INDIAN INSTITUTE OF ASTROPHYSICS

ANNUAL REPORT

April 1, 1981 - March 31, 1982

CONTENTS

SOLAR PHYSICS

The analysis of the observations acquired by Sivaraman at the Kitt Peak National Observatory in March-April 1981 with Livingston of KPNO as the co-investigator seeking a relation between the K_{2V} bright points and the sub-arcsec magnetic elements in the interior of the network has been completed. These consisted of several area scans around the centre of the solar disc made with the 512 channel magnetograph of the KPNO solar vacuum telescope in the line FeI 8688Å and simultaneous spectroheliograms in K_{2V} made with the east auxiliary facility of the McMath telescope. These were used along with the series of scans measuring brightness and magnetic fields all made with the vacuum telescope earlier in May 1980. The final pictures of these scans were viewed via the Interactive Picture Processing System. From the large sample of bright points examined, they are able to establish the one-to-one correspondence of the bright points and the inner network magnetic elements. They also find that the bright points are associated with either positive or negative polarity elements with equal probablity of field strengths around 10-20 gauss, although a few were found associated with fields as high as 70-80 gauss.

Sivaraman and Jayachandran have completed the detailed analysis of the polarisation photographs obtained at the eclipse of February 16, 1980, based on the microdensitometer traces obtained by Sivaraman with the PDS system of the Kitt Peak National Observatory. The polarisation values in the corona at every 10° position angles and reaching upto 2.5 R_0 have been computed. The brightness distribution in the radial direction at every 20° position angles, derived from the broad band photographs could be represented very well by a 19-degree polynomial. Combining these results with the corresponding polarisation values, they have derived the electron density map of the corona. The low values of the polarisation and the electron density at 165° P.A. show the presence of the coronal hole. The enhancement of the electron density in the equatorial directions matches well with the location of the streamers.

Sivaraman in collaboration with Makarov and Stoyanova of the Pulkovo Observatory, Leningrad commenced a systematic analysis of the movements of the large-scale active regions using the H-alpha filaments as tracers. The location of filaments represented in the form of synoptic charts covering several rotations of the sun over a cycle are used to study the migration of the filaments which in turn represents the migration of large-scale active regions. From a preliminary examination of the poleward drift of these active regions over the solar cycles 20 and 21, they find that the pole reversals exhibited by the sun can be detected with equal accuracy and ease as from full-disc magnetograms. Using the Kodaikanal H-alpha spectroheliograms as the basic material, they propose to extend this analysis back in time (for which the magnetograms do not exist) reaching to 1904 to study the poleward drift and pole reversals exhibited by the sun in the past.

Jagdev Singh has obtained coronal spectrum covering the region (5200-5400Å and 6250-6450Å) at a dispersion of 1Å/mm with the Kodaikanal coronagraph and the Echelle spectrograph to map the coronal velocities in the 5303Å and 6374Å lines.

It is known that the integrated solar-active-region area varies in a quasi-periodic manner with the solar rotation period. Since the plage coverage in latitude is variable on the solar surface where the rotational period may differ, it should in principle be possible to detect the differential rotation from plage areas for a disc-averaged sun or for a star. With this in view Singh has attempted a Fourier analysis of the total Ca^+ plage areas on the sun for two solar cycles (1955-1977). Although the differential rotation could be detected only marginally, one interesting result that has come out of this study is the finding, that the rotational velocity reduced by about 6 per cent during this period of 22 years. This reduction may either be a part of a continuous decrease in the rotational velocity or it may be a part of a periodic phenomenon. He plans to extend the analysis to cover a few more years to detect the differential rotation more reliably.

Bagare and Gupta have acquired Ca^+K line plage profiles

at the Kodaikanal solar telescope to study the width properties in different plages and their relation to the emission width in the quiet sun. The $Ca^{+}K$ line was monitored in integrated sunlight on a regular basis to study the long term solar luminosity variations.

Synoptic observations of the sun were continued at Kodaikanal and the following is the summary of the observations made during this year.

	No. of days of Observation
Photoheliograms ..	234
H-alpha spectroheliograms ..	245
K_{232} spectroheliograms ..	223
Prominence spectroheliograms K_{232} ..	173

Regular exchange of solar data and spectroheliograms with the Meudon Observatory continued as in previous years.

Gokhale and Sivaraman have determined the widths of the solar latitude zones over which the sunspot groups having their maximum areas A_* in the intervals 0-25, 25-100, 100-200, 200-500 and 500-1000 (unit = millionths of solar hemisphere) appear during each of the years 1889 to 1976. They find that during each of the eight solar cycles the latitude zone for the small spot groups ($A_* \leq$ 25) is substantially wider than the zones for the larger spot groups. At the beginning of each new solar cycle the latitude zones for $A_* \leq$ 25 suddenly expands while the zones of spot groups with larger A_* continue to shrink for one or two years further. Thus the two components in the distribution of spot groups with respect to A_*, which were discovered by them earlier, are shown to have distinct latitudinal distributions as predicted by the shock transition model of the solar cycle. This conclusion was shown to remain unchanged even when the width of the latitude zone was defined as the root-mean-square deviation from the mean instead of the difference between the maximum and the minimum latitudes. They also find that during the expansion of the zone for $A_* \leq 25$ mh, their mean latitude continues to decrease for one or two years further. This indicates that the expansion of the latitude zone for small spot groups is indeed due

to the arrival of some spot groups of that category, but belonging to the new cycle, at relatively high latitudes. Thus, the thinner magnetic flux tubes of each new solar cycle start emerging earlier than the thicker flux tubes as predicted earlier from the shock transition model.

Gokhale and Venkatakrishnan continued the magnetogasdynamical analysis of the basic postulate of the shock transition model. Having established the existence of the non-linear azimuthal magnetoacoustic wave solution for the relevant equations and boundary conditions, they have commenced computing detailed waveforms and the evolution of the wave on large timescales.

Gokhale determined the "initial", the "mean" and the "final" angular velocities (denoted respectively by Ω_i, Ω_m, and Ω_f) of the rotation of sunspot-groups about the solar axis for those groups which were observed during the last five solar cycles (1923-1976) and which had their maximum areas A_* in the intervals 300-500, 500-1000 and $\geq$1000 units. The "initial" and "final" refer to the first and the last day of the observed life of the spot group and the "mean" implies the average over the whole life. He finds that during each solar cycle and for each interval of A_* the average values $\langle\Omega_m-\Omega_i\rangle$ and $\langle\Omega_f-\Omega_m\rangle$ are positive and large compared to their uncertainties and that these average 'gains' in the angular velocity are successively larger for the larger spot groups. On the contrary, the leading spots in the spot groups were found to be on the average, decelerated. Thus the acceleration deduced for the sunspot groups is not a spurious effect of their asymmetric evolution relative to their centre of gravity or due to changes in the inclinations of the magnetic flux tubes. These results demonstrate that the magnetic flux tubes of sunspots are dragged westward during the lifetime of the spot groups and the net gain in the angular velocity is larger for larger spot groups. In spite of this large gain the large spot groups are known to rotate on the average slower than the smaller ones. He suggests that the initial rotation of the large spot groups must be on the average slower than that of the smaller ones. Gokhale has confirmed this by direct comparison of $\langle\Omega_i\rangle$ for

large and small spot groups appearing at same latitudes. Assuming that the initial rotation speeds of spot groups represent the plasma rotation in the depths of their origin, he has tentatively concluded that the solar rotation speed decreases with depth at large depths beyond the initial increase at small depths.

