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SOLAR PHYSICS

Elaborate preparations for the total solar eclipse of 1983 June 11 in Indonesia were made. The eclipse camp was set up at Tanjung Kodok, a small piece of rocky land overlooking the Java sea near Paciran, a village on the north east coast of Java.

Sivaraman & Singh have derived the two dimensional temperature distribution in the corona from the analysis of the spectra of the 5303\AA coronal emission line using the multislit spectrograph at a dispersion of 2.2\AA mm^{-1} . The slits of the spectrograph were oriented approximately along the solar equator and the spectra were obtained with a single stage image intensifier. From two of the spectra (of 30 and 50s exposure) they have derived line profiles and hence the line widths of the green coronal line at 114 locations within the coronal line ranging from 1.04 to $1.24 R_{\odot}$. The line widths vary from 0.6\AA to 1.4\AA and if wholly ascribed to thermal broadening correspond to a temperature of $1.4-6.5 \times 10^6\text{K}$. The most frequent line widths of 0.9\AA imply a kinetic temperature of $3.1 \times 10^6\text{K}$. According to the ionization equilibrium calculations of Jordan, the FeXIV ions are in maximum abundance at a temperature and the ionization equilibrium calculations is explained as usual by assuming turbulence which in the present eclipse works out to a mean value of 16 km s^{-1} . The value of turbulence derived from such measurements with the 6374\AA line during the eclipse of 1980 was 30 km s^{-1} . This indicates possible dependence of the mean turbulence in the corona on solar activity.

Sivaraman & Singh also obtained the spectra in the 6374\AA line using a second multislit spectrograph with its slits parallel to the rotational axis of the sun. Using the Neon lines as the reference which was simultaneously recorded during the eclipse, they have computed the mean wavelength of the coronal line on the east and the west limb and from this derived a value of 3.5 km s^{-1} for the rotational velocity of the sun which compares well with the photospheric value.

Another experiment that was successfully performed was to measure quantitatively the amount of neutral hydrogen present in the corona from monochromatic images of the corona obtained with the help of a birefringent filter. The monochromatic images were scanned using the optronix microdensitometer by Sivaraman during his visit at the Kiepenheuer Institut, Freiburg. Further processing of the data is in progress.

Sivaraman & Singh have started reducing the data obtained from the other two 1983 eclipse experiments, namely, monochromatic pictures of the solar corona in H-alpha and the broadband pictures of the solar corona.

Singh discussed the relative roles of radiative and collisional excitation mechanisms in the solar corona, by using the line and continuum intensities deduced from the multislit spectra of the Fe X coronal emission line taken at the 1980 eclipse. He has shown that for $R/R_{\odot} < 1.2$, collisional excitation is the predominant mode. Collisional as well as radiative excitation is equally important for $1.2 < R/R_{\odot} < 1.4$, whereas beyond $1.4 R_{\odot}$ radiative excitation becomes dominant.

Sivaraman, Jayachandran, Scaria, Bagare, Babu and Jayarajan have studied the brightness, polarization and electron density in the solar corona of 1980 Feb 16.

Sivaraman has completed his investigation of quantitatively establishing the contribution of the bright points of the Ca II K solar chromosphere to the variations in the K-line profile of the sun viewed as a star. The two ways by which these bright points can participate in the variations are by a change in their total number over the solar surface and by a change in their emission output between solar maximum and minimum. The number counts of these bright points in the interior of the Ca^+ network for four solar cycles, choosing a batch of 10 plates representing each solar maximum and each solar minimum epochs, was evaluated from a count covering 125 network cells on each plate.

He finds that the number of bright points during a solar maximum exceeds that during a solar minimum on an average by about 30%. He concludes from this finding that the integrated K-line profile of the sun during a solar maximum does contain the cumulative contributions due to this excess number of bright points populating the solar surface as compared to the solar minimum period. The work on estimating the contribution from the network boundaries to the integrated K-line profile is in progress.

Bagare continued the long term projects of recording the sunspot magnetic fields and of obtaining the integrated spectra of the sun. The analysis of spectra obtained for the study of relation between the K-line parameters and the magnetic fields of plages is nearing completion. The time sequence and spectral sequence of data in K-line and the velocity measurements from H_{α} observations for the solar flare of 1982 April 14 were analysed. It was observed that the velocity inversion layer follows the ribbon of the flare.

The photoelectric scanning device which was designed and made last year was put into operation to obtain scans of the Ca II K line in the integrated sunlight at the solar tower telescope. A few interesting flare and prominence events have been observed and the data are to be analysed shortly.

It has been observed that there are variations in the integrated K-line parameters which could probably be associated with the calcium plage distribution on the sun and this may be relevant in the study of solar rotation as also rotation of stars with considerable calcium emission.

The microdensitometer at Kodaikanal has been improved for stability of the light source.

Bhattacharyya, Balasubramaniam (Joint Astronomy Program) & Venkatakrisnan have started work on a program to measure the vector magnetic field in the active regions on the sun using the Zeeman-sensitive line 6302 \AA . Their method consists in photographically recording the four Stokes parameters I, Q, U and V of this spectral

line on several positions of an active region, thus obtaining information on the three dimensional pattern for the vector magnetic field. To do so, they have modified the existing spectrograph of the solar tunnel at Kodaikanal by incorporating the polarimeter within the Littrow arrangement.

In order to eliminate the instrumental polarization due to the coelostat mirrors and the grating spectrograph system, the Mueller matrix of each to these is being determined. In the case of the coelostat mirrors, the Mueller matrix obtained from the Fresnel's equations of electromagnetism has terms containing the complex refractive index.

An ellipsometric method of determining the complex refractive indices is being tried. For the grating spectrograph the Stokes parameters of the output beams corresponding to various input beams of known polarization characteristics have been measured. From these measurements the wavelength-dependent Mueller matrix of the spectrograph will be known.

The solar active regions, KKL 18121 and 18125 flared recurrently between 1984 February 22 and 28, first detected by the $H\alpha$ flare patrol at Kodaikanal. The Stokes parameters for these regions have been recorded in the 6302.5A line and analysis is underway. The Stokes profiles of another active region KKL 18122 have also been recorded as this region moved across the disc during the same period.

Venkatakrishnan & Jain have started a program to study the temporal evolution of spicules by measuring the equivalent width of He I 10380A line on the solar disc. The measurements are being made by Dr W.C.Livingston at Kitt Peak National Observatory. Preliminary observations have shown some encouraging results. The work is still in progress. Synoptic observations of the sun were continued at Kodaikanal and the following is the summary of the observations made during the year.

	<u>No . of days</u> <u>of observation</u>
Photoheliograms	213
H-alpha spectroheliograms	201
K ₂₃₂ spectroheliograms	191
Prominence spectroheliograms K ₂₃₂	159

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

Gokhale, Hiremath & Javaraiah found that during each of the solar cycles 1923-33, 1933-44 and 1944-54 there were several sunspot groups whose rotation was abnormally fast or abnormally slow as compared to the mean rotation of sunspot groups at their latitudes. The latitudes at which such abnormally fast or abnormally slow rotating sunspot groups occur seem to shift systematically towards the equator during each cycle. However, the number of such spot groups is not statistically adequate to determine whether the shift in latitudes of such spot groups is an effect of the fast and slow latitude belts discovered by Howard & Labonte or merely an artifact of the butterfly diagrams.

Gokhale found (with Javaraiah's assistance) that there are two or three kinds of relations between the maximum areas, A_{\max} , and lifespans, T , of recurrent sunspot groups during each of the solar cycles 1923-33, 1933-44 and 1944-54. The presence of more-than-one A_{\max} - T relations indicates that magnetic flux tubes of different topological configurations contribute to each sunspot cycle. This provides another useful criterion for theoretical modelling of the solar cycle.

Gokhale found that his model of the solar cycle could account for the presence of downflows $\sim 3 \text{ kms}^{-1}$ within photospheric magnetic flux tubes, as observed by Giovanelli and others. However some recent observations by Harvey & Stenflo have led to doubts regarding the interpretation of the earlier observations. Therefore, at present,

the theoretical prediction only emphasizes the need for resolving the observational controversy.

Venkatakrisnan has completed his project on 'study of convection and magnetic fields on the sun'. The main results of this work are:

- i) buffeting of magnetic flux tubes by granulation leads to downflows within the tubes, and
- ii) inclusion of radiative heat transport in flux tube dynamics leads to oscillations in a tube which is convectively unstable. Thus the interaction of convection with magnetic flux tubes manifests itself both in the form of downflows as well as oscillatory motion. The concept of hydrostatic flux tubes hitherto prevalent in the literature is thus shown to be inconsistent with the dynamic nature of the tubes' environment as well as with the physics of radiating fluids undergoing magnetoconvection.

Assuming a multilevel model for hydrogen atom, Raju is computing hydrogen line emission intensities for an extensive cold region (electron temperature about 10^5K) within the corona. This study is relevant to an interpretation of Balmer lines seen in emission on the coronal spectrogram taken during total solar eclipses.

Sivaraman & Raju are developing a selfconsistent model for the coronal structure over an active region. The data used are the EUV line fluxes, in the lines C II 1335A, Lyman alpha, O VI 1032A, C III 977A, Mg X 625A and O IV 555A, obtained by the Skylab for the active region of 1973 September 11. In the initial phase of this study, the lines of Mg X and O VI were considered and the results reported at the 18th International Cosmic Ray Conference held at Bangalore, 1983 August 22 - September 3.

Raju is continuing diagnostic studies involving emission line intensity ratios of dissimilar elements of the chromosphere-corona transition region and the corona.

Krishan has derived steady state model of a coronal loop which

is based on the invariance of total energy, magnetic helicity and the magnetic flux of a given turbulent plasma. The state of minimum total energy corresponds to a single Chandrasekhar-Kendall function and is therefore force free. The derived radial temperature in the loop agrees well with the one deduced from observations of line emission in the optical and EUV range. Spatial variation of line flux is presented for the lines C II, C III, O IV, O VI, Ne VII, and Mg X. It is found that the hotter lines originate in the cool core of a loop in agreement with the observations. Further, the statistical mechanics of the velocity and magnetic fields is formulated. The plasma subjected to the conservation laws emerges in a most probable state which is described by an equilibrium distribution function containing a Lagrange multiplier for every conserved quantity. The Lagrange multipliers are determined to reproduce the measured expectation values of the conserved quantities. The expectation value of the total energy for a coronal loop is estimated from energy balance considerations. A measure of the root mean square velocity can be obtained from UV and EUV line data. There are no measurements of magnetic helicity and magnetic fluxes. Krishan has assumed some probable values for the invariants and these could be confronted with observations as and when they become available. Measurement of these invariants has been achieved in the case of solar wind plasma. The solar results can be extended to other stellar atmospheres where the direct measurements of magnetic helicity and magnetic fluxes may never be available.

