



Space Life and Matter: The Coming of Age of Indian Science. Hari Pulakkat. Hachette Book Publishing India Pvt Ltd, 4th/5th Floors, Corporate Centre, Plot No. 94, Sector 44, Gurugram 122 003. 2021. xxii + 314 pages. Price: Rs 699.

This is an absorbing book by Hari Pulakkat on the history of science and its growth in India post-independence. There have been many outstanding individual Indian scientists who have achieved worldwide recognition prior to independence under British India. C. V. Raman, the Nobel laureate; S. N. Bose famously known for the Bose–Einstein statistics, who many believe missed the Nobel Prize for reasons unknown; the famous J. C. Bose who proved that plants are like any other life form, P. C. Ray; S. Ramanujam – the great mathematician; S. Chandrasekhar, the Nobel laureate and Meghnad Saha to name a few. While these great scientists excelled in the pursuit of science, the colonial period did not facilitate building of great institutions of science and technology (S&T) in the country. Of course, there was the Indian Institute of Science (IISc) set up in 1909 and a few acclaimed universities. Post-independence, it was imperative for the country to build institutions for the growth of S&T and to develop scientific temper. Many aspiring, young, bright Indians, some of whom had studied entirely in the country and some others who were carrying out frontline research abroad, were keen to contribute to the development of independent India. In some respects, the Second World War had also forced some of them to return. Homi Bhabha and Vikram Sarabhai, both from rich and aristocratic families, studying in the United Kingdom returned to India as the Second World War

began. The political establishment which had taken the reigns of the country had realized that national development can only be achieved through the application of S&T, and was keen to harness the talent within the country and fulfil the aspirations of those returning from abroad. Setting up of the Tata Institute of Fundamental Research (TIFR), Physical Research Laboratory (PRL), Indian Institutes of Technology, many laboratories under the Council of Scientific and Industrial Research, and the University Department of Chemical Technology (UDCT), Bombay, provided the much required fillip. This book narrates these developments in a captivating manner through the lives of individual personalities, institutions they had built and nurtured, their struggles as well as scientific achievements. The book addresses three important areas covering space, materials sciences (matter) and biology/biotechnology (life), as the title suggests. It comprises 15 chapters; six covering space, another six on matter and three on life, including three epilogues and a prologue in the beginning.

The first six chapters are devoted to the exciting happenings in the field of cosmic rays, radio astronomy and astrophysics, indigenous development of satellites to observe X-rays, and a multi-wavelength observatory called ASTROSAT. Each of these is an absorbing and fascinating story of great and passionate individuals who not only formulated scientifically important programmes, but developed and established necessary technical and scientific infrastructure, built groups of equally passionate bright young scientists and engineers around them and brought India to the forefront in selected areas of scientific research. B. V. Sreekantan, a bright, hard-working and committed physicist from a small place near Mysore symbolizes this generation of scientists and institution-builders. Under the guidance of Bhabha, he began experiments to study cosmic rays and their interaction in the deep mines of Kolar Gold Field. Carrying out research, contemporary to the international scenario by building instruments indigenously with shoe-string budgets at great personal hardships, training a number of younger researchers and being second to none marked his career. Govind Swarup is synonymous with radio astronomy and its growth in India. His journey from Stanford University, USA to TIFR, at the invitation of Bhabha, his passion to build a contemporary radio telescope on the foothills of Ooty to answer some of the basic questions on the origin

and evolution of the universe subsequent to the big bang is inspiring. The way Swarup worked under resource constraints and technology limitations has been vividly brought out. Subsequent development of the giant metre wave radio telescope at Narayangaon near Pune under his visionary leadership speaks volumes about his passion, and commitment to excel and be on par internationally. Today, if India is counted among the few nations carrying out unique observations, having a large pool of radio astronomers, it is entirely due to the efforts of Swarup. While describing the evolution of radio astronomy in India, Pulakkat vividly and in simple language explains various concepts on the origin of the universe, the big bang theory, different stellar objects and their origin and the phenomenon of emitting electromagnetic radiation at different wavelengths, and how the radio telescopes built were able to answer some of the fundamental questions.

