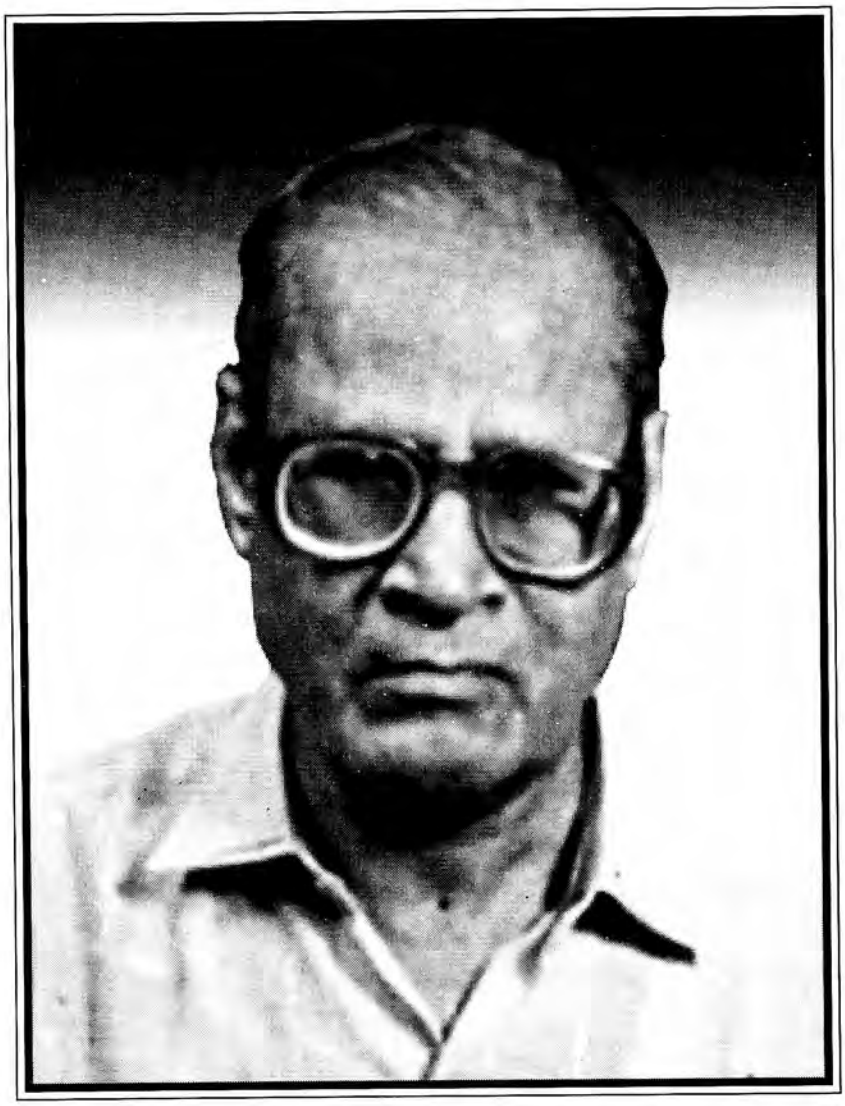
KRISHNA DAMODAR ABHYANKAR

(21 June 1928 - 08 November 2007)

Biog. Mem. Fell. INSA, New Delhi **34** 199-209 (2008)



KRISHNA DAMODAR ABHYANKAR

(1928-2007)

(Elected Fellow 1989)

EARLY EDUCATION AND FAMILY BACKGROUND

KRISHNA DAMODAR ABHYANKAR was born on the 21st of June 1928 at Indore, Madhya Pradesh. He was the last among three brothers and three sisters. His father, Shri Damodar Keshav Abhyankar was a school teacher. His mother, Sarojabai Abyankar was a house wife. Krishna Damodar spent his childhood with his uncle Shri Vishnu Keshav Abhyankar, who was a teacher in MS High School, Indore. His cousin is Dr. Shreeram Shankar Abhyankar, FNA, renowned mathematician who is a Professor of Mathematics and Computer Science in Purdue University, USA. He had his early education at the Marathi Primary School Bhoi Mohalla, Indore and Secondary Education at the Marathi Middle School Topkhana, Indore. He stood first in the High School Examination of Ajmer Board winning a Gold Medal and Scholarship. He did his Inter Science and B.Sc. at Holkar College, Indore and M.Sc. at Agra College, Agra. He got his Ph.D. in Astronomy from the University of California at Berkely in 1958.