Krishan has discussed and interpreted recent observations of the fast-time variability in the hard x-ray emission from solar flares. Spikes with time variations of the order of a few milliseconds are seen superimposed on the slowly varying x-ray emission. In the nonthermal model of x-ray emission, the time variability could result from electron acceleration and electron beam propagation effects. In the thermal model, the temporal fluctuations may result from an increase in emission measure during primary energy release phase of the solar flare and a decrease in emission measure due to convective and conductive cooling of the plasma. Krishan has proposed a quanti-

tative treatment based on disruptions in plasmas. The millisecond rise time corresponds to the impulsive heating of the plasma. This phase leads to a steepening of the current profile, and conditions for the excitation of $m = 1$ tearing mode are established. The fast fall time of x-ray spike then represents a quick cooling of the plasma due to the accelerating growth rate of the $m = 1$ tearing mode. The estimated characteristic time durations of an x-ray spike are found to be in good agreement with the observed ones.

Gopalswamy, Thejappa & Sastry continued their investigation of absorptions in the decametric continuum. They found that there is another way in which the intensity reductions in the continuum can take place, that is, the plasma fluctuations generated by a diffused electron beam can interact with ion-sound waves if a shock propagates through the source region, producing electromagnetic radiation that propagates away from the line sight thus causing the absorptions. In connection with the investigation of the outer corona, they studied the transition nature of the decametric corona where the magnetic field changes from closed to predominantly open configuration. Thus, the absorption bursts and type I bursts indicate the existence of both open and closed configurations at decametric levels.

In their study of theory of type I radio bursts, Gopalswamy, Thejappa & Sastry found that under identical conditions, a perpendicular shock can generate ion-sound turbulence to a higher level over a wide wave number range as compared to the lower hybrid waves. The only difficulty with ion-sound waves is that the ion-sound turbulence can exist in a non-isothermal condition. This condition could be realized because of the quenching of the Buneman instability at the initial portion of the shock front which essentially heats electrons, thus causing non-isothermality.

Thejappa collaborated with Krasnosel' Skikh, Kruchina & Volokitin of Space Research Institute, Moscow, in developing the theory of type II solar radio bursts caused by collisionless shock waves propagating in a coronal plasma. This model is based on the basic principles of shock wave theory, which predicts the existence of

a small fraction of ions reflected from the shock front. This ion beam is unstable and can drive low frequency waves ($\omega_{Hi} < \omega < \omega_{Hc}$), which are quickly absorbed by the magnetized electrons of the background plasma, leading to the formation of non-Maxwellian electron 'tails'. Entering the cold background plasma, these hot electrons in turn drive the high frequency Langmuir oscillations with $\omega \approx \omega_{pe}$ to the high level $\omega_L/n_0 T_e \approx 10^{-5} - 10^{-4}$. The conversion of plasma waves into electromagnetic ones is caused by the induced scattering of plasma waves on ions ($\omega \approx \omega_{pe}$) or by merger of two Langmuir waves ($\omega \approx 2\omega_{pe}$).

Thejappa has studied the role of nonlinear processes. The brightness temperature calculated from theory ($T_b \approx 10^{11}K$) appears to be in good agreement with observations.

Singh designed an experiment for the exhibition held at Birla Industrial and Technological Museum, Calcutta, to mark the diamond jubilee of M.N.Saha and S.N.Bose. The experiment for showing the Fraunhofer spectra of the sun was installed at Calcutta by Charles.

SOLAR SYSTEM STUDIES

Bhattacharyya & Vasundhara analysed the Uranus occultation data of 1981 April 26. The planetocentric distance, width and relative extinction of the occulting segments of ϵ , δ and γ rings were found to be in agreement with the model proposed by Elliot et al. (1981). They are further investigating the possibility of the existence of a wave-like features in the ϵ ring of Uranus.

Observations by Vasundhara, Santhanam & Rozario of the occultation of the star SAO 158913 by Saturn's magnetosphere showed several symmetric dips in the light curves between (19^h 55^m - 20^h 33.^m5) U.T. during immersion on 1984 March 24 and between (20^h 5^m - 20^h 45^m) U.T. during emersion on 1984 March 25, indicating presence of particulate or gaseous structure in this region of magnetosphere. Preliminary analysis of the data by Bhattacharyya & Vasundhara indicates that the occulting material, if confined to the visible ring plane, lies at a planetocentric distance of about 12.5 Saturn radii.

Babu, Sivaraman & Shylaja have obtained scanner observations of comet Crommelin covering a wavelength range 3850 - 6000A on 1984 March 2 and 3 at the Cassegrain focus of the 102 cm Kavalur reflector. The scans show CN (0, 0), C₂ (1, 0) and C₂(0, 0) bands very well. The scans also show the NH and OH bands which are rather weak.

Sivaraman, Babu & Shylaja attempted the observations of the earth grazing comet IRAS-Araki-Alcock and another comet Sugano-Sai-gusa-Fujikawa with no success due to bad weather conditions. However, later on, they could obtain a spectrophotometric scan of comet Crommelyn on one night. The analysis of the data is in progress.

Gopalswamy & Sastry have commenced the study of Jovian decametric S-bursts. The most interesting feature is that the shadow-S burst which has the same characteristics as S-burst but occurs in absorption when L and S emissions intersect. This shows separate emission mechanism for S and L bursts; and when they intersect, the coherence of S and L electrons are destroyed by each other. There must be a threshold value for S-electron density below which the shadow bursts occur. If the S- electron density is more than this threshold, then both S and L emissions occur.

Hanumath Sastri initiated in 1984 March a program of synoptic observations of S [II] optical emissions, starting with the red doublet $\lambda\lambda$ 6716, 6731A, from Jovian inner magnetosphere at Io's orbital distance, using the image tube spectrograph facility at the Cassegrain focus of the 1m telescope at Kavalur. The principal objective of the observational program is to study, through spectroscopy, the spatial and temporal variability of the characteristics of Io plasma torus (IPT).

STELLAR PHYSICS

Kameswara Rao continued the study of the scanner energy distribution of R Cr B stars for λ 3250 to λ 8000 with the 102-cm telescope. Rao & Ashoka obtained spectrograms of a few R Cr B stars for radial velocity monitoring using the 102-cm and the 51-cm telescopes.

The 2.8 \AA mm^{-1} Coude spectrogram of Canopus obtained with the 102-cm telescope has been studied by Rao & Mekkaden for variation of Ca II K-line. The star shows variable emission both in K-lines of Ca II and Mg II resonance lines, probably indicating variable plage regions on the star. This is a continuation of the work started by Dr Bappu.

In collaboration with D. Stickland of Royal Greenwich Observatory, Rao has been monitoring ϵ Aur with international Ultraviolet Explorer (IUE) satellite during and outside eclipse. In addition, several coude spectrograms at 20 \AA mm^{-1} have also been obtained at RGO. It is planned to analyse all this information together. Ashoka & Surendranath obtained scanner energy distribution and spectrograms, with 44 \AA mm^{-1} and 22 \AA mm^{-1} dispersion, of the supergiant binary ϵ Aur during its 27.1 yr eclipse with the 102-cm and 51-cm telescopes.

In collaboration with K. Nandy of Royal Observatory, Edinburgh, Rao is analysing IUE observations of several R Cr B stars. Particularly work on V 348 Sgr and R Cr B star surrounded by an optical nebulosity which extends to 8 - 10 arcsec. Analysis of UV data of V 348 Sgr shows that the reddening material is distributed around the star and the nebula shows only reddening due to interstellar medium. The chemical abundance of the nebula indicates that it is deficient in carbon whereas the star is rich in carbon and helium. Their high resolution IUE spectra of R Cr B show emissions in the cores of lines due to Fe II, Mn II, Mg I etc. In addition to Mg II resonance lines. These spectra are being differentially analysed with respect to γ Cyg, to study the nature of the chromosphere.

In a collaborative program with Nandy, infrared observation at 12μ , 25μ , 60μ , 120μ of several R Cr B stars are being obtained by the infrared astronomy satellite (IRAS). The data are slowly being released to Rao & Nandy and the analysis is in progress. The preliminary analysis of S Aps data shows that the IR excess can be fitted with a blackbody of 700 K.

In collaboration with V.R. Venugopal of Tata Institute of Fundamental Research, Ooty, Rao has made observations at 6 cm and 2 cm of extreme hydrogen-deficient stars MW Sgr, V 348 Sgr, R Cr B, ν Sgr, & HD 160461 using the very large array (VLA) at Socorro, New Mexico, USA. These are being analysed.

Ashoka & Surendranath have used the 102-cm and the 51-cm telescopes to obtain spectrograms to study the radial velocity variations of some β Cephei stars. They have also collected several observations of ν Cen.

The early history of the introduction of telescope in India in 1689 by Father Richaud, a Jesuit priest, was investigated by Rao, Vagiswari & Louis. His life and astronomical contributions made from India have been discussed.

Rajamohan studied the $H\alpha$ line profile variation in HD 47129 and γ Velorum. Spectra of the Wolf Rayet star γ Velorum was obtained on IIIa F plates at a dispersion of $22A \text{ mm}^{-1}$. The $H\alpha$ line in γ Velorum has a broad flat-topped profile with a fairly sharp stationary emission component superposed on it. There seems to be a periodic change in the intensity of the violet and red wings but no strong changes are seen as a function of phase whereas in the blue region the violet-shifted He I 3888A line is very strong and sharp close to zero phase (Wolf Rayet behind) and strong but split near phase 0.25.

HD 47129 was observed at $45A \text{ mm}^{-1}$ dispersion on 09802 plates as well as at $22A \text{ mm}^{-1}$ dispersion using a Varo image tube. The strength of the $H\alpha$ emission component is found to be associated with the primary component. The behaviour of the violet and red emission components are found to be dependent on the orbital phase.

