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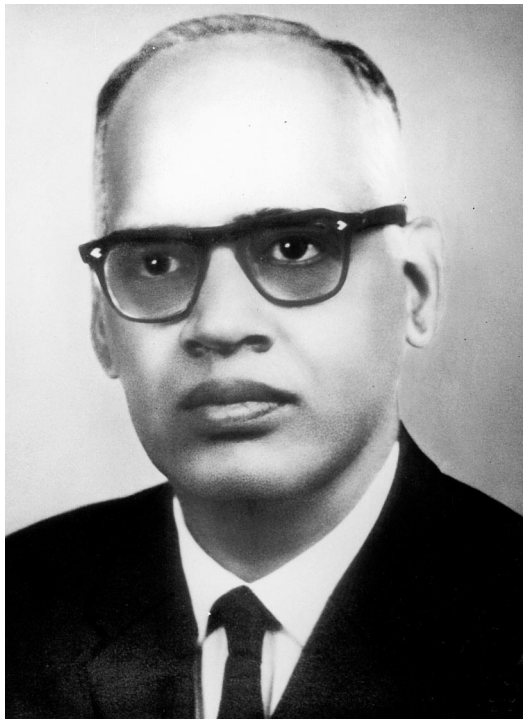
G. N. Ramachandran (1922–2001)



Professor Gopalasamudram Narayana Ramachandran, physicist turned outstanding structural biologist, passed away on 7 April 2001 at Chennai (Madras) at the age of 78.

G. N. Ramachandran was born in Ernakulam, India, on 8 October 1922. After his Bachelor's (Honours) degree in physics, he joined the Department of Physics, Indian Institute of Science, Bangalore, to work with the legendary C. V. Raman. This was to be the beginning of his passionate involvement in the pursuit of science culminating in a large number of pioneering contributions. He earned his Master's degree by research for a study on 'Optics of heterogeneous matter'. Ramachandran worked on a number of problems related to light scattering, optics, crystal perfection and thermo-optic behaviour of solids with Raman, and received his DSc from Madras University. He was the first to record 'X-ray topographs', a method of studying surface features of crystals.

Ramachandran spent two years (1947–1949) at the Cavendish Laboratory in Cambridge, headed by Lawrence Bragg, under the prestigious 1851 Exhibition Scholarship. There he earned a PhD for studies on 'X-ray diffuse scattering and its application to determination of elastic constants' carried out with W. A. Wooster.

Ramachandran returned to India to become Professor and Head of the Department of Physics, University of Madras, in 1952, after a short stint as Assistant Professor at the Department of Physics, Indian Institute of Science, Bangalore. It is here he completely shifted his interest to the application of X-ray diffraction to the study of biomolecules, a subject matter that was predicted by

the then leaders Bragg, Bernal and Astbury to hold great promise for revealing the many facets of life processes. In less than 10 years, Ramachandran transformed the Department of Physics into an internationally renowned centre for biophysics by making several fundamental contributions in quick succession to different aspects of structural biology. He gave a head start to this field when the subject was still nascent and brought India on a par with the elite groups in the UK and USA.

It is part of history that the young Ramachandran along with G. Kartha within a span of two years proposed the triple helical structure for collagen, a protein from extra-cellular matrix, in 1954. This was just a year after the double helical structure for DNA by Watson and Crick was propounded and a couple of years after the discovery of the α-helix by Pauling. Ramachandran thus joined the big league of structural biologists when he was hardly 32. It is a mark of genius and profound insight that he could extract the correct structure of collagen, the most complex material at that period, from a fibre pattern with a handful of X-ray reflections. It is amazing that his first venture into structural biology, unaided by the benefit of any previous history or experience, was so quickly successful. This was unlike the other discoveries at that time when the groups concerned had the enormous advantage of past experience.

Ramachandran single-handedly set up an extremely active school, working simultaneously in several disciplines that included construction of analogue computers, theoretical physics, theoretical crystallography and biomolecular structure determination. His strong background in physics and mathematics enabled him to venture into varied disciplines. Apparently, his Professor (of mathematics) father trained him in mathematics.

Stung by undue criticism on a non-issue about his collagen structure, Ramachandran went on to enunciate the fundamental stereochemical principles for conformational analysis of proteins through the famous Ramachandran plot. By this he chartered a new course, influencing hundreds of investigators throughout the world and leading to an explosive growth of activity in this area. His group quickly demonstrated the applicability of these principles in polysaccharides and nucleic acids as well. The Ramachandran plot contains many new insights relating to protein folding and design for a diligent researcher even today. Pauling is said to have remarked during his visit to Madras that these two pre-eminent contributions should rightfully have originated from his school. There could be no better tribute than this. The review Ramachandran wrote with Sasisekharan in *Advances in Protein Chemistry* at the instance of John Edsall was a landmark in the field and inspired generations of researchers.

Ramachandran became a distinguished leader and brought together a large number of pioneers from various parts of the world, including Lawrence Bragg, Linus Pauling, Dorothy Hodgkin, Stanford Moore, Severo Ochoa, Maurice Wilkins, Paul Flory, Ephraim Katchalski, David Phillips, Elkan Blout, John Edsall, John Schellman and Harold Scheraga, who visited the young Madras School of Biophysics during the international meetings he organized in 1963 and 1967.

Ramachandran was a crystallographer *par excellence*. Tackling the phase problem through anomalous dispersion, development of a novel Fourier method for structural analysis and statistical studies of a pair of structure factors of related structures were his most notable contributions. In fact, as early as 1965, he pointed out the possibility of single-wavelength anomalous scattering for the structure solution of proteins. The book *Fourier Methods in Crystallography* he wrote with R. Srinivasan was highly acclaimed. He was the originator of National

Seminars in Crystallography that were held regularly at his centre for several years before the venue was shifted to other places.

Another notable contribution from Ramachandran was in relation to three-dimensional image reconstruction which had implications in the development of imaging tools.

Ramachandran left Madras University during 1970 to establish another school of biophysics at the Indian Institute of Science, Bangalore. This centre, true to the high ideals of its founder, is blossoming as an active and vibrant school in structural biology.

Ramachandran received many honors from India and abroad. He was elected Fellow of the Royal Society in 1977. More recently, in 1999, he was awarded the Ewald Prize by the International Union of Crystallography. It was quite unusual that these honors came to Ramachandran late in his life, long after he had made his contributions.

Ramachandran, who was referred to as GNR by his students and colleagues out of admiration, affection and respect, rarely discussed anything but science. He was a lover of classical music and followed the game of cricket. Apparently, he enjoyed playing it, when young, as a fast bowler, naturally. Ramachandran derived enormous support and strength throughout his scientific career from his gentle wife Mrs Rajalakshmi. Her death in 1998 further affected his health. Ramachandran leaves behind two sons and a daughter, all hold doctorate degrees and are engaged in academic pursuits. He was a humane person with a tender heart and donated liberally to the cause of the less privileged.

During his last days, Ramachandran was happy to come back to Madras and it must have been a great solace for him to stay close to the laboratory where he rose to the pinnacle of his scientific achievements.

Ramachandran leaves behind a huge scientific legacy and his outstanding intellectual achievements are bound to serve as a tremendous source of inspiration for all future biophysicists. He was undoubtedly one of the pre-eminent scientists of independent India and his name is immortalized in the 'Ramachandran plot' and 'Ramachandran triple helix'.

I had the privilege and good fortune of graduating from Ramachandran's Madras school and interacting with him scientifically over the years.

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