Prof. Abhyankar married Mrs. Sheilaja Krishna in 1960. She is an MA in Psychology and proficient in Music. Abhyankars had no children.

PROFESSIONAL CAREER

Prof. Abhyankar started his career as a Junior Lecturer in Physics in Holkar College, Indore during 1951-52, Senior Research Scholar of the Government of India, in Kodaikanal Observatory in Tamil Nadu, during 1952-54. He worked on topics in solar physics. On his return to India, he worked as a Meteorologist at the Kodaikanal Observatory, Tamil Nadu, for one year. He then joined as a Reader in Astronomy at the Osmania University, Hyderabad in 1960 and was promoted as a Professor in 1964. He served the University with distinction till his retirement in 1988. He was solely responsiblefor introducing astronomy at the graduate and post graduate levels, he also served as Director, Nizamiah and Japal Rangpur Observatories and Dean, Faculty of Science, Osmania University. He was a Visiting Professor at TIFR, Bombay and at BARC, Srinagar, Kashmir. He was a post doctoral fellow of NRC Canada at the David Dunlap Observatory, University of Toronto during 1963-64. He also served as a NASA Senior Research Associate at the Jet Propulsion Laboratory Pasadena, California, USA during 1967-70. After retirement, he served as CSIR Emeritus Scientist of Osmania University during 1988-90.

RESEARCH CONTRIBUTIONS

Abhyankar has distinguishes himself in both observational astronomy and theoretical astrophysics. His research spans several areas of astrophysics including binary and variable stars, radiative transfer in stellar and planetary atmospheres, solar physics, celestial mechanics, optics and the history of ancient astronomy.

BINARY STARS

Abhyankar's extensive spectroscopic observations of several early binary stars showed that the secondaries of these massive binary systems are unstable. This work has been cited in books: Astronomy of the 20th century by Struve and Zebergs; Binary and multiple systems of stars by Batten.

With his colleagues and students, he has made UBV photometric and spectroscopic observations of a dozen algol and RS CVn type eclipsing binaries, which are published in many contributions from Nizamiah and Japal-Rangpur observatories. They used these observations for determining the orbital elements and absolute dimensions with the aim of understanding their evolutionary status. In addition along with his student Panchatsaram, he made a study of the period changes in about two dozen eclipsing binaries to find out whether they had additional components in them. All these find place in comprehensive catalogues of spectroscopic and eclipsing binaries.

Abhyankar showed that the secondary components of the Algol systems among the binaries are more luminous and hotter for their mass, which indicates that they are deficient in hydrogen due to mass loss during their evolution.

VARIABLE STARS

Abhyankar discovered the variability of the dwarf Cepheid AD Cmi and the short period eclipsing binary BD 18 deg 3477. While studying the MK morphology of the metallic line (Am) stars with his student Sreedhar Rao, he discovered a transitional class between the peculiar (Ap) and metallic line (Am) stars of which 41 sex A is a prototype. It shows variation in the strength of the metallic lines with the orbital phase of the binary, which is caused by the magnetically formatted stellar spots similar to those in AP stars, but without a measurable magnetic field. They have also shown that Am stars can be classified into sub groups according to their spectral characteristics, particularly the strength of the Sr Iiline at 4077 A.

With his student Nagar, he showed that a star spot model gives a better fit to the spectroscopic and photometric variation in the peculiar A type star as compared to the oblate spheroidal model proposed by Bohm - Vitense and Van Dyke. The spot model requires five high temperature circular patches over the surface of the star in agreement with the spectroscopic findings of Pyper.

STELLAR ATMOSPHERES

Abhyankar extended Chandrasekhar's work of 1945 and developed a numerical method for computing absorption line profiles in moving plane parallel stellar atmospheres, which is applicable to any intrinsic line profile and any monotonic velocity Law. Later, in a paper, which is included in the Stuve memorial volume Modern Astrophysics he showed that the integration over the disc removes the sharp features and smooths out the profile. Consequently, it is possible to explain the bewildering variety of line profiles in stars. After this work, researchers have developed sophisticated computer programmes incorporating a variety of intrinsic line source functions, velocity laws and emission conditions.