Seeds for space technology development activities were sown by Vikram Sarabhai in Ahmedabad and Thiruvananthapuram. While activities in Ahmedabad focused on space sciences at PRL, satellite communication, remote sensing and meteorology, and relevant technology development took place at another campus (later christened as the Space Applications Centre (SAC), Indian Space Research Organization (ISRO), Ahmedabad). The development of sounding rockets started at Thiruvananthapuram. A small unit headed by U. R. Rao, who had just returned after his postdoctoral studies in the US began developing satellite sub-systems there. While activities in Thiruvananthapuram have now blossomed into full-fledged development of solid-stage motors, earth-storable liquid engines, cryogenic engines, and launch vehicles, SAC has excelled in the development of state-of-the-art communication, remote sensing, navigation, science payloads and associated data processing, and a gamut of space applications as envisaged by Sarabhai and later nourished by Yash Pal. Considering that Bengaluru is a more suitable place for indigenous development of satellites, U. R. Rao moved to the city for establishing infrastructure facilities for this task. He came from a modest background and faced many hardships in his early years of education. He obtained his postgraduate degree in physics from the Banaras Hindu University, Varanasi and did his Ph.D. under Sarabhai. Rao set up laboratories to build different satellite sub-systems in some primitive industrial sheds in Peenya, Bengaluru. These

efforts have led to the development of very advanced earth observation, satellite communication, global navigation satellite systems as well as satellites for planetary missions and the Sun. Pulakkat brings out various aspects of Rao's early life, difficulties, his perseverance and remarkable foresight and vision for the space programme as well as his accomplishments. U. R. Rao was active in his post-retirement years too. It was his idea to build a satellite (Aditya) to study the Sun's corona, and to put a satellite at the Lagrange point between the earth and the Sun for constant surveillance. It is unfortunate he did not live to see the realization of these missions. Pulakkat has woven a fascinating life story of the man, how and what he created under trying circumstances and his accomplishments over a period of time till his passing away. Pulakkat has also in his inimitable style described tellingly the different management styles of Bhabha and Sarabhai on the one side, and Satish Dhawan and U. R. Rao on the other.

The next six chapters address developments in materials science, chemistry and chemical engineering. Story of the life of C. N. R. Rao over the years coinciding with the rise in the quality and quantum of research in solid state chemistry has been presented, quoting many personal anecdotes in the life of C. N. R. Rao and his many distinguished students. C. N. R. Rao after obtaining his Ph.D. from Purdue University, USA returned to Bengaluru and joined the Chemistry Department at IISc. Rao in addition to being a brilliant scientist, was aggressive and ambitious. He energized research work in the area of structural chemistry, and built a strong group of doctoral students. He was also a voracious publisher of research papers,

about 1600 to his credit as of the writing of this book. He also founded another institution in Bengaluru, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNSASR). Pulakkat adds, 'using his influence and stature, and by lobbying relentlessly over decades, he managed to raise the profile of science and increase funding available for all scientists in India'. Contributions of many distinguished scientists, including M. M. Sharma and R. A. Mashelkar in different areas of chemical engineering, and how they strived towards bringing the fruits of research into industrial products and their marketing are vividly described. How development of methods to reduce wastage at the tanning stage and to treat the waste effluents helped the leather industry is another topic that has been covered in the book.

The last three chapters are devoted to developments in the area of molecular biology/biophysics and genomics. G. N. Ramachandran, a student of Raman was a physicist by qualification, but his interest in structural biology/structure of biomolecules led to the establishment of the Molecular Biophysics Unit at IISc. His work on deducing the triple helical structure for collagen is considered exemplary. Ramachandran's work on phi-psi plots is used to deduce the structure of a large number of protein molecules the world over. As an exceptionally bright scientist, he had his own idiosyncrasies. Pulakkat has given almost a ring-side view of the life of Ramachandran and also the work of his illustrious students. How a molecular biology unit led by Obaid Siddiqi came up in an institute like TIFR meant for nuclear science and mathematics, and details of the advanced research in different aspects of molecular biology are provided in the next

chapter. It also describes the setting up of the National Centre for Biological Sciences at Bengaluru as part of the parent institute TIFR and remarkably important research of international recognition carried out there. Setting up a centre for genomics is the topic of the last chapter.

To me personally, reading this fascinating book has been exhilarating and purely nostalgic. I had the privilege of interacting (however briefly) with Sreekantan and Swarup during my graduate studies at the TIFR in the early seventies, and more closely working under the mentorship of U. R. Rao in ISRO. The book is written in a story-telling fashion in a simple language. Most complex concepts of astrophysics, stellar objects and how they radiate, satellites, radio telescopes, chemistry, materials science, chemical engineering, structural and molecular biology have been explained in a language understood by people who are not necessarily professional scientists. Personal lives of scientists, their background, their passion for science and commitment to work for India have been explained in a telling fashion. It is an outstanding account of the history of science and its growth in independent India. Obviously, there are many other areas of S&T which need to be told in a similar fashion. That perhaps is the material for another book. This book is a must for libraries of all colleges and universities in the country.

RANGANATH R. NAVALGUND

*Dahlia 201,
Esteem Gardenia Apartments,
Sahakarnagar,
Bengaluru 560 092, India
e-mail: navalrr@gmail.com*