Hasan and Gokhale have in progress an investigation to evolve a steady two-dimensional model for quiescent prominences. In this, the dynamical support to the prominence material is provided by closed magnetic loops resulting from the reconnection of magnetic fields and the region which demarcates closed and open field lines is defined as the prominence-corona interface. They have derived quantitative estimates of temperature, density and velocity along the field line solving the MHD equations for a specific magnetic geometry and transverse velocity of gas. They find that far from the interface the vertical stratification of temperature and density agrees well with those observed in the corona and as the interface is approached, the density/temperature stratification changes and tends to the form observed in quiescent prominences.

Hasan has studied the convective collapse of a magnetic flux tube extending vertically in the convection zone of the Sun. Starting from a flux tube in hydrostatic equilibrium, he has solved numerically, the non-linear time dependent equations of MHD to study the response of the flux tube to an initial velocity perturbation U(z). He finds that the temporal evolution of the flux tube depends on β, the ratio of the thermal to magnetic pressure at the initial epoch and U(z). An initial velocity perturbation in the form of a downflow triggers the convective collapse of the tube. This leads to an intensification of the magnetic field, a result which is in general agreement with the findings of the previous linear analyses. A new feature of this work is that it allows one to study the convective collapse during the non-linear phase of the instability responsible for the collapse.

Extending his earlier study of thermally driven time dependent flow along a magnetic field, Venkatakrishnan commenced the investigation of mass flow across a magnetic field. He has

made trials using various schemes like the modified Lax-Wendroff method of Rubin and Burstein and the numerical flux corrected transport scheme of Boris and Book to make the best choice of the method suited to the problem. Preliminary findings confirm the results of linear analysis that a resonance would occur when the period of the heat input function matches the time taken for a 'fast' wave to traverse the length of the gas column. His aim is to understand the non-linear flow produced as a result of time-dependent spatially non-uniform heat input. Such conditions occur in the excitation zone for radial and non-radial pulsations and on the surface of a star in a binary system being non-uniformly heated by its companion.

Raju is making a search for emission lines from the solar chromosphere - corona transition region and the corona, whose relative intensities are sensitive to variations in electron density and temperature. This diagnostic approach was till now confined only to ions of a given element obviation thereby the problem associated with elemental abundances. From the ionisation equilibrium calculations for some of the elements, Raju finds that their ionisation equilibrium curves overlap rather closely over the relevant temperature ranges. He plans to use this finding to obtain the relative abundances of elements in the chromosphere-corona transition region. He has also plans to derive line-intensity ratios for lines of dissimilar elements that are sensitive to density and temperature variations.

From the two-dimensional maps of the slowly-varying continuum emission from the sun at decameter wavelengths, Sastry and his collaborators have derived the brightness temperatures and find that they vary from 0.2 to 1.5 x 10^6 K. They find that the position of the centroid of the brightness distribution is sometimes shifted by as much as .2 to 3 solar radii from the centre of the sun. Model calculations using different density and temperature distributions are in progress to interpret these results. Using the decameter radio telescope at Gauribidanur they have also detected many types of radio bursts in absorption from

the sun. These bursts, observed for the first time now, are characterised by a sudden or sometimes gradual decrease of the background continuum followed by a subsequent rise to the preabsorption level. Sastry, Subramanian and Krishan propose that the absorption bursts may be either due to the quenching of the instability responsible for the continuum emission or due to a non-linear wave-wave interaction where the energy is transferred from one spectral region to another.

Thejappa and Sastry find that the time profiles of weak Type III radio bursts from the sun can assume a variety of forms of which three distinct types are (1) profiles whose intensity rise to a small but steady value before the onset of the main burst (2) profiles where the intensity of the main burst reduces to a finite level and remains steady before decaying to the base level and (3) profiles where the steady state is present during the rise as well as the decay phase of the main burst. From an analysis they conclude that these profiles are not due to random superposition of bursts with varying amplitudes nor manifestations of fundamental-harmonic pairs, but, at least some of them, could be due to bursts caused by ordered electron beams ejected with a constant time delay at the base of the corona.

Vinod Krishan has investigated the mechanism of spatial resonance of Alfvén waves for heating a collisionless plasma in the presence of a twisted magnetic field. This theoretical system conforms to the conditions in solar coronal regions. Besides modifying the equilibrium condition for a cylindrical plasma, the azimuthal component of the magnetic field gives extra contribution to the energy deposition rate of Alfven waves. This new term clearly brings out the effects associated with the finite life time of the Alfvén waves.

Physics of the Solar System

Concentrated efforts were made for observing the occultation of star BD-10°422 by Uranus on April 26, 1981 from different locations within India. The teams at Kavalur and at Nainital could observe with a good degree of success, whereas the Ahmedabad and Japal-Rangapur observations were marred by clouds.

Physics of Stars

The lunar occultation observing program was continued by Bhattacharyya at Kavalur and he has acquired photoelectric records of 30 new stars. Also the observations of rapid variables, a collaborative effort with Indian Space Research Organisation, were continued.

Bappu in collaboration with Uchida of the Tokyo Astronomical Observatory has investigated the phenomenon of the renewal of chromospheric activity, as a star evolves into the red-giant stage. They interpret this revival in terms of the reappearance of dynamo activity in the interior due to the spin-up of the core caused by its contraction in the course of evolution from the main-sequence to the giant phase. They find that a region of very high rotational shear develops between the core and the envelope and mechanisms of angular momentum transfer may operate to smear this large shear and bring the inner part of the envelope into sheared rotation. According to them a convective layer develops in the envelope from the surface inwards as the latter expands and the temperature is lowered. As a consequence, a dynamo layer or a layer in which the sheared rotation coexists with the convection reappears in the inner parts of the envelope, when the envelope-convection reaches down and invades the layer of sheared rotation. Surface chromospheric activity is thus renewed when the regenerated magnetic field is brought up to the surface by the envelope-convection.

The program of observations of RCrB stars in the ultraviolet, visual and infrared was continued by Kameswara Rao. The analysis of the IUE low-resolution spectra of MV Sagittarii obtained by him in collaboration with Nandy of the Royal Observatory, Edinburg

and by other observers shows a prominent absorption feature at 2200Å. Assuming that this is caused by interstellar medium they have derived the value of E_{B-V}=0.55 from the strength of 2200Å band. They have fitted the dereddened continuum obtained on different occasions to the theoretical energy distribution of a helium star model with T_{eff} = 18000 K and log g = 2.5. The IUE spectra of October 1980 show enhanced (circumstellar) absorption lines of Fe II, Si II, O I, C I and others along with the absorption lines of a B star. Based on the similarity of the spectroscopic phenomenon of MV Sgr with that of Alpha Sco system, they have proposed a model in which a cool companion star surrounded by dust blows gas occasionally towards the hotter hydrogen-deficient B star, which can explain the irregular light variations and the spectroscopic phenomenon. From an examination of the IUE spectra of R CrB and XX Cam, Rao finds that the 1303Å feature due to O I, which results mainly through fluorescence with hydrogen Lyman Beta in normal F-G supergiants, is absent in these, indicating the deficiency of hydrogen in the chromosphere of R CrB. Rao is continuing to obtain scanner observations of R CrB stars at the time of light maximum and minimum to determine the energy distribution in them. In order to study the extinction properties he is following the minimum of RY Sgr, which is in progress since December 1981. Infrared photometric program of R CrB stars is also in progress. Rao and Kulkarni of Physical Research Laboratory observed V 3795 Sgr in the JHK bands and found indications of some infrared excess. Rao, in collaboration with Stickland of Royal Greenwich Observatory and Gilra of Kapteyn Astronomical Laboratory has obtained high and low resolution spectra of Epsilon Aur in February 1981, August 1981 and March 1982 from the IUE. The eclipse of this 27.1-year-period binary is anticipated to commence in July 1982. The changes in the profiles of Mg II resonance lines, compared with the earlier observations of 1978 and 1979, are already prominent. Combining the IUE data with Kavalur scanner observations they have derived the energy distribution curve in the range 3300-7600Å. They propose to continue these observations to cover the minimum phase to study the nature of the mysterious secondary star.

