INTRODUCTION

Professor Kalpathi Ramakrishna Ramanathan was born in Kalpathi, Palghat, on 28 February 1893. He had his early education in the Government Victoria College, Palghat and the Presidency College, Madras, from where he took his Bachelor's and Master's degrees in Physics. Professor Stephenson of the Maharajah's College of Science, Trivandrum who was his examiner was so impressed with young Ramanathan that he immediately offered him the post of demonstrator in his Department. During the seven years he worked in Trivandrum he also served as Honorary Director of the Trivandrum Observatory. His first scientific paper was on Thunderstorms in Trivandrum, published during this period. He was to return to meteorology many years later.

He joined Professor C.V. Raman as a University of Madras research scholar towards the end of the year 1921, and collaborated with him in the studies of the molecular scattering of light then in progress in Professor Raman's laboratory in Calcutta. He published ten papers on molecular scattering of light and X-ray diffraction in liquids, gases and mixtures within a period of less than one year and was awarded the D.Sc. degree of the University of Madras for this work.

Domestic responsibilities forced him in 1922 to take up a teaching appointment at Rangoon. Even so, he continued to visit Calcutta during the vacations, and collaborate in the work going on in Professor Raman's laboratory. Three years later he resigned his lecturership at Rangoon to take up the position of Meteorologist in the India Meteorological Department. He retired from the India Meteorological Department in February 1948, on attaining the age of 55 years and soon after joined the Physical Research Laboratory, Ahmedabad as Professor of Atmospheric Physics and its first Director. He retired from the Directorship in 1966, but is still continuing as an Emeritus Professor.

Professor Ramanathan's work in light scattering is well known. During the year he spent at Calcutta, he carried out a series of studies in collaboration with Professor Raman on the intensity and depolarization of light scattered by substances like ether, benzene and carbon dioxide as they passed from the liquid to the gaseous state through their critical temperatures. In addition to these investigations, Raman and Ramanathan also began studies on the role of concentrations of components in light scattering by liquid mixtures and extended their ideas of the fluctuation theory to the understanding of X-ray diffraction by liquids.

It was during his visits to Calcutta on his vacations from Rangoon, that he began work on an intensive examination of the molecular diffraction of light by water. He detected a "weak fluorescence" in the scattered beam, and attributed it to impurities in the liquid. Raman, who was not satisfied with this explanation, felt it was a characteristic of the substance, and his investigations of this "feeble fluorescence"during the next few years led to the discovery of the Raman Effect in 1928.

Professor Ramanathan's research work in the India Meteorological Department covered a wide range of subjects, in each of which he has made basic contributions. Solar and atmospheric radiation, the spectrum of the night sky, meteorological optics and acoustics, terrestrial magnetism, seismology, studies of the Indian monsoon and of storms, depressions and cyclones in the Indian seas, and the general circulation of the atmosphere over India and its neighbourhood were all of equal interest to him. His principal preoccupation, however, was the study of the thermal structure and movements of the upper air, and it is in this field that his contributions are outstanding. He organized the first upper air soundings over India from Agra

using Dines meteorographs and high altitude balloons, and was the first to publish the now famous diagram showing the distribution of upper air temperatures over the world up to 25 km in sumer and winter. It incorporated the valuable sounding-balloon data obtained at a number of stations in India, and a few stations in other parts of the world. This diagram showed clearly the cold and high tropopause over the tropics, and the marked inversion above the tropical tropopause. It also revealed that the coldest air in the atmosphere occurs above the equator, and not the poles. In spite of the immense amount of data gathered since on the upper atmosphere, Ramanathan's diagram still retains its premier place.

Professor Ramanathan established the new Upper Air Division at Poona in 1928, and during the next few years together with his colleagues and research students, he carried out here a comprehensive study of the upper atmosphere over India and its neighbourhood, and also undertook a systematic analysis of the upper winds. His Memoir on the general circulation of the atmosphere over India and its neighbourhood was the first clear and comprehensive study of the subject and is still considered a standard work of reference on the subject.

Prof. Ramanathan's research work at the Physical Research Laboratory was mainly concerned with studies of atmospheric ozone, night airglow, ionospheric and space physics, and solar and galactic influences on the ionosphere. He established the network of Dobson ozone spectrophotometer stations in India, and with his collaborators took the first measurements of the vertical distribution of ozone in the atmosphere over India. With Dave, he evolved and extended the use and development of the Götz Umkehr method of finding the vertical distribution of ozone in the atmosphere.