SCATTERING ATMOSPHERES

In collaboration with his colleague Fymat at JPL, Pasadena Abhyankar solved many problems of radiative transfer in scattering atmospheres. They include (i) analytical solution of the equation of transfer for an inhomogeneous scattering atmosphere, obtained using a perturbation technique in the case of both isotropic phase function and Rayleigh's phase matrix. This is the only analytical solution so far, because the workers in the field now use numerical techniques involving complicated computer programmes like (i) the layer doubling and layer adding methods (ii) the problem of scattering in a semi infinite atmosphere scattering according to Conservative Rayleigh phase matrix was completely solved by Chandrasekhar in 1940s. Abhyankar and Fymat not only solved the problem for non conservative (9 m perfect) Rayleigh phase matrix, but they also computed the relevant functions for various values of the albedo for single scattering. The work is referred to in the book Multiple light scattering by HC van de Hulst (iii) in collaboration with his student Bhatia, Abhyankar has also computed scattering functions for about three dozen two term Legendre type phase functions.

PLANETARY ATMOSPHERES

Abhyankar and his student Bhatia computed the intensity and polarization line profiles in semi infinite planetary atmospheres scattering according to Rayleigh phase matrix and the two term Legendre type phase functions. This work explained in the inverse phase effect in the equivalent widths of the absorption lines in the spectra of Venus. It also indicated that while Rayleigh scattering prevails in top most layers of the Venusian atmosphere, it is Mie scattering which dominates in the deeper layers.

SOLAR PHYSICS

According to Bijerkins, the differential rotation of the sun indicates that it is a baroclynic cosmic vortex, in which the poles of the sun should be hotter than the

equator. The theory of stellar structure also predicts a difference of temperature in the same direction, but of a much smaller amount. Abhyankar measured the equivalent widths of Ca II K and Ca Ig lines in the spectra of the pole and the equator of the sun and used Wolly's method of calcium ionization to derive the temperature between them. It was found that the poles are hotter than the equator by about 100K.

In collaboration with his colleague Ramanathan, Abhyankar determined the equivalent widths of neutral lines of iron and chromium in the spectra of several spots and used the method of the curve of growth to determine their temperature. It showed that the temperature of the sun spot depends on its size, the larger spots being cooler than the smaller ones.

During the total eclipse of 16th February 1980, Abhyankar and his student Antony Raj photographed the solar corona simultaneously in two colours - red and blue, and studied the variation of the intensity and polarization in the corona. Besides confirming the symmetric nature of the corona during the solar maximum and a coronal temperature of about 2 million degrees, they found that the electron density in the corona was higher than normal at the maximum phase of the solar cycle and that the F corona was brighter in the red with a variation in intensity which was in agreement with the van de Hulst's value. Further, a study of the coronal streamers showed that almost all the streamers had their origin in some optical feature of the solar surface, such as filament, a prominence or an active region.

CELESTIAL MECHANICS

Abhyankar computed the orbits of small particles near the Langrangian points L2 and L3 in the restricted problem of three bodies and demonstrated that they are indeed unstable as predicted by theory. This work is now referred to most text books in celestial mechanics.

Besides, he has made contributions in various other areas such as Halley's comet, moon illusion, mass radius relationship for neutron stars, multidimensional singular integral equations, Beta Canis Majoris type of variables.

OPTICS

Abhyankar and Fymat suggested a new method of using the technique of the Fourier Transform Spectroscopy for determining the Stokes parameters of polarization as a function of wave length. They received NASA patent award for this discovery. They also derived all the relations between the elements of the phase matrix of scattering.

ANCIENT ASTRONOMY

Abhyankar showed that the Mahashivaratri festival coincided with the winter solstice, which heralded the beginning of the sacrificial year, around 3000 BC. He has also indicated the original 28 nakshatras and has made a search for the earliest vedic calendar.

AWARDS AND HONOURS

Prof. Abhyankar was the recipient of several honours and awards including the Best Teacher Award from the Andhra Pradesh Government, NASA Award (along with his colleague) for Patent Rights on a new technique of measuring optical polarization, INSA Vainu Bappu Award in 1998 and MP Birla Award. He was elected Fellow of Royal Astronomical Society, Indian Academy of Sciences, Indian National Science Academy. He was a member of Sigma Xi of USA, Astronomical Society of the Pacific, American Astronomical Society and International Astronomical Union, He established the Astronomical Society of India. He served ASI in several capacities including its President. Prof. Abhyankar was the founder member of the Andhra Pradesh Academy of Sciences and also the Maharashtra Academy of Sciences. He has been the Chairman of the Advisory Committee of the positional Astronomy Centre, Kolkata.