Rao and Gilra have acquired several spectra of II Puppis

at the Cassegrain and Coudé focus of 102 cm reflector. They propose to study the mass loss phenomenon using these spectra along with the IUE data obtained earlier. They have completed the analysis of the observations of HD 62001, the enigmatic central star of the missing nebula VV 1-7. From the UBV photometry of the two nearby tenth-magnitude stars, they find that the ultraviolet photometric variations detected earlier by Astronomical Netherlands Satellite are due to one of these stars getting in and out of the field of view and not caused by intrinsic variations.

According to Luck and Lambert the spectrum of the supergiant HR 8752 changed gradually from G0 Ia in 1950 to K2-3 Ia by August 1973 and later a shell was ejected giving rise to low-excitation emission lines in 1975 as observed by Harmer. Rao is examining Lick Observatory infrared spectra of this supergiant obtained in 1972 along with the recent image-tube spectra in the red region obtained at 102 cm telescope at Kavalur. The 1972 spectra show the presence of high-excitation lines of both ionised as well as neutral elements and correspond to a spectral type close to G0 Ia and not K2-K3. Also seen in these spectra are enhanced absorption lines due to Fe I (Multiplet 60) of low excitation, presumably due to a cool gas shell. The transition from G0 to K2 appears to have taken place in a period of about one year. Rao is monitoring spectroscopically other F supergiants like 89 Her and ρ Cas to look for similar changes.

Rajamohan and Rao, engaged in the study of the stars in the Scorpio-centauras association, find that the star HD 147010 within the reflection nebula VdB 102 is a hot Ap silicon star rather than a normal A supergiant. They have derived a colour excess E_{B-V} of 0.29 and a value of 4.3 for R, the ratio of total to selective absorption, from the UBV and JHK photometry. The high value of R implies bigger grain size and confirms the association of the star with the nebula. They have fitted the dereddened colours of the star to a theoretical energy distribution with $T_{eff} = 13000 \pm 500$ K and log g $= 3.6 \pm 0.2$. They also find that the star is a spectrum variable and in particular the lines of Cr II show large intensity variations, although no variation in the radial velocity is detectable.

Rajamohan continued the spectroscopic observations of the Wolf-Rayet binary Gamma Velorum in the range 5000-6000Å thus supplementing last year's observations in this wavelength range. He has also continued the observational search for emission and emission variability amongst Scorpio-Centaurus members.

The analysis of the photometric observations of HD 81410, that showed the RS CVn type of variability during earlier observations, was completed by Raveendran, Mekkaden and Mohin. They find a light variation of ~0.15 mag in B and V and a period of 12.86833 that satisfies all the available photometric data. The star appears redder at fainter visual magnitudes and this they attribute to the darker and hence relatively cooler regions present on the visible hemisphere. From the observed amplitude of light variation and derived mass function f (m) = 0.073 M_0, they suspect that the secondary is probably an F dwarf; this is also supported by the fact that (U-B) of this sytem is brighter by ~0.2 mag than a typical K giant with the observed (B-V) and (R-I) colours. The spectral types of the components and the strong Ca II H and K emission indicate that HD 81410 is a member of the RS CVn group of binaries. The three image-tube spectrograms at a dispersion of 66Å/mm show that the H-alpha line is completely filled in by emission. Their analysis of the UBV photometric observations of HR 1099, as RS CVn variable, shows that in 1979-80 the amplitude of light variation was ~0.15 mag, while during 1980-81 it reduced to ~0.08 mag and the two light curves differ in all respects. In addition they find an increase in brightness with an increase in wave amplitude at the epoch of light curve maximum but a constant brightness at light minimum. In terms of the star-spot model this implies that there is always a hemisphere of the active component nearly saturated with spots that occupy a larger fraction of the stellar surface when the wave amplitude is smaller. They do not find evidence for the continuous migration of the photometric wave. The amplitude of the wave shows a sharp rise followed by a slow decay with a period around 5-6 years.

Mahipal Singh has acquired extensive observations of Delta Orionis and a large number of B and Be stars in the H-alpha and blue

regions using the 102 cm reflector.

The physical parameters for nearly 100 Ap and 25 Am stars were derived by Babu and Shylaja. Examining the relations between their T_{eff}, radii, M_{bol} and the bolometric corrections they find that the bolometric corrections for Ap stars follow the same sequence as normal stars when related to temperature. On the other hand, Am stars are apparently redder than their normal counterparts, the blanketing in blue and ultraviolet regions being the major cause. For the relatively cooler Am stars they find that the (B-V) colours are less affected by blanketing. These stars also show a fairly wide range in evolutionary status among themselves.

The period-luminosity (P-L) relation among the RR Lyrae stars in globular clusters was brought out by Sandage from a study of the cluster M3. He showed that in the photographic band, the M3 RR Lyrae variables of shorter period are bluer and brighter than those with longer period. This P-L relation apparently contradicts the one known for Cepheids of periods >1d. Also, the large scatter in the plot for the M3 variables did not permit an establishment of a reliable P-L relation. Bappu and Scaria showed that brightness measurements of stars close to the centre of M3 are affected by background contribution. They have derived the median magnitudes for 213 variables in M3 from the photographic magnitudes at maximum and minimum given in Helven Sawyer's third catalogue, and they find that a plot of these median magnitudes vs periods for stars beyond 3 arcmin from the centre, shows an unambigous P-L relation. They have extended this approach to other globular clusters deriving magnitudes from this catalogue of variable stars. From this they establish an inverse median brightness-period relation that holds good in the case of Oosterhoff group I clusters for periods >0.48d and for group II clusters for periods >0.6d. For periods <0.48d in group I clusters and <0.6d in group II clusters, the median brightness remains constant with a tendency to fall with decreasing period. For M3 the change in period from 0.48d to 0.58d corresponds to a change in magnitude (Pg) of about 0.28 while for ωCen, the m_{pg} changes by about 0.3 for a period change from 0.6d to 0.9d. They propose to use the P-L

relation to evaluate the reddening in several globular clusters and dwarf spheroidal galaxies.