His major contributions in the study of atmospheric ozone are on the extremely important relationship between atmospheric ozone and the general circulation of the atmosphere, which he announced during his Presidential address to the International Association of Meteorology at Rome, in 1954. The attention attracted by this address led to the establishment of a large number of ozone measuring stations in the world during the International Geophysical Year, and theoretical studies of the behaviour and transport of ozone in the upper atmosphere.

Another important breakthrough in the study of the geographical distribution of ozone was his work on the dependence of ozone distribution on meteorological phenomena such as jet streams and their location, tropopause discontinuities and inter-latitudinal air exchange.

His third major contribution was the discovery of the quasi-biennial oscillation of total ozone in the tropics associated with the 26-month oscillation in stratospheric winds and temperatures, which he announced in his Presidential address at the International Ozone Symposium at Albuquerque in 1964. He also pointed out that the variations in the northern and southern hemispheres are in opposite phases.

Professor Ramanathan has been deeply interested in twilight and airglow studies since 1930. The first airglow spectrum at low latitudes was taken by him in Poona in 1930. This work, continued by him and his students at Poona and later Ahmedabad, Mount Abu, Gulmarg and Srinagar, established the nocturnal and seasonal variations of the green and red lines of oxygen and the effect of solar flares on the green emissions. One of the major contributions, again with Dave, was the estimation of the contribution of secondary and higher order scattering in twilight.

Of importance are also the contributions made by Professor Ramanathan and his students to ionospheric and space studies during the last 30 years, such as the effect of electron-ion collisions in the F-region of the ionosphere on the absorption of cosmic radio noise, and the

effect on the lower ionosphere of X-rays from discrete galactic sources. He considered, long before any one else, the ionosphere as another region where circulation systems similar to those in the lower atmosphere were bound to exist.

He also took an active part in space research both in India and abroad. The successful implementation of the Indian and global meteorological rocket network and the synoptic exploration of the dynamic structure of the upper atmosphere were in large measure due to Professor Ramanathan's support. Of even greater importance in the long term is the interest and support Professor Ramanathan provided for the studies of the interaction between the neutral and electrical atmospheres. His recognition of the thread of unity, which is a principal characteristic of space age atmospheric physics, is possibly the greatest contribution to be attributed to Professor Ramanathan.

Professor Ramanathan has during the last four decades held many distinguished national and international positions connected with research in meteorology and atmospheric physics, hydrology and oceanography and ionospheric and space physics. He was elected President of the International Association of Meteorology in 1954, President of the International Union of Geodesy and Geophysics in 1957, and President of the International Ozone Commission for three terms from 1961–1967.

As President of IAMAP, IOC and IUGG he effectively promoted international co-operation in research in meteorology and atmospheric physics, geophysics and oceanography, hydrology and aeronomy, and the organization of various international observational programmes such as the International Geophysical Year, the International Geophysical Cooperation, the International Years of the Quiet Sun, the International Indian Ocean Expedition, the International Hydrological Decade, and Monex. He played a crucial role in the establishment of the International Meteorological Centre at Bombay during the IIOE, and the formation of the Indian Institute of Tropical Meteorology thereafter.

As a recognition of Professor Ramanathan's contributions to scientific knowledge and his leadership in research, the World Meteorological Organisation awarded him the International Meteorological Organisation Prize in 1961. The Royal Meteorological Society elected him an Honorary Fellow in 1960. The Indian National Science Academy awarded him the Aryabhata medal. He was honoured by the President of India with the award of the Padma Bhushan in 1965 and the Padma Vibhushan in 1975 for his services to science and the country.

Professor Ramanathan is a Founder Fellow of the Indian Academy of Sciences, and served continuously for fifteen years as a member of its Council. The Academy commemorated his sixtieth birthday by publishing a special issue in 1953. Thirty years later, this volume is also being published by the Academy as a tribute to a great scientist, who by his energy and enthusiasm for research inspired many generations of students, and who has had an enduring influence on the growth and development of several scientific fields during the last seven decades, both in this country and abroad.

Anna Mani