AS A PERSON

Prof. Abhyankar was of reserved nature and spoke little. Besides his professional activities for Telugu, Marathi and Urdu encyclopedia, he gave talks on All India Radio. He composed about 50 poems and recited them in All India Radio, Hyderabad and Bombay. His popular articles on Astronomy regularly appeared in Dream 2047. He was not only a successful teacher, but also a great enthusiast. He was one amongst a few people who were good at both observational and theoretical astronomy. He played a crucial role in establishing the Japal Rangpur Observatory (JRO) in Andhra Pradesh.

This great Indian astrophysicist, teacher who popularised astronomy passed away in Hyderabad on the 8th of November 2007at the age of 79.

V RAMAMURTI, FNA
Old No. 2, New No. 5, Fourth Main Road
Kasturba Nagar
Chennai-600 020 (TN)
Phone: 044-24412590
E-mail: ramamurti@hotmail.com

BIBLIOGRAPHY

(a) Research Articles

1955 (With DAS AK) Differences of temperature between pole and equator of the sun *Nature* **172** 496-497.

– (With DAS AK) Temperature at the poles and the equator of the sun *Vistas in Astronomy* **1** 458-466.

– (With RAMANATHAN AS) Equivalent widths of atomic lines in sunspot spectra *Astrophysical Jou* **121** 739-749.

– With O Struve The spectrum of Nu Eridani *Astrophysical Jou* **122** 409-416.

1957 Period and spectrum of Plaskett's star Astronomical society of the Pacific **69** 385-386.

1958 (With STRUVE O and SHAHADE J) The spectrum of Plaskett's star *Memoirs soc R sc Liege quatrieme serie* **70** 408-410.

– (With SPINRAD H) Light variability of HD 47129 *Astronomical Soc Pacific* **70** 411-414.

1959 A study of some early type close binary stars *Astronomical Jou Su* **4** 157-198.

– Stability of straight line solutions in the restricted problem of three bodies *Astronomical Jou* **64** 163-169.

– (With STABLEFORD C) A spectro photometric study of several Beta Canis Majoris variables *Astrophysical Jou* **130** 811-816.

– AD CMi – A new ultra short period variable *Astrophysical Jou* **130** 834-842

1960 A note on the evolution of close binary systems *The observatory* **80** 26-28.

1962 Photometric elements of YY Cmi Zeitshrift fur *Astrophysik* **54** 25-33.

– Photometric observation of YY Cmi *The Nizamiah observatory contribution* **1** 1-11.

1963 On the measurement of radial velocities from high dispersion spectrograms *The Observatory* **83** 252-253.

1964 Modern Astronomy in India *Jou Royal Astronomical Soc of Canada* **58** *Astronomical Jou* 218-220.

– On the Schuster problem for a moving atmosphere II *Astronomical Jou* **140** 1353-1367.

1965 On the Schuster problem of a moving atmosphere III **141** 1056-1067.

1966 (With SARMA MBK) A study of spectroscopic binary Cr BA Royal *Astronomical Soc* **133** 437-446.

1968 Scattering in the twilight atmosphere of venus JPL space prog *summary* **37-51V III** 181-184.

– Scattering of visible radiation around the spherical atmosphere of venus Icarus **9** 507-525.

1969 (With FYMAT AL) Linearisation of global equations of radiative transfer *JPL Space programme summary* **37-56 III** 50-52.

– (With FYMAT AL) Iteration scheme for solving the linearised X and Hequations *JPL Space programme summary* **37-56 VIII** 53-55.

– (With FYMAT AL) A new type of multi dimensional singular linear integral equation *Jou Math and Mech* **19** 115-122.

1969 (With FYMAT AL) Effect of linearisation of the transfer problem on the computation of the emergent radiation field *JPL Space Programme Summary* 37-**57 III** 57-59.

- (With FYMAT AL) Error analysis of the linearisation method in radiative transfer theory *JPL Space Programme* **37-57 VIII** 25-28.

- (With FYMAT AL) Theory of radiative transfer in inhomogeneous atmospheres I-Perturbation method *Astrophysical Jou* **158** 315-324.

