Dr. A. K. Das, D. Sc., F. R. A. S., F. N. I.

Dr. Anil Kumar Das, who retired in April 1960 as Deputy Director General in charge of the Astrophysical Observatory, Kodaikanal and took up the post of Director, Nizamiah Observatory and Professor of Astronomy, Osmania University in 1960, passed away on 18 February 1961 at Hyderabad after a heart attack. He had a distinguished service of thirty years with the India Meteorological Department, of which 14 years were spent in the Kodaikanal Observatory.

Das was born on 1 February 1902 at Chinsura, Hooghly, West Bengal. He had his school and college education in Bengal and passed the M.Sc. degree examination from the Presidency College, Calcutta in 1924 obtaining the first position in the first class and winning the Calcutta University Gold Medal.

As there were little facilities in India at that time for research work in spectroscopy and astronomy, Das left for France in 1925 to work at the Paris University, in the Laboratoira de Physique and started spectroscopic work under Prof. Ch. Fabry. In 1928 he was awarded the degree of 'Doctor of Sciences' by the Paris University on his dissertation "Studies on the Absorption Spectra of Halogens". For the next two years, Dr. Das worked with Prof. Max Born at the Institut für Theoretische Physik and with Prof. Augenheister at the Geophysikalisches Institut, Gottingen. He then proceeded to England. During his stay in France, Germany, England and other continental countries he came in contact with a large number of well known physicists and astronomers and maintained a life long association with many of them. By this time, he had published several papers on spectroscopy and astrophysics and established a reputation as a very promising research worker.

Dr. Das joined the India Meteorological Department as Assistant Meteorologist on 8 March 1930. He was posted at Meteorological Office, Poona for a short while and then to Calcutta where he did weather forecasting work till August 1934. During this short period he published a few papers on weather forecasting, tornadoes, thundersquall etc. In September 1934, he proceeded to England on leave and stayed there for nearly a year, where in association with Prof. F.J.M. Stratton, Director, Solar Physics Observatory, Cambridge, he worked on Spectrophotometric investigation of the temperature of the Sun. He returned to India in August 1935 and was posted to the Upper Air Observatory at Agra.

With his characteristic energy and foresight, Dr. Das started investigations on Cosmic Rays at Agra and later started the same work at Kodaikanal. He

published a paper in *Indian Journal of Physics* (**14**, 191, 1940) entitled "Measurement of Cosmic Rays at Agra and Kodaikanal" in which were described the measurements carried out during 1936-38 on cosmic ray intensity at Agra and Kodaikanal. Work on cosmic ray had not begun in India except for a few measurements directly sponsored by Compton and Millikan and this was the first account of a systematic investigation on the variation of cosmic ray intensity at two widely different places varying in latitude as well as in altitude. There was an attempt in this paper to correlate solar phenomena with cosmic ray intensity.

In September 1937, Dr. Das was posted as Assistant Director, Kodaikanal Observatory. He worked in this post till June 1942. During this period he published a series of papers on solar prominences and motion of gases in the Sun's atmosphere. In a statistical analysis of 14 years' data, published in *Indian Journal of Physics* (**14**, 311, 1940), he showed that the area of calcium prominences was maximum in January and minimum in July. The earth at its perihelion is 3 million miles nearer in January and the increased gravitational attraction on the sun causes a corresponding increase in the area of the prominences. This increase was found to vary in accordance with an approximate inverse cube law of distance between the sun and the earth—thus confirming the gravitational theory. In a series of papers on "The motion of Gases in the Sun's atmosphere" Parts I to IV published in *Indian Journal of Physics* during the years 1940 to 1942, Dr. Das attempted to work out a unified theory based on simple particle dynamics to explain many of the hitherto unexplained behaviour of solar happenings. The magnetohydrodynamical theory of Alfven was developed a few years later and attempted to explain these on the basis of this new concept. In later years Dr. Das extended his work to explain the behaviour of sunspots as well on the basis of his ideas.

Edlen's discovery that λ 5303, the most prominent of coronal lines, was due to an iron atom which has lost 13 electrons and the other lines due to iron, nickel and calcium atoms stripped of a large number of electrons came sometime in 1941. It is a startling discovery since, in the solar atmosphere itself, we have singly or doubly ionised atoms of iron. The physical mechanism producing such highly ionised heavy atoms at such a large height as the corona bewildered the astrophysicists. Dr. Das came out with a rather convincing theory (*Science and Culture*, **7**, 357, 1941-42; *Indian Journal of Physics*, **16**, 277, 1942) based on his core hypothesis. Even today, the problem of the origin of these highly ionised particles in the corona has not been satisfactorily solved, but the idea of particle ejection expressed 20 years ago by Dr. Das, is gaining ground.

During World War II, Dr. Das was posted outside Kodaikanal for meteorological duties but he went back to Kodaikanal Observatory in early 1946 and was appointed as Director of the Observatory in July 1946. Now followed an unbroken period of 14 years during which Dr. Das strove hard and steadfastly

to organise and develop an astrophysical observatory at Kodaikanal equipped with the most up-to-date instruments for work on the most modern lines. At the same time, he kept up his scientific contributions and guided a number of research workers in the field of Astrophysics, Geomagnetism, Ionosphere, Cosmic rays and other allied subjects.