Objective-grating spectra for 44 galactic clusters were obtained with the 102 cm Kavalur reflector as part of the program of galactic cluster photometry by Bappu and Babu. Twenty-eight of these are well studied ones and are being used for calibration. Of the remaining 16, they find that five clusters possess stars of B3 or earlier spectral types. Out of these five clusters, they have acquired photoelectric as well as photographic photometric observations for Ocl 506 and Ocl 499. In addition they have photometric observation in progress of Ocl 556 and Ocl 585 chosen from their preliminary survey. A preliminary examination of the observations shows that probably the latter clusters do not belong to the class of young clusters although they may be considered as marginal cases.

STELLAR ATMOSPHERES (THEORETICAL)

Mallik has arrived at a new birthrate of planetary nebulae based on a new set of distances for the local objects (≤ 1 kpc as projected on the plane) derived by applying the empirical mass-radius relation of Pottasch and Maciel to the Cahn and Kaler catalogue. Since most planetaries are optically thick, the distances in the Cahn and Kaler catalogue turn out to be over-estimates. Mallik has adopted a new approach to lifetime calculations appropriate for optically thick nebulae and has arrived at a number density in the solar neighbourhood of 46 ± 6 kpc^{-3} which is substantially lower than those of Cahn-Wayatt and Smith. The new density leads to a birthrate of $(3.0 \pm 0.5) \times 10^{-3}$ kpc^{-3} yr^{-1} which he finds is in good agreement with white-dwarf birthrate determined by Green.

Peraiah and his collaborators continued the work on partial frequency redistribution (PRD) in spectral lines with transfer of line radiation. Employing the PRD function R_{III} in the comoving frame they find that the differences in the level-population densities do not change significantly due to radial velocities of the gases. They have also considered the R_{III} and R_V in the rest frame. The wing emission is enhanced in the case of R_V compared to that of R_{III}.

The cores of R_V are deeper than those of R_{III}. They have considered only angle-averaged functions and a study of angle dependent R_{III} and R_V function is needed in both the rest frame and the comoving frame. They have derived numerically the shape of the emission profiles from the absorption profiles, employing the redistribution functions R_{II} and R_{III} and find approximation that the emission and absorption profiles are identical holds true only for a scattering medium; but in a partially scattering medium, these two profiles differ considerably.

They have commenced an investigation of the reflection effect from the components of close binary systems. As a first step, they plan to obtain the distribution of radiation field from the component's surface which receives the incident radiation. The problem does not conform to any symmetric aspects of radiative transfer (i.e.) neither plane-parallel, nor spherically-symmetric nor cylindrically symmetry. The boundary conditions are quite different from other symmetric problems. They have therefore invoked the rod model, plane parallel model and spherically symmetric model in their study.

Peraiah and collaborators have taken up the problem of interpretation of the profiles of the resonance lines observed in planetary nebulae. The C II resonance lines at 1334.5Å and 1335.7Å are observed in NGC 3242 in absorption and emission respectively. This can be understood on the basis of low population of the upper fine structure level ($2P_{3/2}$ with E.P. 64 cm^{-1}) of the ground state with respect to the lower $2P_{1/2}$. They have used the statistical equilibrium equation together with radiative transfer to derive a better representation of the population densities in different levels. Some of the nebular lines indicate that the radial velocities may be of considerable importance and therefore they are studying the effects of high velocities on the ionisation structure of the nebulae.

They have also in progress the study of the hydronamical aspects of the shell of the star Pleione.

Novae, Supernovae and Supernova Remnants

Shylaja has made scanner observations of Nova Coronae Austrinae 1981 from April through June 1981 corresponding to the nebular phase.

From a study of stellar deathrates derived from the frequency of supernovae, Prabhu and Kochhar find clear evidence for a variation in the slope of initial mass function (IMF) at the high-mass end, between different galaxies. Sc galaxies that are more prolific SN producers have more SN II (precursor masses 7 $M_{\odot}$) compared to SN I and thus have a flatter IMF. Spirals with a higher H I content, well-defined dust lanes and massive H II complexes all have a similar flatter IMF. The IMF is steeper in spiral galaxies with a lower content of gas and dust, and smaller H II regions. They have extrapolated these results to the ellipticals and lenticulars that have retained some of their gas or acquired some from their environments which may explain the paucity of SN II in ellipticals and lenticulars. It appears that the IMF is flatter whenever the environments are conducive to more vigorous star formation. This runs counter to the standard assumption that the IMF is independent of star formation rate.

Kochhar and Prabhu have also correlated the occurrence of supernovae (SN) with nuclear activity in elliptical (E) and lenticular (L) galaxies. They have argued that SB I come from short-lived stars and hence do not occur in a typical EL galaxy, which is gas free and does not form stars and only if an EL galaxy accretes matter from outside - from another galaxy or from the inter-galactic medium-then can form stars and produce SN. This gas will be seen as H I and/or dust, and eventually fall into the centre giving rise to nuclear activity. According to them, the radio and optical emission from the nuclei of EL galaxies and the occurrence of SN in them are related and the manifestation of the same phenomenon, namely, accretion of gas from outside. They have also shown that, contrary to the general belief, supernovic ELs are bluer than the non-supernovic ones.

Sastry and his collaborators have mapped the extended supernova remnant HB9 (G 160.5 + 2.8) and IC 433 (G 189.1 + 2.9) at 34.5 MHz

with the Gauribidanur Radio Telescope* with a resolution of 26 x 40 arcmin^2. They obtain an integrated flux density of 750 $\pm$ 150 Jy for HB9 and a constant spectral index of - 0.58 $\pm$ 0.06 in the range 34.5 MHz to 2700 MHz without any spectral break. They do not find any significant variation of spectral index across the remnant. IC 433 has an integrated flux density of 440 $\pm$ 88 Jy and a spectral index of - 0.36 $\pm$ 0.04 in the frequency range from 20 MHz to 10700 MHz. They attribute the reduction in flux at a very low frequencies to free-free absorption in the interstellar medium and/or in the H II region S249.

Vinod Krishan has investigated the synchrotron radiation spectrum in an inhomogeneous magnetic field keeping in mind the magnetic field in some of the cosmic sources which may acquire a periodicity in space as well as in time. The radiation from a relativistic electron beam in a periodic magnetic field differs significantly from the one in a uniform magnetic field. The aim is to provide a single mechanism for the generation of radio to hard X-ray radiation in sources like the Crab Pulsar.

Interstellar Grains

Shah has undertaken the study of model reflection nebula containing mixture of the interstellar grains in the case of the star within the nebula. The nebular geometry is in the form of plane-parallel homogeneous slab. The wavelength dependent indices of refraction have been incorporated throughout the present work for each of the grain species consisting of ice, graphite, enstatite silicate and silicon carbide. Shah has considered separately one-two, and three-component mixtures of the grains in various proportions of their number densities. Each of the grain species follows a properly normalised size distribution function. The calculations have been carried out on the UBV colours and polarisation that can be caused

---

*The Gauribidanur Radio Telescope is operated jointly by the Indian Institute of Astrophysics and Raman Research Institute.

by the representative mixtures of the grains in the model reflection nebula containing the star within. He finds that a general agreement with observation of the Merope reflection nebula provided materials like ice, graphite and enstatite silicate are chosen for the calculations. It appears that SiC is not an important component of the grain mixture at least in the case of Merope reflection nebula.