Analysis of the microspectra for spectral classification has been taken up by Rajamohan. He has shown that the microspectra at $10,000A \text{ mm}^{-1}$ dispersion can be ingeniously used for spectral classification fairly accurately in the absence of interstellar extinction. The E - emulsion with its green dip around 5500A combines with the prismatic dispersion to produce a stellar image

longward of 5500Å and an elongated image shortward of it. By analysing a short exposure of NGC 2362 with IV - E emulsion it is shown that if measurements are restricted to a given density level of exposure, the ratio of the lengths of the blue and red images is a function of (B-V) colour of the stars. Also the length of the blue image is found to be a function of the relative blue magnitude of the stars.

Prabhu, in collaboration with K.V.K.Iyengar of TIFR, Bombay, has obtained optical spectra of about a dozen stars from the Equatorial Infrared Catalogue, with a view to classifying them. More stars are planned to be observed during the current year. The reductions are in progress.

S.V.Mallik has obtained widened red spectra of a few bright late G and K supergiants using a 10" camera with a Varo image tube on the echelle spectrograph at the Coude focus of the 102-cm telescope at Kavalur. The dispersion of the spectra obtained is 7Å/mm^{-1} and the exposure time is of the order of one-and-half hours for a fourth magnitude star. On all the echellograms, the $H\alpha$ line is seen to have a distinctly blue shifted absorption core as well as small emission components on either red or blue side lying above the level of continuum. The NaI D lines $\lambda\lambda$ 5890, 5896 and K I line λ 7699 are also seen to be asymmetric clearly indicating the presence of differential expansion in the outer atmospheres of these supergiants. Analysis of the data is in progress.

With a view to comparing the observed line profiles with theory, S.V.Mallik has used a co-moving-frame radiative-transfer code developed by Peraiah for spherically symmetric expanding atmospheres. The source functions for photoionization-dominated lines have been calculated assuming a two-level atom, a Doppler profile and complete redistribution of photons. The line opacities have been assumed to be very large. Various density and velocity distributions have been tried for the extent of the line forming region. The source functions thus computed for a given integrated optical depth and velocity are seen to fall by two or three orders of magni-

tude across the line forming region. The corresponding emergent line profiles have then been transformed to the observer's frame. The computer profiles besides being asymmetric show small emission components above the level of the continuum. The strength of this emission component is found to increase with decreasing optical depth and increasing velocity. Using data from various lines formed at different depths in the expanding atmospheres, S.V.Mallik hopes to model the outer layers of the late type stars and determine mass loss rates.

Shylaja obtained spectrophotometric scans of Wolf-Rayet binaries, CQ Cep and HD 50896, for almost a complete phase coverage. The reduction of the data is in progress.

Shylaja & Babu have analysed the spectrometric observations of the hot Si star HD 34452, obtained during 1979-83. They have found that the broad, continuum features near $\lambda\lambda$ 4200, 5200 and 6300A are striking. The variation in the continuum leads to effective temperatures ranging from 12000 to 20000 K. They have also defined an index for measurement of the strength of the 5200A feature and find that this has a periodicity of 2.466 days, which is the same as that obtained by others for photometric and spectroscopic variability. They have also begun the spectrophotometric observations of southern Ap and Am stars. About 15 stars have been observed.

Sivaraman & Shylaja are continuing to supplement the data on the empirical relation, found between Ca II K-line width and age in case of late type stars.

From observations obtained in 1981, Shylaja found that nova Corona Austrinae, being a fast nova, had already entered the nebular phase at the time of observations. She has calculated the electron densities and mass of the ionized hydrogen in the shell. The excess flux at longer wavelengths is attributed to the probable appearance of dust shell. Nova Normae 1983 reached a maximum during 1983 September. Attempts at observations were, however, thwarted by bad weather.

With a view to studying the abundance anomalies of different elements Giridhar has derived the atmospheric abundances of Fe-peak elements Ca, Ti, V, Cr, Fe, Ni and heavier s-process elements Y, Ba, Ce and Sm for the bright Cepheid α UMi. High dispersion spectra of this Cepheid were obtained using the Kavalur Coude spectrograph. She has derived the atmospheric abundances using the method of spectrum synthesis. She has in progress the analysis of C I and O I lines at 4700Å and 6300Å respectively to derive the carbon and oxygen abundances. The evolutionary status of the Cepheid can be studied in the light of these derived abundances.

D.C.V.Mallik has explored the consequences of a new initial-final mass relation for low and intermediate mass stars and studied its implications for the birthrate of planetary nebulae. The mass distribution of the nuclei of planetary nebulae, and the new initial-final mass relation, set a lower limit on the initial mass of planetary nebula progenitors which is substantially higher than $1 M_{\odot}$. With such a raised lower limit the theoretical estimate of the death-rate of mainsequence stars is consistent with the observed planetary nebulae birthrate only if the distance scale due to Budworth were used in deriving the latter. The observed birthrates based on other distance scales are too high and incompatible with the lower mass limit determined above and the current IMF for the solar neighbourhood.

D.C.V.Mallik has also derived a theoretical height distribution of the progenitors of the current generation of planetaries and finds that a raised lower limit on the mass helps explain the observed low mean distances of these nebulae from the galactic plane.

Mohin, Raveendran & Mekkaden have continued their photometric program on late type emission binaries using the 34-cm telescope. Because of the prevalent poor sky conditions much observational data could not be collected. However they could observe on 16 nights, through B and V filters, HD 116204, a star with Ca II H and K emission and with composite spectrum. Reduction of the data is in progress. They had observed HD 22403 during the 1980-81 observing season to check for its light variability. This is a single-lined spectroscopic binary with a period of about 1.9 days and the spectral type is

close to dG5. They have completed the analysis of the photometric data which shows that it is a light variable with a period close to that of the spectroscopic; and the amplitude in visual light is about 0.07 mag. The nature and phasing of the light curve clearly indicates that the light variation is definitely not due to geometrical eclipses. They attribute the cause for the observed light variation to star-spots distributed nonuniformly on the surface of the visible companion.

Raveendran has completed the analysis of the photometric observations of BD + 25° 2511 obtained during the 1981, 1982 and 1983 observing seasons. It is a spectroscopic binary with double Ca II H and K emissions and is most likely a member of Coma Berenices Cluster. His observations show that it is a light variable with a variable amplitude. All the three sets of data were subjected to a method of period determination developed by Raveendran, Mohin & Mekkaden which yielded a consistent period of about 3.5 days. The nature of the light curve shows that the observed light variation is not due to geometrical eclipses. Raveendran has obtained spectrophotometric scans of a few long period variables of type C and the data analysis is in progress.

Parthasarathy & S.P.Parsons (Space Telescope Science Institute) are studying the chromospheres of long-period population II Cepheids. They have observed AL Vir (period = 10.3 days) and W Vir (period = 17.3 days) with the International Ultraviolet Explorer at two phases each, and found a great range in Mg II emission behaviour. W Vir showed Mg II 2800Å emission well in excess of the local continuum near maximum and minimum light. AV Vir showed only photospheric absorption in Mg II at both times. The spectrum resembles that of early F-type luminous stars with their pronounced Fe II absorption features.

Among classical Cepheids with periods near 10 days, Mg II emission strength builds rapidly at the time of maximum outward acceleration of the photosphere, around phase 0.7 - 0.8. This emission subsequently fades toward much smaller but still detectable levels

at minimum light. In this framework, the observations of both population II Cepheids are surprising. If similar mechanism of shock heating and radiational cooling operate in both population types with similar efficiencies, then AL Vir should have had detectable emission and the enormous emission in W Vir is unexpected. It is not possible to conclude at present whether the abundance differences between population I and population II have a direct affect on the nature of Cepheid chromospheres.

Parthasarathy is studying the relation between stellar absolute magnitude M_V and Mg II K line (2795.5A) emission width. He confirmed the existence of a tight linear correlation between stellar absolute magnitude M_V and Mg II K line emission width $\log W$ (kms^{-1}) using the IUE high resolution (0.2A) data of 100 late-type stars. A least squares fit to the data gives the relation $M = 37.80 - 16.06 \log W$. This relation is analogous to the Wilson - Bappu effect for Ca II K emission widths in late type stars.

Parthasarathy & Lambert (University of Texas, Austin) continued their study of Epsilon Aurigae in eclipse.

Peraiah and his associates are working on the problems of line formation in stellar atmospheres and relation topics. Peraiah, Mohan Rao & Rangarajan calculated the effects of different partial redistribution function on the formation of lines. They have employed the angle-averaged redistribution function of R_{II} , R_{III} , R_V with isotropic phase function. They found that in a medium with constant internal sources, the source function in the wings increases with the noncoherence in the redistribution function. The variation of the emergent intensities mimic the variation of the source function.

Nagendra & Peraiah studied the effects of radiative transfer in magnetized atmospheres. They have compared their results with those obtained by two different methods, namely the 'Stokes vector formulation' and 'normal wave representation'. The effects of the inhomogeneities of the magnetic field and the bulk velocities of the medium on the formation of Zeeman lines are calculated in cool magnetic white dwarfs.

Peraiah & Srinivasa Rao continue to work on the problems of reflection effect in close binary systems. They have estimated the changes in the temperature distribution due to the incident radiation from the secondary component assuming radiative equilibrium in a scattering medium. They have found that the temperature can change as much as 40-50% depending upon the region in the atmosphere. Peraiah & Varghese are working on a new type of numerical solution in radiative transfer equation in spherical symmetry. They have developed a new solution which satisfies the tests of conservation of radiative flux and other important fundamental physical characteristics. This solution has been successfully applied to media in which there is scattering and/or absorption.

In collaboration with S.M.Chitre of TIFR, Bombay, Gokhale has started investigating the effects of rotation on the non-radial acoustic and gravity modes of oscillations of a star. They have also undertaken a study of the stability of azimuthal oscillations of a star whose poloidal magnetic field has a contribution from currents in the stellar environment in addition to the fields provided by the internal currents.

INTERSTELLAR MEDIUM

Observations on galactic H II regions in continuum absorption at 34.5 MHz are being continued by Sastry and collaborators. They have completed analysis of observations of the giant H II region complex W 51. The mean electron temperature of W 51 is found to be 9500 ± 600 K. The derived background temperature on the far side of W 51 is $28,000 \pm 2600$ K. The proportion of nonthermal emission originating on the near side of W 51 corresponds to a mean galactic emissivity of 2K pc^{-1} at 34.5 MHz. The present observations also indicate that the H II region complex is surrounded by a non-thermal ring which is probably a supernova remnant.

