Ranjan Roy Daniel (1923–2005)

The country lost a dedicated and hard-working scientist, Ranjan Roy Daniel, on 27 March 2005 following prolonged illness. After a successful scientific career at the Tata Institute of Fundamental Research (TIFR), Mumbai, Daniel had initiated and managed many scientific projects in the country, bringing scientists from different areas and different government departments, to work together to achieve common scientific goals. His involvement in international organizations brought credit to his endeavour and to the nation for promoting science in developing countries. Health problems came in the way of his dedication to science; he retired from active service in 1995 and came to Nagercoil, his hometown, where he spent the rest of his life encouraging science and technology education.

Daniel was born in Nagercoil in Kanyakumari district, Tamil Nadu, as the third child of five in the family, to Masilamani Arumanayagam Daniel and Theresa Chellammal Daniel on 11 August 1923. His father was a teacher in the erstwhile Travancore Government Service, while his mother was a housewife. His entire schooling from 1928 to 1939 was in the Scott Christian High School, Nagercoil and to quote Daniel 'I had a carefree life in all respects in this small town'. After passing the Intermediate exam in 1941 from the Scott Christian College, Daniel studied at the Loyola College, Madras and obtained his B Sc degree from the University of Madras in 1943. He then worked as a physics demonstrator in the Scott Christian College for a year. Daniel told me that at this crucial juncture in his life, his classmate at Loyola College, D. Venkatesan informed him of the opportunity to join Banares Hindu University (BHU), Varanasi and persuaded Daniel to seek admission in BHU. Thus, Daniel went to Banares, took his M Sc degree in physics from BHU with wireless as special subject in 1946, and worked as a temporary lecturer for a year. He was always grateful to Venkatesan (who was also a cosmic ray physicist at the University of Calgary, Canada until his death), for influencing his career.

Daniel's research career started when he joined TIFR in 1947 as a research assistant. He worked on meson scattering and charge particle interactions in nuclear emulsions under the guidance of Homi J. Bhabha. A year after he joined the Institute, he married Serena Padmini Samuel. The Government of India sponsored him for higher studies at the University of Bristol, United Kingdom in 1951, where he carried out research in the H. H. Wills Physics Laboratory, headed by the Nobel

Laureate C. F. Powell, using nuclear emulsions exposed to cosmic rays at high altitudes. Daniel obtained his Ph D degree in April 1953 under D. H. Perkins. He returned to TIFR in the same year and concentrated on the study of the production of heavy mesons in nuclear interactions at high energies. The study of the nuclear scattering of K-mesons was used to test the concept of the conservation of strangeness in strong interactions. He was also involved in the study of high-energy interactions using accelerator particles.

When the discovery of fundamental particles and the study of their properties using cosmic rays were taken over by accelerator experiments with controlled beams in the late fifties, the emulsion group at TIFR slowly turned its attention to primary cosmic ray studies. Daniel did not lose any time in taking a lead role in this endeavour with the help of young scientists coming out of the Atomic Energy Training School. His interest in this area varied from high-energy interactions by cosmic rays well beyond the realm of accelerator energies to composition and energy spectra of primary nuclei. The advantage of the geographical location of India, over which cosmic ray particles of rigidity more than 10 GV/c could alone penetrate the earth's magnetic field, was fully made use of by balloon-borne emulsion detectors to study high-energy primary cosmic rays. Daniel measured fragmentation cross-sections of high-energy heavy nuclei and undertook a study of the transformation in the composition of galactic cosmic radiations due to their interaction with interstellar gas during propagation in the galaxy. His participation in the international collaboration to study nuclear interactions at 'jet' energies using ICEF emulsion stack exposed to cosmic rays, as the leader of the group working at TIFR, yielded interesting results.

The first attempt to measure the energy spectrum of high-energy cosmic ray electron component was started in 1961, using a hyper-sensitized nuclear emulsion stack exposed over Hyderabad; but the emulsions could not be processed properly. Successful processing was achieved in the next attempt made in 1963, when an identical stack was oriented in the east-west direction during the balloon flight. Search for electrons was undertaken by Daniel along with a few senior members of the emulsion group for a year, but this yielded no results and his colleagues abandoned the search. He did not take this disappointment to heart, but decided to continue the search alone, patiently and with hope. In April 1964, he described to me in detail the attempts made till then and asked me whether I had any new idea regarding this. This surprised me as I had joined the Institute in August 1961 and the only experience I had was working with a large emulsion-tungsten sandwiched stack, a collaboration between TIFR and the University of Bristol, for very high energy interactions and gamma rays using electromagnetic cascades produced by them, but was well versed with the first high speed computer in India at TIFR. I suggested to scan for possible electron pairs between one radiation and one conversion length from the top of the emulsion stack, so that while tracing to its origin one should find the electron track nearby, if the pair is the cascade product of the primary electron. The next day he came to me with several questions, but I had by then a set of calculated number of the photons radiated by the electrons and of the number materialized between the suggested distances us-

ing electromagnetic theory. He was convinced only after a lengthy discussion and told me that he would scan at one conversion length from the top of the emulsion, and I then left for my vacation. When he got two electrons in the next week, he wrote me a letter with excitement that he would wait for me to return to continue the work. Thus started my close relationship with him in research.