Ionised Hydrogen Regions in our Galaxy

Detailed maps of two galactic thermal sources, the Rosette Nebulae and W 51 have been obtained by Sastry and his collaborators with the Gauribidanur Radio Telescope. They have derived an average kinetic temperature of around 4500 K for the Rosette Nebula which agrees well with the earlier measurements based on recombination lines and high frequency continuum.

Galaxies

The study of the stellar content of galaxies is important to know the kinds of stars that populate galaxies of different morphological types. A knowledge of the stellar content in Our Galaxy is available in a skeletal form derived from studies of spectra of individual stars and star clusters in different directions. To a similar study of other galaxies, the most promising approach would be the spectroscopy or photometry of the integrated light from the stellar aggregates constituting the galaxy. As an exploratory investigation, Pati and Bappu have obtained spectrograms of five galaxies in the spectral regions 5000Å-8800Å at a dispersion of 220-250Å/mm with the cassegrain image tube spectrograph. Apart from H-alpha they have identified a few other population discriminants like the Na I doublets, and titanium and vandium oxide bands longward of the atmospheric A band. The infrared Ca II triplets and pottasium lines at 7665 and 7699Å were detected marginally. They have plans to extend this to cover a large number of galaxies with a faster system.

Mallik has completed an investigation on chemical yields and stellar birthrates. The estimates of chemical yields are important in stellar and galactic evolution studies. While they provide

constraints on the theory of advanced stellar evolution and nucleosynthesis, they also provide essential clues to the overall past rate of nucleosynthesis and hence the history of stellar birthrate is assumed to be known. In his earlier calculations Mallik had used the stellar evolution data for massive stars based on the $M - M_{\alpha}$ relationship of Chiosi and co-workers with mass-loss evolutionary sequences. Recently Maeder has shown that the mass loss from massive stars does not substantially alter the mass of the He core in the post H-burning era. As a result the chemical yields are nearly the same as those derived from conservative stellar evolutionary sequences. Applying the Initial Mass Function of Lequeux to Maeder's data, Mallik has derived first the current yields, then the ratio $\Delta y / \Delta Z$ and finally the variation of the star formation rate over the galactic history. He has also calculated the nucleosynthetic yields from intermediate-mass stars using the recent stellar models of Renzini and Voli which include the effects of hot bottom burning. His results show that even under the most favourable circumstances the theoretical $\Delta Y / \Delta Z$ falls below the observed value of this ratio, the heavy element yield is generally higher than observed and the variation in the star formation rate is larger than what is predicted from the age-metallicity relation of stars. The intermediate mass stars contribute substantially to He production (~ 47%) and to the production of CNO elements (~36%).

High Energy Astrophysics

Das has applied the conformal gravity QSO models developed earlier by him and Narlikar of Tata Institute of Fundamental Research, to a few specific cases to interpret the alignment of quasars in close pairs, triplets or in groups of larger numbers both with the same redshifts as well as with widely different redshifts. Their investigation shows that the double QSO 0957 + 561 A & B may be a pair of similar QSOs ejected from the nearby galaxy NGC 3079. They have arrived at a similar conclusion in the case of 1548 + 114 a and b and Ton 155 and 156.

Continuing his attempts to interpret the observed superluminal ($v>C$) speeds of expansion of radio sources in terms of large

velocity magnification, Das finds the need to replace the post-Newtonian approach by "Stiff" equations of state to represent the dense central matter and full general relativistic treatment. He has commenced detailed work on these lines.

A considerable number of QSOs are found to be close to galaxies. Except in very few cases whose optical connections between the QSOs and galaxies are apparent such as MKN 205 and NGC 4319, the association can be confirmed as real, or rejected as chance coincidence only by statistical methods. Methods of analysis employed so far by authors do not seem satisfactory enough to lead to unambigous conclusions. Das and Sivaram have commenced a reanalysis of the quasar - galaxy association data to estimate their significance.

Kapoor has studied the nontangential emission of photons in the orbital plane by a monochromatic source of radiation orbiting a black hole in an eccentric orbit using geometrical optics. He has examined the frequency shift in radiation which is a combination of Doppler effect and gravitational redshift for various angles of emission. For compact orbits, purely on geometrical grounds, he finds that features of astrophysical interest are observed, namely, the spectral line broadening with an asymmetrical profile in the case of a stellar mass black hole and peculiar line oscillations in the case of a supermassive blackhole.

The astrophysical importance of the negative positronium ion identified recently in the laboratory is gaining ground. Sivaram and Vinod Krishan find that the presence of Ps^- ions will contribute additionally to the width of the 0.511 MeV γ ray line formed by pair annihilation. The formation of Ps^- ion from an aggregate of electrons, positrons and positronium results in a variable positron in the 0.511 MeV γ ray line source.

Vinod Krishan and Sivaram have examined the neutron-antineutron oscillations in the neutron rich astrophysical sources such as solar flares, supernova explosions, neutron stars and the nucleosynthetic phase of the early universe in an attempt to account for

the antiproton flux of cosmic rays at low energies and γ ray emission at GeV energies. The low magnetic fields and high neutron concentration provide the right environment for the production of antineutrons and hence antiprotons and GeV γ rays.

Sivaram has sought to understand Weinberg's unexplained empirical relation for the typical mass of an elementary particle $m \sim (\kappa^2 Ho/GC)^{1/3}$. He concludes that the relation is an operational constraint (in the Machian sense) on the mass of the particle (defined in terms of its self-gravity) imposed by invoking the combined effect of the uncertainty principle and cosmology. He has also studied the cosmological evolution of neutrino/antineutrino ratio. From a study of thermonuclear processes during different stages of stellar evolution, he concludes that during one Hubble time, a universe with a net baryon number develops an excess of neutrinos over antineutrinos. The excess is of the same order as the observed relative strength of CP violation in kaon decay.

SOLAR-TERRESTRIAL RELATIONSHIPS

Hanumath Sastri has made a detailed investigation of the relationship between the depth of the equatorial ionisation anomaly (EIA) and the evening rise of F-region at the dip equator, based on ionosonde data of stations in the Indian sector corresponding to a two year period of high sunspot activity. He finds that the day-to-day variability in the post-sunset rise of F-region at the dip equator has a significant positive correlation with that of EIA depth, and a significant negative correlation with the peak ionisation density of F-region at the dip equator during all seasons and on geomagnetically quiet as well as disturbed days. The day-to-day changes of peak ionisation density of F-region at the EIA crest latitude exhibit a significant positive correlation, with a decay of 2 hours, with those of the evening rise of F-region at the dip equator, irrespective of season and level of geomagnetic activity except during quiet days of local winter months. These salient findings of the study are in accordance with the prevailing consensus that the post-sunspot activity is due to a renewal of the 'fountain' mechanism.

in the Indian sector; the conspicious absence of a significant relationship of the day-to-day variability of peak ionisation density of F-region at the crest latitude of EIA with that of the post-sunset height rise of F-region at the dip equator during quiet days of winter months; he suggests this is due to the effect of poleward neutral air winds.

