in building fast reactor systems and it was therefore decided to set up a critical facility (a small reactor which produces no power) for neutronic experiments at BARC. This would provide valuable experience for handling fast-neutron prompt critical assemblies, which incidentally are also relevant in connection with nuclear explosive systems. This was obviously one of the considerations, as the following events would prove. With Ramanna guiding the overall physics programme at BARC, Iyengar spearheaded the programme to design and build PURNIMA 1, which became critical on 18 May 1972.

Around this time, India's interest in a Peaceful Nuclear Experiment (PNE) for leaching of copper ores was presented at a meeting at IAEA in Vienna. Ramanna was clearly building up the preparedness for a nuclear device. When the time came and the then Prime Minister, Indira Gandhi gave permission to go ahead with the project towards the end of 1972, Ramanna chose Iyengar as the leader of the team to oversee and guide the PNE project. The PNE was conducted successfully on 18 May 1974, about 20 months after the permission was granted. The PNE was, as Iyengar put it, 'the most exhilerating experience of my career … This involved building up a group, inculcating a spirit of cooperation and jointly achieving results'. Following this he was awarded the Padma Bhushan by the Government of India.

When Ramanna took over as Director of BARC in 1972, the mantle of Directorship of the Physics Group was handed over to Iyengar. From 1972 to 1983, he was given expanding responsibilities of Groups other than Physics in BARC, culminating in the Directorship of BARC in 1984. Iyengar became the Chairman of AEC in 1990 for a three-year term. Naturally, his administrative responsibilities and scope of work continually expanded during this period. Iyengar played an important leadership role in planning for new accelerators at VECC (Kolkata), RRCAT (Indore) and TIFR. Realizing that exposure to the world's best facilities is necessary for our scientists, Iyengar established collaborative programmes with laboratories like CERN – Geneva, Fermilab – Chicago and Rutherford Appleton Laboratory – UK. These collaborations not only allowed our scientists access to the laboratories, but provided us opportunities to develop frontline technologies, which in turn substantially contributed to our own programmes. It is this foresight that Iyengar brought to bear on all programmes which were undertaken at BARC, be they in physical sciences, biological sciences, or engineering and technology. And in matters of importance to BARC like, for example, the commissioning of Dhruva, he would get involved personally and lead from the front. I also remember his unstinted support and encouragement to the superconductivity programme after the discovery of high-temperature superconductors in the late seventies. However, his support was not confined to generating some research papers alone, but to the overall development of both science and technology emerging out of the effort.

Another programme which Iyengar supported strongly in the late eighties, and was personally involved in, was that of cold fusion, which now goes under the name of condensed matter nuclear science. A controversial area of research at any time, his involvement, in my view, was basically because of his strong belief in experimental science, in the power of observation as against over-dependence on existing theories to predict 'all' phenomena.

Many developmental programmes were undertaken in BARC when Iyengar was the Director and in the Department of Atomic Energy when he was the Chairman of AEC. In his decision-making during these phases he would, characteristically, not allow nibbling procedural issues to come in the way of important scientific and technological progress.

Iyengar retired in 1993 but continued to be a member of AEC for the next five years. After retirement, he was Advisor to Kerala Government's Department of Science and Technology between 1993 and 1997. During this period he established the Rajiv Gandhi Institute at Thiruvananthapuram. He took a keen interest in rural science education through his involvement, as a Trustee, in the NGO, Agastya Foundation, whose nerve centre is in a rural area in Chittoor District, Andhra Pradesh.

This obituary would be incomplete if I do not mention Iyengar's disagreement with some aspects of the Indo-US nuclear deal. This, I think, was a result of his strong belief, born out of a long experience of working in a regime of sanctions from nuclear powers, that the deal would come in the way of India pursuing independent basic research and technical development in cutting-edge areas related to atomic energy and that the country would be that much poorer for it.

The perception and understanding that basic science and technology are two sides of a coin, the 'Ardhanarishwara' of modern civilization, was fully integrated in the persona of Iyengar, and his career was a balance between the two.

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