Mallik & Jain have started a collaborative program with Sahu and Desai of the Physical Research Laboratory, Ahmedabad to study the internal kinematics of bipolar planetary nebulae. They have

used the Fabry-Perot spectrometer, fabricated by Desai and coworkers, at the Cassegrain focus of the 102-cm Kavalur reflector to obtain high-resolution profiles of H , (N II) and (O III) lines in a selected set of bipolar planetary nebulae. Spatially resolve data on NGC 650/1 and NGC 2346 have been obtained during the observing runs in 1983 December and 1984 January and February. Reduction and analysis are in progress.

Shah has modified the techniques for calculating the first and the second kinds of spherical Bessel functions of complex argument lying in any quadrant of the complex plane. It has been found that the computation of the higher orders of Neumann function is more stable if one uses the Wronskian relation between these two kinds of functions. This is done by upward recursion for Neumann function. One can compute arbitrary higher orders of these functions to desired accuracy. The corresponding FORTRAN computer code, BELJAY, has been developed to suit the needs in various fields of science and engineering. The sample results show that these functions for different quadrants are interested.

An unusual result is as follows: Provided the imaginary part of the complex argument z is large compared to unity and the real part of z is not too close to zero, the Bessel functions of the first and the second kinds for a given order are interdependent in the sense that one can be derived from the other upto a certain maximum order. Furthermore, for the same absolute value of z lying on positive or negative y - axis, it has been found that the corresponding Bessel functions satisfy certain special properties.

Shah proposes to give a new representation to Guttler's theory of electromagnetic scattering by concentric spheres with core and mantle having different indices of refraction.

THE GALAXY

Giridhar has determined the places of formation of 25 classical Cepheids for which accurate values of $[Fe/H]$ are known, in an attempt to study the chemical inhomogeneities across the spiral arm of the Galaxy. To

derive the birthsites. the galactic orbits of Cepheids are numerically integrated backwards in time under the influence of axisymmetric and spiral-like gravitational field of the Galaxy. A steeper variation of [Fe/H] across the Sagittarius and the Perseus arm is encountered as compared to the overall variation of [Fe/H] across the galactic disc. She has proposed an explanation of these local chemical inhomogeneities in the framework of density wave theory.

Work on chemical evolution of galaxies has also been continued. D.C.V.Mallik and S.V.Mallik have used the revised counts of O stars in the greater solar neighborhood along with the counts for the less massive stars given by Miller and Scalo (1979, Ap.J.Suppl. 41, 513) to redetermine the current SFR and the IMF in the solar neighborhood. These have, then, been used with recent stellar models to compute the nucleosynthetic yields and the present rate of nucleosynthesis. The contribution of the low and intermediate mass stars to galactic nucleosynthesis has also been added.

The results show that the present rate of nucleosynthesis is greatly enhanced compared to the earlier estimates, partly due to the new IMF which is flatter at the massive star end and partly due to the improvements in the stellar models which do not show any substantial helium core reduction due to massloss. As a consequence, a large variation in the rate of star formation during the history of the galactic disc is not longer required to explain the presently observed abundances of metals. However, the heavy element yield per generation is rather high and not supported by the observations. Also the helium to heavy element enrichment ratio is found to be less than unity contrary to some of the observations in the Galaxy and other external galaxies.

Continuing the study of the faint galactic open clusters in the anticentre direction, Babu has completed the photometric and photographic work on two young clusters OCL 506 and 585, while the work on OCL 499 and 556 is in progress. Photometry of OCL 427 and 493 has just started. The distance to OCL 585 is found to be 1.06 ± 0.012 kpc and its age close to 2×10^8 yr. OCL 556 shows two

distinct stellar concentrations separated by a small region of low star density. It could be either a single cluster intercepted by a foreground strip of interstellar medium or two different clusters at the same distance.

Parthasarathy and Scaria continued the survey of red stars in the direction of the Large Magellanic Cloud using the technique of microspectra. Ultra-low dispersion ($10,000 \text{ \AA mm}^{-1}$) survey of the regions north east of the LMC bar have resulted in more than 300 additional red stars. Most of the red stars in the direction of LMC found in our surveys (Bappu, Parthasarathy & Scaria 1977, 1978, 1979) are now confirmed by various authors to be LMC members and are mostly M supergiants, M giants and carbon stars.

Pati continued his program of integrated spectroscopy of galaxies. During most of the allotted observing runs, inclement weather prevented collection of data. In addition, the image tube used with the spectrograph showed a marked degradation of sensitivity, with the result that the already long exposures of 4 to 5 hours needed to be doubled. Clear skies of such duration were not available. A new image tube has been set up in a housing which would adapt to the spectrograph set up. The final testing for focus is currently being done, and will enable observations to be resumed.

In the meantime, the photometer was used in the few partially clear nights available with a view to obtaining complete photometric scans across some of the program galaxies. The experiment consists of placing the aperture at different positions across the galaxy. Typically, a 12 arcsec diaphragm is used in the outer regions and a 9 arcsec diaphragm in the inner regions. The sky is also monitored after every two or three diaphragm position counts on the galaxy. Several standard stars are also monitored during the night. Counts are taken for each position in the U, B, V, R and I bands. Due to the nonavailability of fully clear nights only partial scans of some objects could be obtained. Since the sky as well as the standard stars have also been monitored, these would be completed when clear nights are available. Typically, a galaxy would need 25 to 30

positions, each in five filter bands with the exposure in each band being repeated several times and each exposure lasting five to ten seconds. Partial scans of NGC 3368 and NGC 3623 were obtained. A usable spectrum of NGC 5236 using the spectrograph was also obtained. The above data are being acquired to synthesize populations in external galaxies. The spectra will yield indices for lines which are sensitive to stellar type and luminosity. The colours will also yield information on predominant stellar types. The scans across the galaxies will yield information on luminosity profiles in different colours, leading to information on the distribution of different stellar types across a galaxy.

Studies of models for the synthesis are being continued to aid in the construction of a model which would be physically meaningful and at the same time yield a unique solution.

HIGH ENERGY ASTROPHYSICS AND COSMOLOGY

A semi-Newtonian condition of rotational stability has been applied by Datta and A.Ray of TIFR, Bombay to the recently discovered millisecond pulsar PSR 1937+214 to obtain lower limits on the mass and moment of inertia and an upper limit on the radius of the neutron star. The lower limits on mass are found to be substantially higher than previous estimates. Results for various equations of state have been compared with observational data for neutron star masses.

The rapid rotation of the millisecond pulsar PSR 1937+214 suggests that it may be close to the point of rotational instability. If fast pulsars are remnants of galactic bulge x-ray sources, the limits on the structure of rotating neutron stars, as implied by the requirement of rotational stability have been used by Datta to set limits on the surface dipole magnetic field and the slow down rate.

Kapoor & Datta have investigated the frequency shifts and line broadening of radiation from the surface of rapidly rotating neutron stars using axially perturbed interior spherical metric

and a representative choice of the equations of state for neutron star matter. The effect of rotation on the surface redshift and Doppler broadening are found to be substantial for rotation close to the secular instability limit, relevant for fast pulsars discovered recently. If gamma-ray line emission originates from the surface of such pulsars, the results obtained by Kapoor and Datta can be used to constrain the validity of the equation of state of matter at high densities.

In a paper submitted to the Gravity Research Foundation (USA) for their 1984 essay competition, Datta, Kapoor & A.Ray (TIFR) have discussed the general relativistic effects of rotation on the structure and surface emission of the fast pulsar PSR 1937 + 214 which is close to the point of rotational instability using axially perturbed interior spherical metric. From the stability requirement for this pulsar, lower limits on the neutron stars mass and moment of inertia and an upper limit on the radius are obtained. The results on the surface redshift indicate an enhancement by about (10-30%) over those based on a simple Schwarzschild metric considerations which ignore rotation. Effect of rotation on the gamma ray line broadening also turns out to be substantial producing an asymmetrical line profile. A highly asymmetrical profile, if observed, would lead additional support to the idea that gamma ray line emission takes place at the surface, and is not predominantly gravitationally broadened.

Kapoor & Datta are investigating the effect of rotation on the shape of the pulse from a fast pulsar.

Kochhar & Sivaram have shown that the instability induced by viscosity at the point of bifurcation where the Jacobi ellipsoids branch off from the sequence of Maclaurin spheroids is not inhibited by the presence of a magnetic field. Thus even the slightest viscosity would induced instability beyond the bifurcation point, just as in the nonmagnetic case. The only effect a magnetic field along the axis of rotation has is to shift the bifurcation point to $e > 0.8127$.

Kochhar & Sivaram have suggested a model for the millisecond pulsar PSR 1937 + 214 according to which the immediate progenitor of the pulsar was a binary consisting of two neutron stars of unequal mass. The heavier neutron star was spun up by the transfer of angular momentum from the orbit and the lighter neutron star was tidally disrupted leaving behind a millisecond pulsar.

From data on the slow down of the millisecond pulsar Sivaram & Kochhar have suggested that the surface magnetic field of the neutron star $\sim 10^7$ gauss, which by Pacini's mechanism would make the pulsar optically undetectable and rather accretion disc spun-up models untenable. Gravitational radiation from the pulsar was estimated and it was shown that it should have an equatorial ellipticity $E \sim 10^{-9}$, which can be accounted for if the equatorial magnetic field departs from axisymmetry by one part in 10^3 .

Kochhar & Sivaram have studied the post-Newtonian effects in the millisecond pulsar. The point of bifurcation and the point of maximum angular velocity squared (Ω^2) still occur at the same value of the eccentricity but now correspond to a higher Ω . Post-Newtonian effects were found to be about 10% of the classical value, and a $1.4 M_{\odot}$ neutron star will have a period of 0.98 ms at the bifurcation point, the shortest it can have.

A 16-channel filter bank receiver with a channel width of 50 KHz is being used to observe pulsars at 34.5 MHz. Using a sampling time of 4 milliseconds for each channel and a total integration time of 40 min the two pulsars PSR 0950 + 08 and PSR 1919 + 21 have been detected. The mean flux density of PSR 0950 + 08 at 34.5 MHz is 1.82 ± 0.05 Jy, and the pulse energy is $461 \pm 115 \cdot 10^{-29}$ Jy m^{-2} H^{-1} . Sastry and coworkers hope to detect several more pulsars and the data will be used to study scattering properties of the interstellar medium.