Hanumath Sastri continued his studies of the phase variability of Sq(H), the Solar quiet day variation of the H-component of geomagnetic field in the equatorial electrojet regions. He finds that on days with an abnormal Sq(H) phase limited to the electrojet belt, the ionospheric equatorial anomaly either disappears or reduces in strength quite consistently within about 2 hr of the onset of complete or partial counterelectroject (CEJ) conditions, responsible for the occurrence of abnormal Sq(H) phase. Further, the remarkably poor development of the anomaly in the afternoon period in the Indian sector as compared to that in the East Asian Sector reported very recently in the literature, has been shown by him to occur only on days with an abnormal Sq(H) phase in the Indian equatorial electro jet region. These results lend substantiative support to the inference of his recent studies that the occurrence of an abnormal Sq(H) phase in the electrojet belt is closely associated with perturbations in the electrojet electric field. He investigated further the causative mechanism(s) of Sq(H) phase variability on 'normal quiet days' (NQDs) in the equatorial electrojet regions. He finds that much, if not all, of the phase variability of Sq(H) on NQDs may be caused by the influence of southward (negative) perturbation fields in H-component, similar in nature to those that occur on 'abnormal quiet days' (AQDs), but of much smaller amplitude and close to the normal time of the diurnal maximum of H-component. The perturbation fields are inferred to be essentially of the ionospheric dynamo region origin and represent changes in the electrojet current brought about by variability in the local vertical wind structures and/or in the electron density profiles of the E-region.

Hanumath Sastri and Ramesh obtained evidence to show that

the longitudinal extent of the forenoon bite-out (FNB) in the diurnal variation of F_0 F_2 at low geomagnetic latitudes can sometimes be very narrow, and that marked differences in the extent of development of FNB can occasionally occur at locations separated in longitude by about 3 hr. They have in progress further analysis of data to confirm the trends noticed in the preliminary study as regards the dependence of the localised development of FNB on season and level of geomagnetic activity.

LIBRARY

During the year 1981-82, 350 books and 34 reports were added to the Library. The library subscribed to 122 journals and continued to receive publications, preprints and reprints from other institutions on an exchange basis.

234 CM TELESCOPE PROJECT

The dome for the 2.3 metre telescope is undergoing commissioning trials. Electrical busbar system will also be commissioned at the same time. Cassegrain platform hydraulic system erection has been completed and it awaits trial runs.

Work on the fabrication of telescope mount has progressed rather slowly at Walchandnagar in spite of continuous monitoring and expediting. Shop assembly is expected to start by September 1, 1982. Electronic controls for shop testing has been made ready at BARC. Control systems and console fabrication and wiring is progressing at BARC.

Polishing and figuring of primary mirror is progressing satisfactorily in spite of a setback on account of nonavailability of Cerium Oxide. Work on secondary mirrors will continue shortly. A 2.8 metre aluminising plant has been erected in the observatory building and commissioning trials will be undertaken shortly.

INSTRUMENTATION AND TECHNIQUES

Major project was the design and development of the control and data acquisition system for the 234 cm telescope project, in which considerable progress was achieved. The scope has been divided into four separate tasks (i) Development of analog inner control loops for two axes and digital overall loops (ii) Development of incremental and absolute position encoder readouts and conversion systems (iii) Development of auxiliary system of motor controls and encoder readouts complete with the console and communication design and (iv) Development of interface and software for linking with a powerful computer system.

Notable advances were achieved in all four tasks. Analog loops for testing telescope movements at the workshop was designed and got ready; computer simulation of the completed telescope control loop is under way. Digital loops using microprocessors have been designed and are awaiting simulation trials. Raghu has completed encoder readout and display system and has taken up the process of integration of this with the overall control system. Santhanam has designed the auxiliary motor control and encoder readout arrangements and a laboratory model on that basis is being set up. Development of interface and software for the computer link up has commenced by Venkatesan. Part of the program is being done by our engineers at the laboratories of the Bhabha Atomic Research Centre under a collaborative program. Simulataneously the equipment for intensified television cameras for use with 234 cm telescope was tested on the 102 cm telescope and kept ready for incorporation with the completed system.

Work on CCD imaging of faint astronomical objects continued in the laboratory. Chandramohan completed a hardware system for digitisation of images and storing the same in buffer memories.

In view of the great potentialities of two crossed Babinet compensators in the testing of concave aspheric surface, a technique developed by Saxena, a theoretical analysis has also been developed by him of the fringe profiles of the pattern. This provides

a suitable guideline for the best selection of test configuration. He has designed and fabricated a recorder for recording the polarisation interferograms, Hartmann plates and shadowgrams. This facility is used for recording of interferograms for the 2.34 metre primary and other mirrors to evaluate the quality of the surfaces in the course of mirror polishing work.

Prabhu and Sunetra Giridhar have developed software facility compatible with the desk top microcomputer HCL Micro 2200 linked to the microdensitometer for digital reduction of spectrograms. The software package consists of a set of programs which are not linked anticipating user-interaction. The plate characteristics are determined from the digitised data of a calibration plate. Baker transformed densities (log d) are used since the characteristic curve has the least non-linearity in this representation. A polynomial fit is obtained for this curve. A program which determines maximum/minimum deflection in a given interval of data helps in determining the pseudo-continuum. After discarding the points which have not reached the continuum, a polynomial fit to the continuum is obtained. An averaging routine helps the evaluation of the mean background as a function of position (e.g. in the case of the image-tube spectra). The spectrophotometric data are then smoothed by a triangular smoothing function converted to relative intensity units, interpolated background is subtracted and reduced to continuum intensity. Two version of line identification routine are available for determining the positions of absorption/emission lines. A polynomial fit may be obtained for the wavelength scale on the plate. The spectrum may finally be interpolated at regular intervals in wavelength and printed out.

Jain has conducted several experiments and obtained interferograms from an automated version of a laboratory model of Michelson interferometer with a view to design and fabricate a Fourier Transform Spectrometer for high resolution studies in the infrared.

Considerable progress has been made by Hanumath Sastri regarding the development of the HF coherent phase path sounder.

Wiring of the EHT unregulated power supplies and the various stages of the transmitter unit is completed. Integration of the phase path sounder has been completed and the transmitter is made operational in March 1982. Installation of the transmitting and receiving antennas, overall integration of the sounder and starting of field trials to assess the performance of the system are to be taken up very shortly.

Observing Conditions at Kavalur and Kodaikanal

There were 1581 hours of observing at Kavalur. Photometric skies were available for 627 hours. On 96 nights spectroscopic work was

Table I

Hours of observation and seeing at Kavalur

Month	Hours of spectroscopic work	Hours of possible photometry	Number of nights when spectroscopic work 9 hours or greater was done	Number of nights with average seeing better than 1.5"
1981 Apr	169.0.	49.0	7	7
May	144.5	44.0	7	3
Jun	27.5	1.0	0	0
Jul	25.0	0	0	0
Aug	39.0	0	0	0
Sep	48.5	12.5	2	0
Oct	78.0	13.0	1	0
Nov	132.0	87.0	10	9
Dec	168.0	56.0	11	5
1982 Jan	246.5	60.5	19	4
Feb	266.0	184.0	21	15
Mar	237.0	120.0	18	10
Total	1581.0	627.0	96	53

carried out for a duration of 9 hours or more. Average seeing better than 1.5 seconds of arc prevailed on 53 nights. The month-wise distribution of these features are given in Table I.