While carrying out this experiment with the help of only one assistant, two questions arose for the first time in the emulsion technique. What is the detection probability of an electron for the criteria adopted in the search and how does it vary with energy? Further, how does one overcome the effect of spurious scattering while determining the energy? These questions were answered by the results of extensive theoretical calculations carried out by me. Though Daniel was convinced, as a true experimentalist, he was satisfied only after these results were verified using emulsion stacks exposed to accelerator energies. He supported me in all the theoretical work I initiated and carried out in relation to astrophysical aspects of cosmic ray electrons. We published many papers relating to cosmic ray confinement, relationship with the universal blackbody radiation, galactic radio background and magnetic field distributions and galactic halo; K. C. Anand was also a partner in some of these publications. The electron era in the Institute came to an end in 1973, when it was found that we could not maintain the same momentum using the same technique. While I was at the NASA Johnson Space Flight Center as senior research associate of the National Research Council from 1974 to 1977, Daniel joined our group as NRC senior research associate in 1976 for a year. My close collaboration with him resulted in three large review articles published together and I was a co-author in more than one-third of his published papers in refereed journals and international conference proceedings.

While he was deeply involved in cosmic ray electrons, Daniel also undertook a research programme to look for energetic neutrons from the sun. The same detector was used to study energetic neutrons and low energy gamma rays in the atmosphere, and upper limits on cosmic gamma ray flux were obtained. When he took over the responsibility of the Dean of the Physics Faculty in 1970, his direct involvement in research became less due to his administrative responsibilities. Seeing the end to cosmic ray research using nuclear emulsions, he decided to promote the idea envisaged by many in the cosmic ray group to look into the relatively unexplored area of far-infrared astronomy. It was a Herculean task, as cryogenic technology at liquid helium temperatures was not available in the country and the technique to maintain a stable platform to keep a large telescope pointing to directions as preplanned needed careful innovations. Further, it was not easy to get enough foreign exchange to import the basic components and detector elements to leap forward in this area of research. It took a decade for a few dedicated scientists to breathe a sigh of relief in getting the infrared telescope operational, in spite of the frustration for not being able to publish papers over this period. However, the telescope was lost during the first flight, shattering their hope. Daniel gave support and stood by the scientists, when an attempt was made to abandon this project. He convinced the Institute to provide the required funds to make a better telescope. Many papers were published using this new telescope.

Daniel was now involved in many national projects and had a successful career as a major scientific figure in India. As the Chairman of the Advisory Committee for Space Science of ISRO, he provided the leadership for a number of projects. Scientists from universities and national laboratories participated in these projects and the projects were funded by various ministries of the Government of India by government agencies. To achieve success in such multi-agency projects is not an easy task; it requires excellent judgment in choosing the project, diplomatic skills and commitment. Daniel also persuaded and encouraged scientists to carry out scientific experiments using Indian satellites to promote a sense of national achievement in spite of the low success rate for such initial ventures, which may not lead to exciting results.

After his retirement from TIFR as a Senior Professor in August 1988, Daniel was appointed as Scientific Secretary of the Committee on Science and Technology in Developing Countries (COSTED) from 1988 to 1995. He reorganized the International Secretariat of the COSTED in Chennai and initiated new regional and international programmes. During this period, he was also the Emeritus Scientist of CSIR. As a national representative of the Indian National Science Academy (INSA), New Delhi, he represented India in the international arena, in particular, as a member of the COSPAR Bureau, where he showed firm leadership in activities promoting the development of research in developing counties. He was responsible for initiating the process of major revision of the COSPAR Charter. He helped in promoting international cooperation by introducing new modes of support for scientists and organizing symposia as Chairman of the COSPAR Panel on Space Research in Developing Countries and later as Scientific Secretary of the ICSU Committee on Science and Technology in Developing Countries of Asia. He was able to find funds and wisely used them to support participation of scientists from developing countries in international conferences. As Chairman of the National Committee for IGBP, he initiated, organized and coordinated with foresight, an Indian long-term programme related to the Study of Global Change for the International Geosphere Biosphere Programme. This was supported by various government departments and agencies. He edited an innovative book on the concept of biotechnology written by a team of international experts, which was published by Orient Longman Ltd in 1996.

Daniel was awarded the Sir C. V. Raman Award for Experimental Research in 1974 for his outstanding contributions to the study of cosmic rays, particularly high energy electrons. The INSA–Vainu Bappu Memorial Award was presented to him in 1992 for his pioneering contributions in high-energy cosmic ray electrons and his leadership in balloon-borne far-infrared astronomy. In the same year, Padmabushan was conferred on him by the Government of India for his contribution to the welfare of the nation through science and technology. The COSPAR International Cooperation Medal was awarded to Daniel in 1994 for his outstanding contributions in promoting international cooperation towards the development of research in developing countries. He was a Fellow of Indian Academy of Sciences (IAS), Bangalore; INSA; National Academy of Sciences, Allahabad; Maharashtra Academy of Sciences; Third World Academy of Sciences and Corresponding Member of International Academy of Astronautics. He served as a member of the council of both IAS and INSA, and served as Vice President of

the latter. He was the founder member of Indian Physics Association and Astronomical Society of India. He was the founder Chairman of the Bombay Association for Science Education. Daniel also served in various capacities as Member/Chairman/Convener in National Committees and Managing Councils.

After returning to his native town, Daniel was involved in promoting science and technology education in the district level by giving lectures. He wrote newspaper articles on global issues relating to the impact of human action on the environment and its implication for the 21st century. He edited a book on *Concept in Space Science* written by experts in this field, with the limited facility in his hometown. This work was sponsored and funded by ISRO and co-sponsored by COSPAR, TWAS and the UN Office for Outer Space Affairs, and was published by Universities Press (India) Pvt Ltd in 2002. His health slowly failed due to complications connected with prostate cancer treatment and he breathed his last 27 March 2005. Daniel is survived by his wife, four children, and 8 grandchildren.

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