FOREWORD

Professor Udipi Ramachandra Rao attains sixty years of age on March 10, 1992, as he completes four decades of highly active and distinguished scientific career having excelled in wide ranging fields of activity, beginning with cosmic radiation and including X-ray and γ-ray astronomy and satellite technology. Since he took over as Chairman, Indian Space Research Organisation (ISRO) and Chairman, Space Commission in 1984, he has guided with great distinction the multifarious activities of the space programme of the country.

After taking his Masters degree from the Banaras Hindu University in 1953, he joined the Physical Research Laboratory (PRL) the same year to work in the area of cosmic radiation under the guidance of Dr. Vikram A. Sarabhai. He received his Ph.D. in 1960 and subsequently joined the Massachusetts Institute of Technology in 1961 as Post-doctoral Research Fellow. There he worked on cosmic ray modulation and in the investigation of solar wind properties. In 1963, he joined the then Southwest Centre for Advanced Studies as an Assistant Professor where he continued his investigations on cosmic radiations.

I had first seen him in action at the time of my first visit to PRL in 1960 during the Cosmic Ray Symposium. I remember to have been completely overwhelmed by the presentations by PRL scientists on Cosmic Ray variations. However, being neither an experimentalist nor being really involved in cosmic ray research, I could not quite understand the importance of the many "wiggly" curves that I saw at that time. However, as it turned out, the situation was soon to become clear, thanks to the subsequent work carried out by Prof. Rao and his collaborators. His work led to a major contribution to our understanding of the cosmic ray time

variation and, in particular, to the understanding of diurnal and semi-diurnal variation. The concept of the "asymptotic cone of acceptance" which is now universally used in cosmic ray variations was proposed by him.

Another important contribution made by him and his colleagues (K.G. McCracken, R.P. Bukata, B.C. Fowler, F.R. Allum, R.A.R. Palmeira, E.P. Keath, W.R. Sheldon and H. Carmichael) from experiments on Pioneer series of deep space probes and Explorer satellites was relating to the microstructure of the interplanetary field. These works led to the formulation of a unified model based on convection and diffusion to explain all cosmic ray variations. Furthermore, cosmic ray anisotropies observed on different spacecrafts located at different heliodistances were extensively used to understand the nature of the interplanetary field, the extent and properties of corotating structures on the Sun, the nature of the corotating shock fronts, intense cosmic ray storms and their behaviour, thus leading to the understanding of the interplanetary medium as a whole.

Beginning with the Biermann conjecture on the possible existence of a solar wind using the orientation of the comet tails, Parker (1958) gave a theoretical justification, indeed a compulsive argument for the existence of the solar wind. An important contribution of Prof. Rao in this connection is the establishment of the continuous nature of the solar wind and its properties using the Mariner-2 observations. He was able to establish, for the first time, the significant correlation of solar wind parameters with geomagnetic disturbances observed on the earth thus establishing the dynamic interaction of solar wind with earth's atmosphere.

As we look back on these scientific revelations about the heliospheric plasma, cosmic rays and electromagnetic environment around us, they must have been exciting times! To see, for the first time, through space probes' and satellites' vision what lay beyond, but which could at best be conjectured on the basis of ground based observations alone. The sense of excitement and expectancy can be discerned, for instance, from the picture on p. 1 . Being a part of such an excitement is what a scientist really looks forward to in his scientific career. This is what sustains the scientific spirit and it is these moments of excitement that one cherishes as years roll by.

Prof. Rao was awarded the "Group Achievement Award" by NASA in 1973 for his work on Pioneers 6, 7, 8 & 9, deep space probes and Explorer 34 and 41 satellites which yielded the various results mentioned above. The moments of the awards are great, but the moments of excitement are even greater.