Solar observations were made at the Kodaikanal tower

Table II

Number of days of observation and seeing at Kodaikanl

Month and year	Number of days of observation	Seeing	
		Greater than 2 and less than 4"	4" or greater
1981 Apr	19	7	12
May	18	7	11
Jun	4	3	1
Jul	13	4	9
Aug	10	3	7
Sep	10	6	4
Oct	4	4	0
Nov	13	6	7
Dec	18	7	11
1982 Jan	25	8	17
Feb	27	17	10
Mar	26	17	9
Total	187	89	98

STAFF

M.K.V.Bappu, PhD	: Director
J.C.Bhattacharyya, DPhil	: Professor
M.H.Gokhale, PhD	: Associate Professor
A.Peraiah, DPhil	: Associate Professor
Ch.V.Sastry, PhD	: Associate Professor
G.A.Shah, PhD	: Associate Professor
K.R.Sivaraman, PhD	: Associate Professor
P.K.Das, PhD	: Reader
J.Hanumath Sastri, PhD	: Reader
N.Kameswara Rao, PhD	: Reader
R.K.Kochhar, PhD	: Reader
P.K.Raju, PhD	: Reader
S.Sirajul Hasan, PhD	: Reader
Vinod Krishan, PhD	: Reader
K.C.Abdur Raheem, BSc	: Fellow
Jagdev Singh, MSc	: Fellow
S.K.Jain, PhD	: Fellow
R.C.Kapoor, PhD	: Fellow
Mahipal Singh, DPhil	: Fellow
D.C.V.Mallik, PhD	: Fellow
M.Parthasarathy, PhD	: Fellow
T.P.Prabhu, PhD	: Fellow
R.Rajamohan, PhD	: Fellow
A.K.Saxena, PhD	: Fellow
K.K.Scaria, PhD	: Fellow
P.Venkatakrishnan, MSc	: Fellow
G.S.D.Babu, MSc	: Research Associate
S.P.Bagare, PhD	: Research Associate
M.Jayachandran, MSc	: Research Associate
A.K.Pati, MSc	: Research Associate
A.V.Raveendran, MSc	: Research Associate
K.R.Subramanian, MSc	: Research Associate
B.S.Shylaja, MSc	: Research Associate
G.Thejappa, MSc	: Research Associate
Sushma Vasu Mallik, PhD	: Post Doctoral Fellow
Bhaskar Datta, PhD	: Visiting Fellow
C.Sivaram, PhD	: Visiting Fellow

The technical, administrative and non-technical maintenance staff numbered 254.

COUNCIL MEETINGS

The Governing Council had two meetings during the year one at New-Delhi and another at Bangalore.

BIBLIOGRAPHY

Babu, G.S.D.
Shylaja, B.S.
Spectrophotometric studies of Ap stars - Astrophys. Sp. Sci., 81, 269.

Babu, G.S.D.
Shylaja, B.S.
Spectrophotometric studies of Am stars - Astrophys. Sp. Sci.,83, 367.

Bagare, S.P.
Murthy, N.S.
Intensity distribution in the $A^2\Pi$-$X^2\Sigma^+$ System of YO - Pramana (in press)

Bappu, M.K.V.
Chromospheric emission intensities and stellar evolution - Current Science 51, 24.

Bappu, M.K.V.
Liller, W.
Occultation of BD-19°4222 by Uranus - IAU Circular No.3599.

Bappu, M.K.V.
Uchida, Y.
Chromospheric activity of late type giants and supergiants I. Reappearance of dynamo activity in the interior due to the spin-up of the core in evolution - J.Astrophys.Astr. (in press)

Bhattacharyya, J.C.
Lunar occultation techniques in binary investigations - Proc. Second Asian-Pacific Regional Astronomy Meeting, Bandung.

Bhattacharyya, J.C.
Occultations: A precise method in astronomical studies - A review, Current Science, 51, 443.

Bhattacharyya, J.C.
Role of basic search in science - Sci. Culture, 48, 56.

Das, G.C.
Characteristics of damping of pulses on the Sun - Sol.Phys.71, 215.

Gokhale, M.H.
Sivaraman, K.R.
The two components in the distribution of spot groups with respect to their maximum areas - J.Astrophys. Astr. 2, 363.

Gokhale, M.H.
Sivaraman, K.R.
Phase difference between the two components of the solar cycle - Bull. Astr. Soc. India (in press)

Hasan, S.S.
Venkatakrishnan, P.
The transient response of the solarwind to changes in flow geometry - Solar Phys. (in press)

Jagdev Singh
Bappu, M.K.V.
Saxena, A.K.
Eclipse observations of coronal emission lines 1. FeX 6374Å profiles at the eclipse on 16 February 1980 - J.Astrophys. Astr. (in press)

Kameswara Rao, N.
Nandy, K.
Ultraviolet observations of the Hydrogen deficient variable star MV Sagittarii J.Astrophys. Astr. 3, 79.

Kameswara Rao, N. Rajamohan, R.	Spectrum variability of HD 147010 - IBVS No.2121.
Kameswara Rao, N. Rajamohan, R.	HD 147010: The Ap star in the reflection nebula V&B 102 in Upper Scorpius region - J.Astrophys.Astr. (in press)
Kapoor, R.C.	On the frequency shift in radiation from a source orbiting a black hole - Bull. Astr. Soc. India, 9, 232.
Krishan, V.	Excitation of high - M tearing modes at the solar flare site - Sol.Phys. (in press)
Krishan, V. Sivaraman, K.R.	Peculiarities on the ionic tail of Comet Ikeya Seki (1965f) - Moon Planets, 26, 209.
Krishan, V. Sivaram, C.	Astrophysical consequences of neutron - antineutron oscillations - Astrophys. Sp. Sci. (in press)
Mallik, S.V.	A study of the H-alpha line in late G and K supergiants - J.Astrophys. Astr. 3, 39.
Mekkaden, M.V. Raveendran, A.V. Mchin, S.	Spot activity in the RS CVn Binary HR 1099 - J.Astrophys. Astr. 3, 27.
Murty, P.S.	CO in the IUE spectrum of comet Bradfield (1979 1) - Moon Planets, 26, 101.
Murty, P.S.	New identifications of YO and CeO in R Cygni - Astrophys. Lett. (in press)
Peraiah, A.	On the Balmer progression in the expanding shell of Pleione - J.Astrophys. Astr. (in press)
Peraiah, A.	Flux vector splitting of the inviscid radiation gasdynamic equation - Kodaikanal Obs. Bull. (in press)
Peraiah, A.	Transient solution of equations of hydrodynamics in gas clouds - Kodaikanal Obs. Bull. (in press)
Rajamohan, R. Venkatakrishnan, P.	Synchronisation in Binary stars - Bull. astr. Soc. India, 2, 309.
Raveendran, A.V. Mekkaden, M.V. Mohin, S.	HD 81410: A new RS CVn Binary - Mon. Not. R. astr. Soc., 199, 707.
Raveendran, A.V. Mekkaden, M.V. Mohin, S.	On the photometric period HD 81410 - IBVS No.1975