With the pioneering work of Evershed, Royds and Narayana, Kodaikanal had already established itself as an important centre for solar researches. A committee for the planning of post war development of Astronomy and Astrophysics in India was appointed in 1945 by the Government of India with Prof. M. N. Saha as Chairman. The Committee remarked "On account of the restricted nature of its activities Kodaikanal Observatory has not grown and kept pace with development of new knowledge and fundamental discoveries in Astrophysics, and our considered view is that in consideration of its excellent location for astrophysical work and the very good work done by the institution in the past *immediate steps should be taken* for its development". Dr. Das established a small modern workshop and trained young persons in the construction of astrophysical apparatus. To quote the words of Dr. Das "These efforts were so successful that within a very few years it became possible to build locally at an insignificant cost quite a number of perfectly satisfactory instruments of solar research, such as high dispersion Spectrographs, Coelostats, Siderostats, Photoelectric Photometers and a variety of other physical apparatus which made the daily routine work as well as the investigational work of the observatory far quicker and more convenient than before".

Kodaikanal situated at geographical latitude 10°N and geomagnetic latitude $\frac{1}{2}$ °N is advantageously situated for researches in some branches of Astrophysics and Geophysics. Simultaneous investigations of geomagnetism, ionosphere, solar activity and other factors are of the highest scientific importance. Dr. Das took full advantage of the situation and carefully planned researches on all the subjects at Kodaikanal, where a magnetic observatory was established in 1948.

Investigation of the Ionosphere near the geomagnetic equator has great physical significance. In 1951, Dr. Das installed a C-3 automatic ionospheric recorder. Observations with this recorder have brought out many new phenomena peculiar only to the equatorial (geomagnetic) belt. For example, spread echoes and sporadic *E*, which are occasional at other latitudes, are of regular occurrence at Kodaikanal and their properties have been very systematically studied.

Dr. Das began organising a division of Radio Astronomy at the Kodaikanal Observatory. Two "radio telescopes" on 100 and 200 Mc/s, employing Ryle's interferometer technique, are working at Kodaikanal since 1951. Dr. Das had plans to develop and expand this branch of work in later years.

The Stellar Physics Division was already in existence with a 20-inch reflecting telescope and an 8-inch refractor. They were old instruments although quite useful. Dr. Das made plans to equip this division with a 100-inch telescope

and a 46/34-inch Schmidt-Cassegrain telescope. These are very costly instruments and the necessary funds were not forthcoming. He however completely rebuilt the existing instruments, added many new fixtures and adapted them to the latitude of Kodaikanal so that their utility in the spheres of work to which they are most suited could be enhanced.

The Solar Physics Division was, and still is, the most highly developed branch of the observatory. The observatory was already equipped with a fair number of optical telescopes and spectrographs including both H-alpha spectrohelioscope and K and H-alpha spectroheliographs. But new and more powerful equipment were lacking and Dr. Das devoted his attention to providing such equipment.

Corona and coronal streamers have fascinated the astronomers for centuries ever since they were seen at the time of solar eclipses. But they had no means of investigation of these, except during total solar eclipses and even on those rare occasions the chance of success depended on the mercy of the weather. In a period of 85 years, it was possible to study the corona observationally for a total period of only about 4 hours. Lyot's invention of the Coronagraph enabling coronal observations to be made at any time from the sunlit hemisphere was a remarkable astronomical advance. Dr. Das lost no time in arranging for a Coronagraph at Kodaikanal. Through his persistent efforts and personal contacts he had the telescope of the Coronagraph (20 cm) built by the associates and co-workers of Prof. Bernard Lyot. The monochromatic Heliograph is another of Lyot's inventions to study the sun's chromosphere and connected solar pehnomena in a part of the red H-alpha line of the hydrogen atom. Dr. Das obtained the interference polarising filter from France and had the Heliograph installed at the same time as the Coronagraph.

The toughest of all the assignments which Dr. Das took upon himself was the construction of a large solar Telescope combined with a powerful Spectrograph of exceptionally high dispersive and resolving powers. It consists of a coelostat with three fused silica mirrors of fully 60 cm aperture and two telescope objectives of 37·5 and 20 cm apertures. The primary and secondary mirrors of the coelostat are mounted on a substantial, double-walled stone-masonry tower of 11-metre height above ground and are so arranged that a broad beam of sunlight can always be reflected vertically downwards; the third mirror of the coelostat (mounted on the floor of the tunnel) reflects the light horizontally into an underground tunnel of about 70-metre length. This long tunnel houses the telescope objectives and mirrors mounted on long horizontal steel rails and an exeptionally powerful 20-metre long Spectrograph having both a reflection grating and a system of prisms as its alternate dispersive organ. The instrument incorporates every desirable feature useful for solar research. The design, construction and installation of the equipment required very thoughtful planning, foresight, energy and determination on the part of Dr. Das. The equipment was fully ready for operation just a few months before he retired from the Kodaikanal Observatory.