In a paper submitted to the Gravity Research Foundation (USA) for their 1984 essay competition, Sivaram has explored the possibility that stellar objects in their late stages of evolution would generate

very high frequency (10^{16} - 10^{21} Hz) thermal gravitational radiation, which in the core of very young neutron stars could be rather high ($\sim 10^{32}$ erg s^{-1}) and therefore important in their cooling. White dwarfs and main sequence stars can also generate such radiation (with frequency $\sim 10^{18}$ Hz) from plasma - Coulomb collisions. Moreover models of the earliest phase of the big bang would also predict a thermal gravitational wave background whose detection (at frequencies $\sim 10^{11}$ Hz) would enable us to definitely conclude in favour of or rule out some of the recent modifications proposed to the big bang to resolve several difficulties like singularities. Possible methods of detecting the radiation are suggested by converting it into electromagnetic radiation for instance.

Datta & J.D. Anand (Delhi University) have considered high density matter using conventional neutron matter equation of state and quantum chromodynamics. Instanton effects are estimated and are found to nontrivially affect the neutron matter to quark matter phase transition.

Flat-spectrum quasars are known to have a flat luminosity function. Evolutionary effects then imply that almost every galactic nucleus contains a defunct quasar which cannot be detected. Recently Shklovsky (1982: IAU Symp. No.97.) has tried in terms of the escape of supermassive blackholes (mass $\sim 10^9 M_{\odot}$) is a consequence of successive asymmetric ejection of massive plasma clouds, leading to a feature known as asymmetric jet of a compact radio source, from accretion disc of a supercritically accreting blackhole located in the centre of the galaxy. This blackhole can gain a recoil velocity as high as 10^4 kms^{-1} and leave the galaxy forever. Kapoor has demonstrated that the supermassive blackhole on its way out of the galactic nucleus captures a large amount of gaseous matter and stars which it carries along. Violent physical processes such as stellar collisions release enough gas to go into or form an accretion disc to feed the blackhole and thus lengthen the lifetime of the quasar. It is demonstrated that the object is not stripped of its gaseous contents by ram pressure due to the interstellar or intergalactic matter. If such a recoil is a general occurrence, the prolonged

activity of the quasar would tend to steepen the flat luminosity function for flat-spectrum sources. This inherent difficulty can be circumvented if the mass of the central engine of the quasar is $\lesssim 10^7 M_{\odot}$ and it acquires a large enough recoil velocity to escape out of the nucleus and the galaxy.

Kapoor has made a numerical study of the motion of a supermassive blackhole through a galaxy which has recoiled from the centre of the latter as a result of anisotropic emission of gravitational radiation or asymmetric plasma emission. It is found that the effect of dynamical friction on its motion through the galaxy, estimated using the impulsive approximation technique, is minimal for a blackhole of mass $\sim 10^9 M_{\odot}$ and for recoil taking place at a velocity larger than that of escape. Recoiling at a velocity $\gtrsim 1.1$ times the escape velocity, the blackhole escapes from the galaxy whereas for velocity of recoil at or less than the escape velocity, the dynamical frictional force becomes relatively more pronounced and damped oscillatory motion of the blackhole ensues. The phenomenon of recoil of a supermassive blackhole from a galactic nucleus, although rare, can be astrophysically spectacular in view of the fact that the blackhole may carry a substantial amount of gaseous material as well as a large number of galactic stars it captures in the course of its motion. Some recent observations are cited where the recoil phenomenon might be applicable. Further computations are in progress.

Prabhu has obtained spectra of two extragalactic supernovae - one in NGC 5236 in 1983 July and the other in NGC 4419 in 1984 January. Both the supernovae exhibit type I spectrum. The 6130A dip in the spectrum of SN 1984 in NGC 4419 is highly blueshifted. The spectrum of SN 1983n in NGC 5236 was recorded through moonlit clouds since the skies were very poor. The spectrum of moon was hence superposed. This background was subtracted digitally after filtering the noise out from both the supernova + moon spectrum and the lunar background spectrum. The reductions of the data on the supernova in NGC 4419 are in progress.

Kochhar & Prabhu have completed their investigation of the correlation between the supernova occurrence and nuclear activity in elliptical galaxies. Prabhu & Kochhar find that there is also a correlation between ellipticity and the fraction of radio luminosity obtained in the central core of extended radio galaxies, the higher core-strength galaxies being flatter. Taken together, and in the light of recent work on elliptical galaxies, this would imply that there is a class of intrinsically rounder, massive ellipticals with higher metallicity and higher velocity dispersion which produce supernovae, and are more efficient in producing extended (double) radio sources. It is argued that all these observations suggest that this class of galaxies are continually accreting gas from their environments to produce stars which explode as supernovae. Eventually, this gas would reach the nuclear regions to feed the engine and to trigger the radio activity.

The hypothesis that light neutral fermions can be candidates to explain the problem of missing mass in large galaxies and galaxy clusters has been examined by Datta & Sivaram in relation to available observational information and theoretical considerations. It is found that neither light neutrinos nor gravitinos can satisfactorily explain the missing mass problem.

Sivaram extended Dirac's large numbers hypothesis to include weak and strong interactions by constructing dimensionless relations which connect the Fermi and pion-nucleon coupling constants to cosmological parameters. Unified models of weak, strong and gravitational interactions were used as the basis for this construction. These relations when studied in the framework of Dirac's cosmology suggest that the weak and strong interaction coupling constants have not changed with time. Several interesting coincidences and relationships connecting the parameters of cosmology and quantum physics were pointed out and it was shown that none of the fundamental constants of particle physics changes with the cosmological epoch. This would be consistent with a study of the abundances of the samarium isotopes ($Sm\ 149$ and $Sm\ 148$) in the Oklo natural reactor which would impose variations in the strong interaction constant of less than $10^{-19}\ yr^{-1}$

with similar results for the weak and electromagnetic coupling constants.

Very recently the concept of using spin polarized nuclei to boost up the rates of thermonuclear reactions in controlled fusion reactors has been proposed. This makes use of the fact that the cross-section for the reactions between two nuclei are boosted up when they are both in the spin state which contributes most to the reaction cross section. For instance in the $P-B^{11}$ reaction the fusion proceeds via a spin - 2 intermediate state and aligning the P (spin - 1/2) and B¹¹ (spin 3/2). Spins can be shown to increase the cross-section by a factor of 8/5. Similarly one can evaluate the increase for the helium-producing nuclear reactions involving the isotopes D, He³ etc, when these are suitably polarized. The latter isotopes are precisely the ones which produced the helium in the big bang. A primordial magnetic field if present during the nucleosynthesis of the big bang expansion would have polarized the nuclei as the universe expanded. To avoid overproducing helium, this would put rather stringent constraints on the strength of such a field whose present value can be evaluated to be less than 10^{-8} gauss.

One could also expect a thermal background of high frequency ($\sim 10^{11}$ Hz) gravitational radiation in big bang model of the universe analogous to the microwave background of electromagnetic radiation. However most of the recent modifications to the conventional big bang such as the inflationary models do not predict such remnant gravitational radiation. The precise manner in which the present day temperature (hence frequency distribution) of this gravitational radiation background depends on the physical conditions and parameters present in the earliest phases of the universe has been worked out by Sivaram and ways to detect this background have been discussed.

SOLAR TERRESTRIAL RELATIONSHIPS

Hanumath Sastri analysed Kodaikanal ionogram data for a 3 yr period of high sunspot activity with a view to assessing the local ionospheric conditions responsible for the marked day - to-day variability of the duration of manifestation of equatorial spread-F (ESF)

irregularities. He finds that the post-sunset time history of the F-region vertical drift V_z (peak amplitude and width of the enhancement in V_z) and hence the peak altitude attained by the bottomside F-region significantly influence the onset and sustenance of ESF in ionograms. This evidence of an altitude dependence of the duration of ESF, which has not been reported before, lends support to the view that gravitationally driven collisional Rayleigh - Taylor instability plays a prominent role in the generation and growth of ESF irregularities in the evening equatorial ionosphere.

Sastri has completed the analysis of ionosonde data of selected equatorial stations for a 3 yr period around the maximum of the 19th sunspot cycle to explore the influence during equinoxes of the sector structure of interplanetary magnetic field (IMF) on the ionospheric F-region. The post-sunset increase of the height of bottomside F-region in the vicinity of the dip equator and the daytime foF2 values in the equatorial ionization anomaly region are found to respond to changes in IMF polarity precisely in the way expected of them because of (i) the changes in annual variation of global geomagnetic activity that are known to occur in association with those in IMF polarity, and (ii) the known dependence of the equatorial ionosphere on geomagnetic activity. For example, compared to days with positive IMF polarity, the post-sunset increase in h'F is reduced in March - April and enhanced in September - October on days with negative IMF polarity. This and other systematic trends suggest a modification of the equatorial electric fields in sympathy with changes in IMF polarity. A repetition of the analysis with data for the 20th sunspot cycle (whose peak of activity was about half that of the 19th cycle) showed the same trends but the response is not as striking as in the 19th cycle. Possible physical mechanisms that can account for this ionosphere-magnetosphere coupling have been discussed.

A regular program of recording the phase path variations of ionospheric reflections at vertical incidence on a probing frequency of 5.0 MHz was initiated 1983 May at Kodaikanal by Hanumath Sastri and his collaborators. A phase path sounder developed by them is used for the program and data are acquired under diverse ionospheric

conditions. The principal objective of the experimental program is to derive detailed information on the characteristics of Travelling Ionospheric Disturbances (TIDs) in the equatorial ionospheric F-region. This will not only lead to a better understanding of the dynamics of the equatorial ionosphere but will also help to model and assess the terrestrial ionospheric modulation (due to TIDs) from the data obtained with the decameter-wave radio telescope at Gauribidanur. Analysis of the first few months' recordings showed that small scale quasi-periodic fluctuations in phase path invariably manifest themselves during daytime superposed on the steady decrease (increase) in phase path in the forenoon (afternoon) hours. The quasi-periodic oscillations have a peak-to-peak amplitude of 300-600m (5-10) and periods in the range 5-20 min, features that are characteristic of gravity wave activity at ionospheric heights. Since the phase sounder offers excellent temporal resolution and has the inherent capability to measure even extremely small variations in phase path, it will be used to study the rapid changes in the ionosphere that occur in association with a host of geophysical events (e.g. solar flares, geomagnetic sudden commencements). Efforts are also in progress to further widen the scope of investigations by augmenting the basic system with additional facilities (multiheight, multiaerial recordings).

