OBITUARY: DEVENDRA LAL (1929–2012)

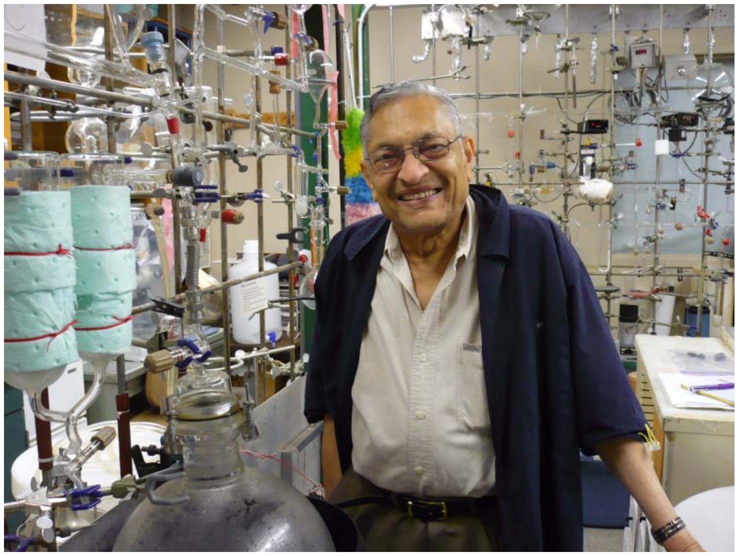

Photo courtesy A J T Jull

Professor Devendra Lal was born on 14 February 1929 in Varanasi (Banaras), India. He was the fifth child in a family of modest means (his father was a postmaster) and was educated at the Banaras Hindu University. He obtained his BSc degree from there in 1947 and a Master's degree in 1949. He then moved to the Tata Institute of Fundamental Research (TIFR), eventually obtaining his PhD from Bombay University in 1960. As a PhD student, he worked with Prof. Bernard Peters at TIFR and he immediately became interested in all aspects of cosmic-ray physics and applications of cosmic-ray effects to materials. He also recognized quickly that it was important to move from physics of cosmic rays to the applications of cosmic rays and their products in geological and oceanographic processes. Although Lal was immersed in these studies, he could not resist courting a charming and gracious young lady, Aruna, who also worked in TIFR, whom he married in 1955. It was typical of Lal that within a week of his marriage he would take his young bride for difficult fieldwork in a Himalayan glacier for cosmogenic ^{10}Be in lakes. Aruna's emotional and intellectual identification with his scientific interests contributed in no small measure to his scientific achievements. Dr. Lal was understandably devastated when his wife passed away in 1993.

His PhD thesis contains work on estimates of cosmic-ray intensity as a function of depth in the atmosphere using the balloon-flight experiments that captured nuclear stars in plastic targets and the effects of this radiation on solid material, and the measurement of cosmogenic nuclides in lakes. These experiments required tons of water in order to count the ^{10}Be and ^{7}Be. The chemical isolation of cosmogenic ^{10}Be from ocean sediments and detection of its extremely weak radioactivity in 1957 was also an important milestone. In the following years, Lal and his students worked hard to isolate and detect many other isotopes of widely different half-lives and chemical affinities sequestered in different chemical reservoirs on Earth, from ^{7}Be, ^{10}Be, ^{33}P, ^{28}Mg, ^{36}Cl, ^{38}S, and ^{32}Si. In a classic and landmark paper in *Handbuch der Physik*, Lal and Peters (1967) worked out the production rates of these isotopes, which was important to their use as probes or tracers of atmospheric, oceanographic, and hydrological processes. This work became the basis for his research on the mechanisms and rates of natural physical and chemical processes on Earth and in the solar system using radionuclides, and formed the basis for cosmogenic-nuclide studies in later work. About this time, he also established a radiocarbon and tritium dating laboratory at TIFR, which was the first in the Indian subcontinent. Throughout his long career, Lal was known for the diversity and creativity of his research interests. He published extensively on cosmic-ray-produced radioisotopes in terrestrial environments, in the atmosphere, in polar ice, in the oceans, as well as in lunar samples and meteorites.

Early in his career, he also started an association with his long-time colleague and mentor, James Arnold, at the Scripps Institution of Oceanography in 1958, which was later incorporated into the newly formed University of California, San Diego (UCSD). Arnold invited him to work with him and Masatake Honda on cosmic-ray-produced radioactivities in meteorites, which resulted in the seminal paper of Honda, Arnold, and Lal (Arnold et al. 1961). From 1972–1983, Lal served as the director of the Physical Research Laboratory (PRL). After retiring from PRL, he spent more time in San Diego and, with Arnold, had a great effect on the study of cosmic-ray effects on terrestrial materials. Lal and Arnold (1985) recognized the potential for great advance in the broad field of cosmogenic nuclides applied to terrestrial processes, since sample sizes had been substantially reduced by the development of accelerator mass spectrometry, which allowed direct measurement of the number of atoms. Many calculations of cosmic-ray effects as a function of altitude in the atmosphere still refer to Lal (1991), which has as its basis his original work with Peters. He also worked on radionuclides as oceanic tracers as part of his work at Scripps, and continued experiments on lunar samples and also developed an interest in ice-core samples.

His wide-ranging work brought him numerous international honors, among them as a Fellow of the Royal Society, Foreign Associate of the US National Academy of Sciences, Fellow of the Indian Academy of Sciences, and the V M Goldschmidt Medal of the Geochemical Society.

To his many friends and colleagues around the world, Lal was best known for his insatiable curiosity, his good humor, and as a caring but demanding teacher. He was fond of asking: “What new idea did you have today?”, often over an Indian dinner. No idea was too big or too outlandish to be considered. He loved to experiment, and if something did not work he would try it another way. He would also devise novel solutions to experimental problems. In one case, in order to solve the problem of keeping 5 kg of ice cold in a large round-bottomed flask to extract cosmogenic ^{14}C from the ice, he procured a plastic Halloween “witch’s cauldron” to put around the container, which was filled with ice and salt. Some of his experiments were on a gigantic scale, such as dating ocean waters by submerging meter-sized frames packed with iron-impregnated sponges or fibers into the deep sea for many hours to extract minute quantities of the natural radioisotope ^{32}Si. Similarly, in 1973, S Biswas and D Lal convinced NASA to place a detector on the outside of the Skylab manned space station, which resulted in direct measurements of the cosmic-ray flux at that location. This experiment required the astronaut to do a “space walk” to install the equipment. He often frustrated his colleagues with his all-consuming passion for science and “big ideas.” All his colleagues can recite numerous “Lal stories” where some apparently very difficult task would be reduced to “why not”?

For a long time, Lal divided his time between Ahmedabad and San Diego, spending most of his time in San Diego after 1983, but always returning to India for at least one month per year. Lal was very influential in India and was the mentor of many Indian scientists. He retained a great affection for his country and was extremely proud when Indian scientists launched a satellite and later when a very successful Indian mission orbited the Moon in 2009, returning some of the highest-resolution pictures yet available.

He continued to work at UCSD until his death on 1 December 2012 at the Scripps Institution.

I am grateful for information from R Weiss, J Goswami, and K Gopalan, who added useful anecdotes and information about Lal's life.

A J Timothy Jull

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