- (With FYMAT AL) Theory of radiative transfer in inhomogeneous atmospheres II *Astrophysical Jou* **158** 325-335.

- (With FYMAT AL) Relations between the elements of the phase matrix for scattering *Jou Mathematical Physics* **10** 1935-1938.

- (With FYMAT AL) On the solution H1 of Ambarzumanian Chandrasekhar H equation *Jou Quantitative spectroscopy and radiative transfer* **9** 1563-1566.

1970 (With FYMAT AL) Imperfect Rayleigh scattering in semi infinite atmosphere *Astronomy and astrophysics* **4** 101-110

- (With FYMAT AL) An alternate form of Ueno's X and Y equations for inhomogeneous atmospheres *Jou Quantitative spectroscopy and radiative transfer* **10** 49-54.

- (With FYMAT AL) A novel type of matrix multidimensional singular linear integral equation *Jou Math and Mech* **19** 587-600.

- (With FYMAT AL) Theory of radiative transfer in inhomogeneous atmospheres III *Astropysical Jou* **159** 1009-1018.

- (With FYMAT AL) Theory of radiative transfer in inhomogeneous atmospheres IV *Astronomical Jou* **159** 1019-1028.

- (With FYMAT AL) An interferometric approach to the measurement of optical polarisation *Applied Optics* 1075-1081.

1971 (With FYMAT AL) Effect of molecular absorption on scattering by planetary atmosphere *Jou Geophysical Research* **76** 732-735.

- (With FYMAT AL) Tables of auxiliary functions for non conservative Rayleigh phase matrix in the case of semi infinite atmosphere *Astrophysical Jou Supplement* **195** 35-101.

1973 (With SANWAL NB and PARTHASARATHY M) UBV Photometry of Zeta Aurigae during the 1971 -72 eclipse *Observatory* **93** 30-32.

1974 (With SANWAL NB and SARMA MBK and PARTHASARATHY M) BD18 3437 a new short period eclipsing binary *Astronomy and Astrophysics Supplement Series* **13** 81-90.

- Variation of of the Galectic force law in the region of the sun *Pramana* **2** 336-340.

- (With PARTHASARATHY M and SANWAL NB) UBV Photometry of RV Corvi *Astronomy and Astrophysics Supplement* **13** 101-108.

- Variable X-ray source and black hole in binaries *Bull Astronomical Soc of India* **2** 13-14.

1976 On the time of vernal equinox *Science Reporter* **13** 424-426.

- (With KULKARNI AG) On the solar atmospheric model *Bull ASI* **5** 40-44.

1977 (With KULKARNI AG) Light elements of TT hydrae *Bull ASI* **5** 105.

1979 (With SARMA MBK) Photometric elements of Wx Eridani *Astrophysics and space Sci* **65** 443-452.

1980 (With KULKARNI AG) Absolute dimensions of TT hydrae *Astrophysics and space sci* **67** 205-212.

1981 (With PANCHASARAN T and LACERTAE SW) - A quadruple system *Bull Astro Soc of India* **9** 31-39.

– (With PANCHASARAN T) An analysis of the orbital periods of some eclipsing binaries suspected to be in the premain sequence contraction phase of evolution *Jou Astrophy and Astronomy* **2** 29-42.

– (With KULKARNI AG) model of the algol type close binary TT hydrae *Jou Astrophy and Astronomy* **2** 119-132.

– (With BHATIA RK) Role of scattering in emergent planetary radiation *Bull Astronomical Soc of India* **9** 99-111.

– (With PANCHASARAN T) A note on the orbital periods of the eclipsing binaries CM LacAA and YY Eri *Bull Astronomical Soc India* **9** 181-213.

1982 (With RAJU ANTONY) Two colour photometry of the solar corona *Proc INSA* **48n3** 91-101.

– (With SUBRAHMANYAM PV) Effect of seeing plus scattering on the observed intensity distribution in the corona *Proc INSA* **48 No 3** 55-58.

– (With PANCHASARAN T) A study of the orbital periods of 22 eclipsing binaries *IAU Colloquium* **69** 47-60.

– (With KAUL J) Analysis of UBV light curves of TT Hyaby Kopal's frequency domain method *Jou Astrophysics and Astronomy* **3** 93-99.

– (With PANCHASARAN T) Secular period changes in ten eclipsing binaries *Bull Astronomical Soc India* **10** 111-136.