Sastri & Saha have integrated a direct-calibration type photometer to record zenith intensities of specific night airglow emissions (O I 630 nm, 557.7 nm and OH (7.2) band emission) at Kodaikanal. The principal objective of the observational program which is due to start 1984 April is to derive information on the aeronomy and dynamics of the equatorial mesosphere and thermosphere. In collaboration with scientists at National Physical Laboratory, New Delhi, they are also recording at Bangalore the signal strength of VHF transmissions from ETS-II satellite with a view to assessing the onset and sustenance characteristics of ESF irregularities at locations from near dip equator to lower-mid latitudes.

INSTRUMENTATION AND TECHNIQUES

Raveendran, Mohin & Mekkaden have designed and constructed a new

five color photometer with the help of Gabriel. The filter wheel can be easily replaced by another one containing a new set of filters. They have tested the new photon counting system designed and built up Santhanam by observing a number of standard stars. In collaboration with Dr T.M.K.Marar of ISRO a project to design and construct a 'two star photometer' was initiated by them and the project is in progress.

The 76-cm optical telescope was fitted with positional displays by Chinnappan. The display circuit is based on a single chip micro-computer. This circuit board displays sidereal time, universal time, hour angle, right ascension and declination.

A plate holder for use at the prime focus of the 234-cm telescope was designed by Scaria, Tapde & Bhattacharyya. The model is getting ready.

Two polarimeters were developed by Jain. One of them is a dc type photopolarimeter whereas the other one is a flicker type photopolarimeter. The dc type polarimeter is a simple photometer with polaroid filter which can be turned about the optical axis of the instrument in steps of 5°. The instrumental polarization, as deduced from observing a large number of standard unpolarized stars, is approximately 0.2%.

The flicker type polarimeter uses a combination of $\lambda/4$ plate and ADP crystal for chopping the incident light. The full double cosine curve, if the incident radiation is polarized, is brought out by turning the analyzer at approximately 1 rpm. A thin microscope cover glass plate is used as the calibrator. Laboratory tests have shown very good performance of the instrument, which will be soon tested on the telescope.

A broad band array operating in the frequency range 30 to 65 MHz has been constructed. It consists of 64 broad band dipoles placed inside corner reflectors. The beam is fixed in the E-W direction but can be tilted in the N-S direction to $\pm 45^\circ$ of the zenith. This tilting is achieved by inserting delays at appropriate junctions, by means of diode switches. The effective area of the array is $64 \lambda^2$.

The antenna system is being used for high time and frequency resolution studies of solar radio bursts.

Venkatesh has carried out computations using power spectra of atmospheric turbulence (wind speed and temperature) obtained at Kavalur, with a view to estimating the atmospheric cell size prevalent at the time of observations. Highly sensitive and fast response hot-wire anemometer and chromel-alumel thermocouple have been used for recording respectively the windspeed and the variations.

Venkatesh found from the above atmospheric eddy size spectrum analysis that there are predominant eddies of sizes 2.5 cm and 2.5 mm, the former being the stronger component, prevalent at the time of seeing observations. Mean windspeeds during the nights of observation have however not been quite high.

Santhanam has developed an automated spectrum scanner and photon counting system base on INTEL 8-bit microprocessor. All photoelectric photometry experiments (such as spectrum scanning, photon counting and occultation programs) may be conducted with this system. The programs are written such that it is motor driven and the communication to the system is through teletype. This unit can be used for fast photometry, detection of short period variables and for the detection and integration of light curve of pulsars. All programs reside in 10 K ($10 * 1024$) EPROMS and the system boots itself when the power is applied.

The observation of Crab pulsar was successfully completed with this system and the period was measured as 33.296 millisec.

Santhanam has designed an integrated stand-alone photon counting system which was installed in 76-cm telescope at Kavalur.

He has designed a multimicroprocessor system for the 234-cm telescope instrumentation wherein a number of motors are operated very precisely and the positional information is displayed at different foci. All the electronic circuits have been fabricated and integration of overall system is under progress for final implementation at the site.

The 234-cm telescope has three modes of control: (i) Manual mode, (ii) Automatic mode using microcomputer, and (iii) Auto mode using microcomputer supervised by VAX 11/780. The Auto mode using microcomputer is being designed and fabricated by Chinnappan. He has fabricated and tested the input-output subsystem to read the hour angle and declination, the absolute position 20-bit encoders and high precision analogue to digital converter to drive the servo amplifiers which in turn drive the torque motor in each axis.

The software for the control system is being written. The system is based on realtime interrupt mode. The tracking of the telescope is by type 1 position control system which gives much advantage in acquisition of the stellar objects as well as in tracking. Velocity feedback incremental encoders is being used to improve the position by counting the incremental encoder pulses between the least significant bit change of the absolute position encoder.

The interface link between VAX and microcomputer has been fabricated. The system works on the interrupt request generated by microprocessor to transfer telescope coordinates to VAX for calculating the various corrections to be applied due to atmospheric, mechanical and other imperfections.

The 1.2m primary mirror and Cassegrain secondary of the PRL telescope have been ground and polished. They are now being figured. Figuring of the Cassegrain secondary is in progress and will be followed by the figuring of the coude secondary.

The 76-cm telescope optics has been completed and installed in the telescope. It is proposed to change the present Pyrex secondary with a Zerodur secondary which is being fabricated in order to further improve the quality of the image.

The 30-cm coating plant supplied by BARC has been installed at Bangalore and put into use for coating of small optics.

The chamfering machine which can take up mirrors upto 46-cm using diamond tools has been fabricated. The machine has provision

for edging and centring of the optical glass blanks also. The 300mm optical glass windows (surface accuracy $\lambda/20$) of DRDL, Hyderabad were chamfered at the edges (edge angle $45^\circ \pm .01^\circ$, width $7\text{mm} \pm .05\text{mm}$) and were delivered to them. The job needed special care because both the surfaces were already figured before chamfering.

Figuring attachment for the 2.34m grinding machine was modified to take up similar size tools upto 15-cm and the balancing of the attachment has been redone by modifying the pivoting system.

Fringe program obtained from the Optical Science Centre, Arizona University, has been successfully utilized for the reduction of the interferometric data obtained from the Babinet compensator fringe records. This procedure is being adopted for the evaluation of the 2.34m primary mirror.

Aluminizing of the primary mirror and the secondary mirrors of the 1.2m telescope of Osmania University was done.

Some of the small optics like field lenses, focus shifter block and optical windows for the 1983 eclipse in Indonesia were fabricated. Eleven coelostat mirrors for the Indonesian eclipse expedition were aluminized. 51-cm telescope optics was realuminized.

Following is the list of other miscellaneous jobs both completed and under progress.

- i) One f/12 telescope 75mm achromat was designed and fabricated for the DST project.
- ii) Hindle sphere of 635mm diameter was fabricated to $\lambda/8$ accuracy for shop use.
- iii) One plano-convex lens of focal length 110mm was completed.
- iv) Six field lenses of 12mm diameter and 680mm focal length and a Fabry lens of 22mm diameter were completed.
- v) Filter glasses of 22mm diameter were cut and polished to the required thickness.
- vi) Test plates of 300mm diameter for 2.3m secondary were fabricated.
- vii) Four optical windows of 22mm diameter for photometer were completed.

- viii) A telescope of 150mm diameter of Newtonian type is under progress.
- ix) 600mm Schmidt corrector plate is being figured.
- x) Work on two 210mm paraboloid mirrors is in progress.

234-CM TELESCOPE PROJECT

The dome of the 2.3m telescope has been commissioned. Other auxiliary systems in the tower have also been commissioned.

The primary mirror is being further improved in order to obtain a light concentration of 90% in 0.5 arcsec.

The 1.27m Hindle sphere for testing Cassegrain and coude secondaries continues to be in the figuring stage. The elements of the Wynne corrector have been fabricated and in all five surfaces of the three elements have been figured and the last one is in the process of figuring.

Pocketing work for the axial support at the back surface of the secondary mirror was completed. Front hyperbolic surface is being ground.

The commissioning of the 2.8m vacuum coating plant at Kavalur has been completed. Test runs have shown a satisfactory performance and the plant is ready for use. Nickel coating of glass neutron guider plates (as requested by BARC) awaits finalization of evaporation supply for which necessary arrangements are being made by them. The job will be completed before the primary mirror reaches Kavalur.

The telescope mount shop assembly is in final stages at Walchandnagar. Fabrication of the drive and control system is progressing satisfactorily and is expected to be available within a few months.

The VAX 11/780 computer system has been received at Kavalur and the commissioning work is in progress.

LIBRARY

During the year 1983-84, 380 books and 22 reports were added to the library. The library subscribed to 116 journals and continued to

receive publications, offprints and preprints from other institutions on an exchange basis.

OBSERVING CONDITIONS AT KODAIKANAL AND KAVALUR

Solar observations were made at the Kodaikanal tower telescope on 143 days. The monthwise seeing conditions are given below. There was no occasion when the seeing was better than 2".