Santhanam, P. Panchapakesan, S. Krishnan, A.	Software for a simple 2 axis NC system - Microprocessors and Microsystems (in press)
Sastri, J.H.	Post sunset behaviour of the equatorial anomaly in the Indian sector - Indian J. Radio Space Phys. 11, 33.
Sastri, J.H.	Phase variability of Sq(h) and the iono spheric equatorial anomaly - Indian J. Radio Space Phys. 11, 83.
Sastri, J.H.	Phase variability of Sq(H) on normal quiet days in the equatorial electrojet region - Geophys.J. R. astr.Soc. (in press)
Sastri, J.H. Ramesh, K.B.	Forenoon bite-out in foF_2 at low latitud - Indian J. Radio Space Phys. 11, 81.
Sastry, Ch.V. Dwarakanath, K.S. Shevgaonkar, R.K.	The structure of the Cygnus Loop at 34.5 MHz. - J.Astrophys. Astr. 2, 339.
Sastry, Ch.V. Subramanian, K.R. Krishan, V.	Absorption bursts in the radio emission from the Sun at decameter wavelengths - Astrophys. Lett. (in press)
Saxena, A.K. Lancelot, J.P.	Theoretical fringe profiles with crossed Babinet compensators in testing concave aspheric surfaces - Appl. Optics (in press)
Scaria, K.K.	Isodensitometry of Omega Centauri and 47 Tucanae - Kodaikanal Obs. Bull. Series A, 3, 36.
Scaria, K.K. Bappu, M.K.V.	Distribution of blue horizontal branch stars in the cluster Omega Centauri and its effect on the radial change in colou and ellipticity of the cluster - Proc. Second Asian-Pacific Regional Astronomy meeting, Bandung.
Scaria, K.K.	Integrated brightness and colour of Omega Centauri - Bull. astr. Soc. India (in press)
Shah, G.A.	Optical colours and polarisations of a model reflection nebula. II. Mixture of grains in the case of the star within the nebula - Bull. astr. Soc. India, 9, 297.
Shevgaonkar, R.K. Sastry, Ch.V. Dwarakanath, K.S.	Observations of the supernova remnants HB9 and IC 443 at 34.5 MHz.-J.Astrophys. Astr. (in press)
Sivaram, C.	Cosmological and quantum constraint on particle masses - American J. Phys., 50 279.

Sivaram, C.	Asymmetric lepton production in a universe with non-zero Baryon number - Astrophys. Sp. Sci. 82, 485.
Sivaram, C. Krishan, V.	Possible effects of positronium negative ion on 0.511 Me V γ ray line in Astrophysical sources - Astrophys. Sp. Sci. 85, 31.
Sivaram, C. Krishan, V.	Neutron Oscillation as a source of low-energy galactic cosmic ray antiprotons - Nature (in press)
Sivaraman, K.R.	K2v/K2r asymmetries in the Sun and stars - Astrophys. J. 254, 814.
Sivaraman, K.R. Livingston, W.C.	Ca II K2v spectral features and their relation to small scale photospheric magnetic fields - Sol. Phys. (in press)
Thejappa, G. Sastry, Ch.V.	Time structure of solar decameter type III radio bursts - J. Astrophys. Astr. (in press)
Venkatakrishnan, P.	Influence of solar wind variability on the recurrence of draughts - Sol. Phys. (in press)
Venkatakrishnan, P.	Wave propagation in solar magnetic tubes - Bull. astr. Soc. India, 9, 214.
Viswanath, C.	Automated microdensitometer - Kodaikanal Obs. Bull. (in press)

SCIENTIFIC MEETINGS

Dr.M.K.V. Bappu was on a Senior Fellowship of the Japan Society for the Promotion of Science from May through July. He attended the IAU Executive Committee meeting at Tbilisi, U.S.S.R. and subsequently visited the observatories of Kislovodsk, Zelenchuck, Crimea and Leningrad in July/August. He also attended the 14th meeting of ICSU General Committee at Dubrovnik, Yugoslavia in September and the meeting of the International Halley Watch Steering Group at NASA, Washington in November. He was on a visiting programme at the Physical Research Laboratory, Ahmedabad as Vikram Sarabhai Professor from November 1981 through January 1982. Dr.Bappu attended the IAU officers meeting in Patras, Greece in February 1982. Mr. A.K.Pati spent two weeks in August/September at the Anglo Australian Observatory, to study the various control systems on the Australian Telescope. Dr.M.Parthasarathy continued with his Fellowship at the McDonald Observatory.

Following scientific meetings were attended by scientists of the Institute who vitally contributed to the discussions and proceedings:

Drs.M.K.V.Bappu, J.C.Bhattacharyya, K.K.Scaria and Mr.A.K.Pati	Second Asian-Pacific Regional Astronomy Meeting, Bandung, Indonesia, 24-29 August, 1981
Dr.J.C.Bhattacharyya	Interdisciplinary approaches to Geomagnetism Workshop, Indian Institute of Geomagnetism, Bombay, May 1981
Dr.J.H.Sastri	J.S.Shirke Memorial Symposium-cum -Workshop on Aeronomy in Eighties, Physical Research Laboratory, Ahmedabad, October 1981.
Drs.J.C.Bhattacharyya, K.R.Sivaraman, Ch.V.Sastry, V.Krishan, R.K.Kochhar, N.Kameswara Rao & G.S.D.Babu	Astronomical Society of India meeting, University of Roorkee, Roorkee, November 1981.
Drs.M.K.V.Bappu, J.C.Bhattacharyya, K.R.Sivaraman, A.Peraiah, A.K.Saxena and S.K Jain	Indo-US Workshop on High Resolution Molecular Spectroscopy, Bhabha Atomic Research Centre, Bombay, December 1981.

Drs.R.C.Kapoor, C.Sivaram and P.K.Das	Workshop on Relativistic Astrophysics and Gravitation, Physical Research Laboratory, Ahmedabad, January 1982.
Drs.M.K.V.Bappu, J.C.Bhattacharyya, K.R.Sivaraman, J.H.Sastri, V.Krishan, D.C.V.Mallik, Mr.G.S.D.Babu & Mr.Jagdev Singh	National Space Science Symposium, Indian Institute of Science, Bangalore, February 1982.

VISITING SCIENTISTS

Scientists who visited the Institute and its field stations and gave colloquia include Prof.C.Uberoi of Indian Institute of Science, Bangalore, Dr.V.B.Sheorey of Physical Research Laboratory, Ahmedabad, Prof.W.Liller of Harvard College Observatory, Cambridge, Massachusetts, Dr.V.I.Makarov of Kislovodsk Station of the Pulkova Observatory, Leningrad, Dr.A.A.Spitalnaya of Pulkova Observatory, Dr. A.P. Gilra of Kapteyn Astronomical Institute, Groningen, Prof.M.R.Kundu of University of Maryland, U.S.A., Dr.Paul J.Wiita of University of Pennsylvania, Prof.S.M.Alladin of Osmania University, Hyderabad, Dr. Bhaskar Datta of Tata Institute of Fundamental Research, Bombay, Dr. K.Shivanandan, Space Infrared Astronomy Section, Naval Research Laboratory, Washington, U.S.A., Dr.B.M.Shustov, Astronomical Council, Academy of Sciences, Moscow, U.S.S.R., Prof.T.Kogure, Department of Astronomy, University of Kyoto, Japan, Shri T.Panchatsaram of Department of Astronomy, Osmania University, Hyderabad, Mr.Shrinivas Kulkarni of University of California, Berkeley, U.S.A., Dr.D.B.Jadhav of Uttar Pradesh State Observatory, Nainital.

Prof.Z.Kopal of University of Manchester, U.K., visited Institute and gave a course of lectures from February 24, 1982 to March 10, 1982.

Rajan