– Three and a half centuries of binary star research *Current Sci* **51** 955-965.

– (With PANCHASARAN T) Light time effect in AK Her and Er Ori *Bull Astronomical Soc India* **10** 315-322.

– (With RAJASEKAR RAO N and LOKANADHAM B) Photometric solution of the eclipsing binary TT Aurigae *Bull Astronomical Soc India* **10** 323-328.

– (With BHATIA RK) Intensity and polarization line profiles in a semi infinite Rayleigh scattering planetary atmosphere *I Jou Astrophsics and Astronomy* **3** 303-324.

1983 (With BHATIA RK) Intensity and Polarisation in planetary atmosphere II *Jou Astrophsics and Astronomy* **4** 27-34.

– (With BHATIA RK) Intensity and polarization in planetary atmosphere III *Jou Astrophysics and Astronomy* **4** 35-46.

– (With BHATIA RK) Multiple scattering and phase variation in equivalent widths *Astrophysics and space Sci* **96** 107-123.

– Music of the spheres *The Observatory* V103 26.

1984 (With RADHAKRISHNAN KR and SARMA MBK) Photometric and spectroscopic study of R Cma *Astrophysics and Space Sci* **99** 229-236.

– Mass loss in semi detached binaries *Astrophysics and Space Sci* **99** 355-361.

1984 (With BHATIA RK) A reconsideration of the effective depth of line formation in planetary atmospheres *Earth, Moon and Planets* **30** 175-187.

– (With RADHAKRISHNAN KR and SARMA MBK) Sarma Period study of algol typeeclipsing binary Bull *Astronomical Soc India* **12** 182-189.

– (With SUBRAHMANYAM PV) Correction for the observed intensity distribution in solar corona *Bull Astronomical Soc India* **12** 190-195.

– (With PANCHASARAN T) Light time effect in T.W.Draconis *Royal Astronomical Soc* **211** 75-82.

– (With BHATIA RK) Multi scattering and dependence of phase variation of equivalent widths on line profile *Bull Astronomical Soc India* **12** 384-392.

– (With BHATIA RK) H and auxiliary functions for phase functions *Bull Astronomical Soc India* **12** 364-383.

– (With RADHAKRISHNAN KR and SARMA MBK) Spectroscopic orbit of R Cma *Bull Astronomical Soc India* **12** 411-416.

1985 (With RADHAKRISHNAN KR and SARMA MBK) UBV photometric study of R Cma *Bull Astronomical Soc India* **13** 261-274.

– (With BHATIA RK and RAO DEVADAS) On the stability of hypothetical quintet system of TW Draconis *Bull Astronomical Soc India* **13** 275-286.

– (With SARMA CVR and SARMA MBK) Period study of the RS Cvn eclipsing binary SV camalopardalis *Bull Astronomical Soc India* **13** 346-358.

1986 (With NAGAR PRAVEEN) Hydrogen deficiency in algol secondaries *IAU Colloquium* **87** 251-257.

– (With ANTONY RAJ K) Polarisation and electron densities in the solar corona of 16 February 1980 *Bull Astronomical Soc India* V14 217-228.

1988 (With VYAS ML) Photoelectric observations of RR leperis Contributions from Nizam observatories N22 1-56 **23** 1-48.

– (With NAGAR PRAVEEN) A comparison between spot and oblate spheroid models *Jou Astrophysics and Astronomy* **9** 173-183.

– (With ANTONY RAJ K) A study of the coronal streamers during solar eclipse *Bull Astronomical Soc India* **16** 67-77.

1990 Astronomical significance of *Mahashivaratri Mahavisva* **3** 5-7.

1991 (With SREEDHAR S and RAO MK) Morphological study of Am stars at 66 A/mm *Jou Astronomy and Astrophysics* **12** 133-178.

– (With RAO CR) Spectroscopic observations of HR 3009 and HR 3335 Contributions from *Nizamiah Japal Rangpur Observatory* **26**.

– Synodic month in the Hindu Panchanga The Observatory V111 315-316. On the mass radius relation for neutron stars *Bull Astro Soc India* **19** 105-107.

1993 A search for the earliest vedic calendar *Jou History of Sci* **28** 1-13.

(b) Books

1992 Astrophysics stars and galaxies Tata Mc Graw Hill New Delhi.

2002 Astrophysics of the solar system Orient Longmans Hyderabad.