Table 1. Number of days of observations and seeing at Kodaikanal

Month and year	Number of days of observation	Seeing	
		4" or greater	Greater than 2" and less than 4"
1983			
Apr	21	20	1
May	14	14	-
Jun	15	15	-
Jul	6	5	1
Aug	7	7	-
Sep	13	13	-
Oct	10	8	2
Nov	15	13	2
Dec	2	2	-
1984			
Jan	4	3	1
Feb	13	6	7
Mar	23	15	8
Total	143	121	22

Table 2. Hours of observation and seeing at Kavalur

Year and month	Hours of spectroscopic work	Hours of possible photometry	Number of nights when spectroscopic work was done 9 hrs or greater	Number of nights with average seeing better than 1.5"
1983 Apr	233.5	66.0	17	Nil
May	129.0	19.0	7	Nil
Jun	71.0	8.5	4	Nil
Jul	27.5	6.0	1	1
Aug	11.5	Nil	Nil	Nil
Sep	48.5	7.0	1	Nil
Oct	88.0	16.0	5	2
Nov	183.0	51.5	10	5
Dec	65.5	22.0	1	3
1984 Jan	155.5	37.0	5	7
Feb	98.5	30.0	4	3
Mar	209.5	75.0	16	4
Total	1321.0	338.5	71	25

LIST OF ACADEMIC STAFF

J.C.Bhattacharyya, D.Phil.	Professor & Director
M.H.Gokhale, Ph.D.	Associate Professor
A.Peraiah, D.Phil.	" "
Ch.V.Sastry, Ph.D.	" "
G.A.Shah, Ph.D.	" "
K.R.Sivaraman, Ph.D.	" "
P.K.Das, Ph.D.	Reader
J.Hanumath Sastri, Ph.D.	"
N.Kameswara Rao, Ph.D.	"
R.K.Kochhar, Ph.D.	"
R.Rajamohan, Ph.D.	"
P.K.Raju, Ph.D.	"
A.K.Saxena, Ph.D.	"
S.Sirajul Hasan, Ph.D.	"
Vinod Krishan, Ph.D.	"
K.C.Abdur Raheem, B.Sc.	Fellow
G.S.D.Babu, M.Sc.	"
S.P.Bagare, Ph.D.	"
Bhaskar Datta, Ph.D.	"
Jagdev Singh, M.Sc.	"
S.K.Jain, Ph.D.	"
R.C.Kapoor, Ph.D.	"
D.C.V.Mallik, Ph.D.	"
A.K.Pati, M.Sc.	"
T.P.Prabhu, Ph.D.	"
K.K.Scaria, Ph.D.	"
C.Sivaram, Ph.D.	"
P.Venkatakrishnan, M.Sc.	"
S.Mohin, M.Sc.	Research Associate
P.M.S.Namboodri, M.Sc.	" "
A.V.Raveendran, M.Sc.	" "
B.S.Shylaja, M.Sc.	" "
K.R.Subramanian, M.Sc.	" "
G.Thejappa, M.Sc.	" "
N.Gopalswamy, Ph.D.	Visiting Scientist
M.Parthasarathy, Ph.D.	" "
S.L.Venkatesh, Ph.D.	Visiting Research Associate
Sunetra Giridhar, Ph.D.	Visiting Research Associate
Sushma Vasu Mallik, Ph.D.	Post Doctoral Fellow

The technical, administrative and nontechnical maintenance staff numbered 271.

COUNCIL MEETINGS

The Governing Council had two meetings during the year at Bangalore.

LIST OF PUBLICATIONS

(Asterisk denotes authors not from the Institute)

- Babu, G.S.D. (1983) Membership of stars in faint galactic open clusters, J. Astrophys. Astr. 4, 235.
- Bappu, M.K.V., Mekkadon, M.V. & Kameswara Rao, N. (1984) Ca II K emission in Canopus, Bull. Astr. Soc. India 12, 196.
- Das, P.K. (1984) Relativistic star clusters with large central redshifts, Mon. Not. R. Astr. Soc. (in the press)
- Datta, B. (1984) Limits on surface magnetic fields on fast pulsars, Nature 308, 338.
- Datta, B., Kapoor, R.C. & Ray, A.* (1984) General relativistic effects
Giridhar, S: (1983) Abundance analysis of selected cepheids and the galactic distribution of metallicity, J. Astrophys. Astr. 4, 75.
- Gokhale, M.H. (1984) Solar Dynamo Theory, Kodaikanal Obs. Bull. (in the press)
- Gopalswamy, N., Thejappa, G. & Sastry, Ch.V. (1984) Observations on the fine structure in solar decametric radio emission. Kodaikanal Obs. Bull. (in the press)
- Jain, S.K. (1983) Fourier transform spectroscopy, Sci. Rep. 20, 576
- Kameswara Rao, N. & Nandy, K.* (1984) The hydrogen deficient irregular variable star V 348 Sgr, 4th European IUE Conf. (in the press)
- Kameswara Rao, N., Vagiswari, A. & Christina Louis (1983) Father J. Richaud and early telescope observations in India. Bull. Astr. Soc. India 12, 81
- Kapoor, R.C. (1984) Motion of a supermassive blackhole through a galaxy. Mon. Not. R. Astr. Soc. (submitted)
- Kapoor, R.C. (1983) Some implications of escape of supermassive blackholes from galactic nuclei due to plasmoid ejection. Astrophys. Sp. Sci. 95, 425
- Kapoor, R.C. & Datta, B. (1984) Frequency shifts and line broadening of radiation from rotating Neutron Stars. Mon. Not. R. Astr. Soc. 209, 895
- Kochhar, R.K. & Prabhu, T.P. (1984) On the correlation between supernova occurrence and nuclear activity in elliptical galaxies. Astrophys. Sp. Sci. (in the press)
- Kochhar, R.K. & Sivaram, C. (1984) A model for the millisecond pulsar PSR 1937 + 214. Astrophys. Sp. Sci. 98, 201

- Kochhar, R.K. & Sivaram, C. (1984) The secular instability of slightly viscous magnetic Maclaurin spherioids. *Astrophys. Sp. Sci.* 96, 447
- Kochhar, R.K. & Sivaram, C. (1984) On the post-Newtonian effects in millisecond pulsars, *Curr. Sci.* 53, 420
- Krishan, V. (1984) Modelling of plasma structure in the solar atmosphere. *Kodaikanal Obs. Bull.* (in the press)
- Krishan, V. (1983) A steady state model of active region coronal loops. *Proc. College on Radiation in Plasmas, Trieste.* (in the press)
- Krishan, V. (1984) Statistical mechanics of velocity and magnetic fields in solar active regions. *Solar Phys.* (in the press)
- Krishan, V. & Kundu, M.R.* (1983) An interpretation of the millisecond time variation in the x-ray emission from the sun. *IAU Symp. No. 107* (in the press)
- Mallik, D.C.V. (1984) On the consequences of a new initial-final mass relation for low and intermediate mass stars and birth rate of planetary nebulae. *Astrophys. Lett.* (submitted)
- Nagendra, K.N. & Peraiah, A. (1984) Polarization of the continuum radiation in the magnetic atmospheres. *Astrophys. Sp. Sci.* (in the press)
- Nagendra, K.N. & Peraiah, A. (1984) Numerical solution of radiative transfer equation in a magnetised media. *Mon. Not. R. Astr. Soc.* (in the press)
- Nambodri, P.M.S., Chandrasekhara*, B.C. & Hanumanthappa*, A.R. (1983) Similarity solutions for buoyancy induced flows in a saturated porous medium adjacent to impermeable horizontal surfaces. *Warme und Stoffubertragung* 18, 17
- Parthasarathy, M. & Parsons*, S.B. (1984) Mg II emission of pop. II long - period Cepheids, *NASA IUE Symp.* (in the press)
- Peraiah, A. (1984) Reflection effect in close binaries. *Proc. Platinum Jubilee Symp. of Nizamiah Observatory* (submitted)
- Peraiah, A. (1984) The interaction principle in radiative transfer. *Astrophys. Sp. Sci.* (in the press)
- Peraiah, A., Nagendra, K.N. (1983) Effects of partial frequency redistributions on level population ratios in a resonance line. *Astrophys. Sp. Sci.* 90, 237
- Peraiah, A. & Verghese, B. (1984) Radiative transfer equation in spherical symmetry. *Astrophys. J.* (in the press)

- Peraiah, A. & Varghese, B. (1984) Radiative transfer in spherical symmetry in non-scattering media. *Astrophys. Sp. Sci.* (in the press)
- Peraiah, A. & Varghese, B. (1984) Solution of radiative transfer equation in spherical symmetry with partially scattering medium. *Astrophys. Sp. Sci.* (in the press)
- Prabhu, T.P. & Kochhar, R.K. (1984) On a correlation between ellipticity and core-strength in extended radio galaxies. *Astrophys. Sp. Sci.* (in the press)
- Prabhu, T.P. (1983) Notes for the observer, *Bull. Astr. Soc. India* 11, 177; 263; 349
- Prabhu, T.P. (1984) Notes for the observer, *Bull. Astr. Soc. India* 12, 94
- Prabhu, T.P. & Kochhar, R.K. (1984) On a correlation between ellipticity and core-strength in extended radio galaxies. *Astrophys. Sp. Sci.* (in the press)
- Prabhu, T.P. & Iyengar*, K.V.K. (1984) Spectral types of a few 'unidentified' Equatorial Infrared Catalogue-1 (EIC-1) Sources. *Bull. Astr. Soc. India* (submitted)
- Rajamohan, R. (1984) H_{α} line profile in early type binary system HD 47129 and γ Velorum. *Astrophys. Sp. Sci.* (in the press)
- Raveendran, A.V. (1984) Light variability of BD+25° 2511. *Astrophys. Sp. Sci.* 99, 171
- Ray*, A. & Datta, B. (1984) Rotating neutron star structure: Implications of the millisecond pulsar PSR 1937+ 214. *Astrophys. J.* (in the press)
- Santhanam, P. & Bhattacharyya, J.C. (1984) A fast optical pulse counting system for Crab pulsar. *Kodaikanal Obs. Bull.* (in the press)
- Sastri, J.H. (1984) Duration of equatorial spread-F. *Ann. Geophys.* (in the press)
- Sastri, J.H. (1984) Patchy occurrence of equatorial spread-F. *Ann. Geophys.* (submitted)
- Sastri, J.H., Ramesh, K.B. & Ramamoorthy, K.S. (1984) A system for recording phase path variations of ionospheric reflections. *Kodaikanal Obs. Bull.* (in the press)
- Scaria, K.K. (1984) A possible period-luminosity relation for RR Lyrae variables in globular clusters. *Astrophys. Sp. Sci.* (in the press)
- Scaria, K.K. (1984) Radial change in ellipticity and number density of BHB stars in the globular clusters. *Mon. Not. R. Astr. Soc.* (submitted)