Dr. Das, while engaged in a large-scale improvement of the observatory, kept up his scientific contributions and wrote a large number of papers. One of the outstanding contributions to solar physics which he made in 1953 was an accurate observational investigation of the temperature difference between the pole and the equator of the sun (*Nature*, **172**, 496, 1953; *Vistas in Astronomy*, **1**, 658, 1955). This was the first time that an observational confirmation was found of Bjerknes' theory, postulated in 1926, that the sun is a baroclinic cosmic vortex in which the angular velocity decreases with distance from equatorial plane and in which, therefore, the temperature increases from the equator to the poles. The observation also lends support to the thermohydrodynamical theory of the origin of sunspots. Shortly before his death Dr. Das published another interesting paper "The Solar Cycle and the Associated Behaviours of Sunspots and Prominences" in the *Kodaikanal Observatory Bulletin* (11 April 1959). In this paper Dr. Das attempted to explain the origin and behaviour of sunspots and prominences from purely dynamical considerations. The theory proposed by Dr. Das was simple and seemed to explain a large number of phenomena, including Evershed effect, with significant success.

Dr. Das organised an expedition to Iraq for taking observations during the solar eclipse of 25 February 1952. He again organised a similar expedition to Ceylon for the total eclipse of 20 June 1955. The weather was unkind during both these expeditions. Dr. Das, foreseeing such a possibility, equipped the 1955 expedition with radioastronomical and magnetic instruments and thus collected some valuable information.

Dr. Das went abroad a number of times. He attended the meeting of the General Assembly of the International Astronomical Union held at Rome in September 1952 and took the opportunity to visit the astronomical observatories in the continent at Arcetri (Florence), Zurich and Arosa (Switzerland), Potsdam (Germany), Paris and Meudon (France). He also visited the leading instrument factories at Cambridge, Oxford and London and the new Greenwich Observatory at Herstmonceaux Castle. In 1955, he undertook another extensive tour. He attended the special symposium on Radio Astronomy organised by the International Astronomical Union at Manchester in August 1955 and then attended the Ninth General Assembly meeting of the I.A.U. at Dublin in August-September 1955. On his way back, he went to the Crimean Observatory (U.S.S.R.) to attend a conference on Physics of the Sun, Stars and Nebulæ and stayed there for about 4 weeks. He also visited the important astronomical observatories in Europe, U.K. and the U.S.S.R. and returned to India in November 1955.

After retiring from Kodaikanal, Dr. Das went to the Ondrejov Observatory (Czechoslovakia) in September 1960 and returned after about two months. This was his last visit abroad. Dr. Das had always attempted to keep himself informed of the latest developments elsewhere in astrophysical researches—either through personal visits or through correspondence. He lost no time in translating these experiences into practice at Kodaikanal.

During his directorship at Kodaikanal, Dr. Das refused, more than once, promotion as Deputy Director General. There was no post of Deputy Director General at Kodaikanal and acceptance of promotion would have meant his leaving Kodaikanal. However, eventually a personal post of Deputy Director General was created for him at Kodaikanal from 1 March 1954. The Government also granted him extension of service for 3 years from 1 February 1957.

Dr. Das had many qualities of head and heart. He was a hard task master and at the same time kind and considerate. The amount of work which he himself had put in for the improvement of Kodaikanal is very large indeed. Dr. Das and his staff formed a compact team almost dedicated to the one great aim in view, namely to make Kodaikanal one of the foremost places of research.

Dr. Das was elected a Fellow of the Royal Astronomical Society and a Fellow of the National Institute of Sciences, India. In recognition of his distinguished services to the Kodaikanal Observatory he was awarded PADMA-SHRI by the Government of India on the Republic Day, 1960. Very unobtrusive, Dr. Das never courted any publicity. Dr. Das had all the qualities of a great research worker. Keen foresight, grim determination, untiring energy and genuine affection for colleagues and research workers in his observatory were some of them.

In his private life, Dr. Das was extremely helpful to anybody who sought his help and guidance. Anybody requesting for any data would never be disappointed. He was a man with an extremely versatile mind with voracious reading habits. He was of a very helpful disposition, and privately he had to extend all kinds of assistance including financial help, to many needy persons whether it was for their childrens' education or for their maintenance. His wife, Millicent A. Das who had predeceased him, was in this respect a very apt companion of Dr. Das and was herself a well-known social worker at Kodaikanal. To those who had come in close contact with Dr. Das and his wife, their demise have been the loss of good friends.

Dr. Das had a genuine and abiding affection for Kodaikanal. With a singular devotion to scientific research, he worked with untiring energy to build up a first class modern institution. The task Dr. Das undertook upon himself is now complete. But he did not have the opportunity of working with the instruments he built through years of toil and strife, most of the equipment were completed just before he left Kodaikanal. Dr. Das had one ambition in life which he had expressed on many occasions. He wanted to work at Kodaikanal during the last years of his life. In fact the assignment he took at Hyderabad was only for three years; thereafter he wanted to proceed to Kodaikanal and had already written to the authorities for permission to this effect. But Providence ordained otherwise, and he died within a year of his leaving Kodaikanal.

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