After completing these investigations, he returned to PRL in 1966 when began, what may be regarded as, the Second phase of his career. He initiated new programmes of research in the field of X-ray and γ-ray astronomy using balloon-borne, rocket-borne and satellite payloads. Prof. Rao and his colleagues investigated detailed spectral properties of Sco X-1, Cyg X-1, Her X-1, Cen X-1 and Cen X-2 sources including the establishment of correlation between the optical and X-ray emissions of Sco X-1, the influence of celestial X-ray sources as a source of ionization for the lower ionosphere, and flare type enhancements on both optical and X-ray emissions, discovery of a new type flare type star near Cirius using optical observations.

The year 1973 marks the beginning of the third phase

in the scientific career of Prof. Rao when he took over as Director of the then newly created Satellite Systems Division of ISRO which grew into ISRO Satellite Centre (ISAC) in 1976. His efforts were now to be directed more towards the establishment of the satellite technology in the country, while he still continued to do, along with colleagues, interesting work on high energy astronomy. The development of the satellite technology in the country beginning with the "Aryabhata" launch in 1975 and through the design, fabrication and successful launch of the two experimental satellites, Bhaskara-1 and II in 1979 and 1981 and the first experimental geostationary satellite "APPLE" in June 1981 under his leadership set the stage for the later design and fabrication of the state-of-the-art remote sensing (IRS series) and communication and weather satellites (INSAT series). The successful launch of IRS-1A and later of IRS-1B with their state-of-the-art imageries is a tribute to the indigenous efforts made by the Indian scientists and technologists carried out under the leadership of Prof. Rao.

A completely indigenous INSAT satellite is waiting to be launched shortly into a geostationary orbit. With its launch, coupled with the successful operations of IRS-1A and 1B, India joins a very select band of nations with a high degree of sophistication in satellite technology.

Prof. Rao took charge as Chairman, Space Commission and Secretary, Department of Space on October 01, 1984. Under his overall direction, apart from the highly successful launches of the IRS-1A and IRS-1B satellites, ASLV launch vehicle programme capable of launching 150 kg. satellite into a low earth orbit and the PSLV launch vehicle capable of launching 1000 kg class of satellite into a polar orbit are under fabrication. Cryogenic engine technology for achieving the launch of GSLV (Geo-Synchronous Launch Vehicle) for launching 2.5 ton class

of satellites into geostationary orbit by 1995.

Awards and honours have come to Prof. Rao aplenty. Apart from the Group Achievement Award by NASA in 1973, he has been awarded a medal of honour by the USSR Academy of Sciences in 1975 for his work on Aryabhata. He is the recipient of the Karnataka State Award on the Rajyotsava Day in 1975. He was awarded the Hari Om Ashram Prerit Vikram Sarabhai Research Award in 1975 for his work in Space Physics. In the same year, he was also awarded the Shanti Swaroop Bhatnagar Award for Engineering Sciences. In 1980, he was awarded the National Design Award by the Institution of Engineers India, and VASVIK Research Award in the field of Electronic Sciences and Technology.

He is also a recipient of the P.C. Mahalanobis Medal 1987 of the Indian National Science Academy and Yuri Gagarin Medal by the Bureau of Federation of Cosmonautics, USSR in 1991. In 1992, he has been awarded the Allan D. Emil Memorial Award for International Co-operation in Astronautics by the International Astronautical Federation whose Vice-President he currently is.

He is a Fellow of the Indian Academy of Sciences, a Fellow of the Indian National Science Academy as well as a Fellow of the National Academy of Sciences of India.

He was awarded "Padma Bhushan" by the Government of India for his services to the nation in 1976.

Should he look back at the pace of his activity and a host of his achievements, Prof. Rao is entitled to feel a sense of satisfaction with his career spanning over four decades. All the distinctions that have come to him are richly deserved. Yet he still looks ahead as he completes his observations of the phenomena associated with sixty revolutions of the earth around the Sun. There are more revolutions to go

and more work to be done with each revolution. We hope and wish that his association with the helio-terra system continues for many many revolutions and he is able to continue his work as actively as he wishes. With these words, I have great pleasure in presenting to him this compilation containing the results of his scientific efforts and activity as contained in his published papers.

(R.K. Varma)