- Shevgaonkar, R.K. & Kundu*, M.R. (1984) Three dimensional structures of two solar regions from VLA observations at 2.6 and 20cm wavelengths. *Astrophys. J.* (submitted)
- Shevgaonkar, R.K., Sastry, Ch.V. & Deshpande*, A. (1984) Observations of the Rosette nebula using the decameter wave radio telescope at Gauribidanur. *Astrophys. Sp. Sci.* (in the press)
- Shylaja, B.S. & Kochhar, R.K. (1984) Comments on the paper "Some properties of white dwarf collapse in low-mass binaries" by V.M.Lipunov, *Astrophys. Sp. Sci.* (in the press)
- Singh, J., Rajamohan, R. & Raheem, K.C.A. (1983) Emission lines of inner corona observed during the total solar eclipse of 1980 February 16. *Bull. Astr. Soc. India* 11, 337
- Sivaram, C. (1984) Dirac's large numbers and its connection with the unification of fundamental interactions. *Proc. Sir Arthur Eddington Centenary Int. Conf. Nagpur Uni.* (in the press)
- Sivaram, C. (1983) The neutron in astrophysics. *Bull. Astr. Soc. India* 11, 117
- Sivaram, C. (1984) Variation of strong and weak interaction constants of Dirac's cosmology. *Astrophys. Sp. Sci.* (in the press)
- Sivaram, C. (1984) Challenges and frontiers in modern astronomy. *Bull. Sci.* 1, 2.
- Sivaram, C. (1983) The gravitational constants and its behaviour at high energies. *Bull. Astr. Soc. India* 11, 214
- Sivaram, C. (1984) Polarized nuclei, big-bang nucleosynthesis and constraints on the primordial magnetic field. *Astrophys. Lett.* (in the press)
- Sivaram, C. & Kochhar, R.K. (1983) On the slow down of the millisecond pulsar PSR 1937 + 214. *Astrophys. Sp. Sci.* 98, 203
- Sivaraman, K.R. (1984) Observations of the Evershed effect - past and present. *Kodaikanal Obs. Bull.* (in the press)
- Sivaraman, K.R., Jayachandran, M., Scaria, K.K., Babu, G.S.D., Bagare, S.P., & Jayarajan, A.P. (1984) Brightness polarization and electron density of the solar corona of Feb 16, 1980. *J. Astrophys. Astr.* 5, 149
- Sivaraman, K.R. Chandrasekhar*, T., Ashok*, N.M. & Pasachoff*, J.M. Fabry-Perot interferometric observations on the coronal red and green lines during the Indonesian eclipse of June 11, 1983. *Appl. Opt.* (submitted)
- Thejappa, G., Sastry, Ch.V. & Gopalswamy, N. (1983) Fine structure in solar decameter radiation. *Proc. 2nd Workshop on Nonlinear and Turbulent Processes. Kiev* (in the press)

Vasundhara, R., Bhattacharyya, J.C. & Rajamohan, R. (1983) Some further measurements of Uranian ring condensations. Moon and Planets 29, 79

Vasundhara, R., Santhanam, P. & Rozario, M. (1984) Possible occultation by Saturnian magnetospheric ring, IAU Circ. No.3941

Venkatakrisnan, P. & Jain S.K. (1983) On the absorption of the He 10830A line by spicules. Bull. Astr. Soc. India 11, 369

INVITED TALKS

Bhattacharyya, J.C. (1983) Minor planets and planetary rings, 9th meeting of Astr. Soc. India, Hyderabad

Bhattacharyya, J.C. (1984) Current trend of development in optical astronomy, 12th All India Symp. on optics and optoelectronics, I.I.Sc.

Gokhale, M.H. (1984) Solar dynamo theory, Evershed Coll. on 'Magnetic Field-Plasma Interaction on the Sun, Kodaikanal

Gokhale, M.H. (1984) Magnetohydrodynamics in stellar interiors and other stellar atmospheres, Meeting of Plasma Science Society of India, Bangalore

Gokhale, M.H. (1983) Solar magnetic fields, National Space Science Symp., Pune

Gopalswamy, N., Thejappa, G. & Sastry, Ch.V. (1984) An interpretation of decametre absorption bursts, 2nd Indo-US Workshop on Solar-Terrestrial Physics, New Delhi

Kameswara Rao, N. (1983) Ultraviolet observations of binary stars, 9th Meeting of Astr. Soc. India, Hyderabad

Kameswara Rao, N. & Nandy*, K. (1984) The hydrogen-deficient irregular variable star V 348 Sgr, 4th European IUE Conf., Rome

Kameswara Rao, N. & Venugopal*, V.R. (1983) Mass loss in evolved stars, Space Sci. Symp. Pune

Kochhar, R.K. (1983) Millisecond pulsars as maximally rotating neutron stars, 9th Meeting of Astr. Soc. India, Hyderabad

Krishan, V. (1984) Millisecond time structure in hard x-ray bursts. 2nd Indo-US Workshop on Solar-Terrestrial Physics, New Delhi

Krishan, V. (1984) Modelling of plasma structure in the solar atmosphere, Evershed Coll. on 'Magnetic Field - Plasma Interaction on the Sun', Kodaikanal

- Prabhu, T.P. (1983) Obese ellipticals, Cambridge Society - TIFR Workshop on Galaxy Interactions, Bombay
- Sivaram, C. (1984) Dirac's large numbers and their connection with the unification of fundamental interactions. Sir Arthur Eddington Centenary Int. Conf. Nagpur
- Sivaram, C. (1984) Gravity at and beyond Planck energies, 12th Meeting of the Indian Assoc. of Gen. Rel. and Grav. Pune
- Sivaraman, K.R. (1984) Fine structure in the interior of supergranulation network, 2nd Indo-US Workshop on Solar-Terrestrial Physics, New Delhi
- Sivaraman, K.R. (1984) Observations of the Evershed effect - past and present, Evershed Coll. on Magnetic Field - Plasma Interaction on the Sun, Kodaikanal
- Venkatakrisnan, P. (1984) Convection and the phenomenon of kilogauss magnetic fields on the sun. Evershed Coll. on 'Magnetic Field - Plasma Interaction on the Sun', Kodaikanal

PAPERS PRESENTED AT SCIENTIFIC MEETINGS

- Bagare, S.P. & Sivaraman, K.R. (1983) Solar flare of 1982 April 14, 18th Int. Cosmic Ray Conf. 4 (SP), 20
- Gopalswamy, N., Thejappa, G., Subramanian, K.R. & Sastry, Ch.V. (1983) Narrow-band short duration radio bursts at decametre wavelength and their interpretation, 9th Meeting of Astr. Soc. India, Hyderabad
- Kameswara Rao, N., Vagiswari, A & Louis, C. (1983) Father J. Richaud and early telescope observations in India, 9th Meeting of Astr. Soc. India, Hyderabad
- Krishan, V. (1983) A steady state model of active regional coronal loops, College on Radiation in Plasmas, Trieste.
- Krishan, V & Kundu*, M.R. (1983) An interpretation of the millisecond time variations in the x-ray emission from the sun. IAU Symp. No.107, Maryland
- Namboodri, P.M.S., Chandrasekhar*, B.C. & Hanumanthappa*, A.R. (1983) Similarity solutions for mixed convection in the presence of horizontal impermeable surfaces in saturated porous media with variable permeability. 12th National Conf. on Fluid Mechanics and Fluid Power, New Delhi
- Parthasarathy, M. & Parsons*, S.B. (1984) Mg II emission of pop.II long-period Cepheids. NASA Symp. on Future of Ultraviolet Astronomy, GSFC, Greenbelt, Maryland
- Shylaja, B.S. (1983) Spectrophotometry of nova corona Austrinae (1981), 9th Meeting of Astr. Soc. India, Hyderabad

Sivaram, C. (1983) Cosmic ray constraints on neutron - antineutron and hydrogen - antihydrogen oscillation timescales. 18th Int. Cosmic Ray Conf. 5 (HE), 515

Sivaram, C. (1983) Decay of massive photinos and gravitinos and KeV x-ray background. 18th Int. Cosmic Ray Conf. 1 (XG), 20

Sivaraman, K.R. & Raju, P.K. (1983) The EUV structure of a solar-active region. 18th Int. Cosmic Ray Conf. 4 (SP), 222

Thejappa, G., Sastry, Ch.V. & Gopalswamy, N. (1983) Fine structure in solar decametre radiation. 2nd Int. Workshop on Nonlinear and Turbulent Processes, Kiev

SCIENTIFIC MEETINGS ATTENDED

J.C.Bhattacharyya, Ch.V.Sastry, P.K.Raju, V.krishan, D.C.V.Mallik, S.K.Jain, C.Sivaram, N.Gopalswamy and K.S.Balasubramaniam attended the 18th International Cosmic Ray Conference, Bangalore, 1984 August 22 - September 3. K.R.Sivaraman, M.H.Gokhale, V.krishan and N.Gopalswamy participated in the 2nd Indo-US Workshop on Solar-Terrestrial Physics, New Delhi, 1984 January 30 - February 3.

Colloquium on 'Magnetic field - plasma interaction on the sun' to mark the 75th anniversary of the Evershed effect, Kodaikanal, 1984 January 23 was attended by J.C.Bhattacharyya, K.R.Sivaraman, M.H.Gokhale, P.K.Raju, V.krishan, P.Venkatakrisnan, N.Gopalswamy, S.L.Venkatesh and K.S.Balasubramaniam. Among others, J.C.Bhattacharyya, N.K.Rao, R.K.Kochhar, D.C.V.Mallik, T.P.Prabhu, N.Gopalswamy and S.L.Venkatesh attended the 3rd Neighbourhood Astronomy Meeting, Raman Research Institute, Bangalore, 1983 June 20-21. J.C.Bhattachayya, M.H.Gokhale, N.K.Rao, J.Singh, R.K.Kochhar, N.Gopalswamy, G.Thejappa and K.S.Balasubramaniam attended the Platinum Jubilee Symposium of the Nizamiah Observatory and the 9th Meeting of the Astronomical Society of India, Hyderabad, 1983 November 22-24.

A number of scientists participated in the Workshop on Image Processing organised by the Institute 1983 September 12-13. J.C.Bhattacharyya, M.H.Gokhale and J.H.Sastri attended the National Space Science Symposium, Pune, 1983 December 7-10. R.C.Kapoor and T.P.Prabhu attended the Cambridge Society-TIFR Workshop on Galaxy Interactions, Bombay, 1983 December 26-30.

K.R.Sivaraman attended the International Halley Watch Steering

Group Meeting at Bamberg. J.C.Bhattacharyya, T.P.Prabhu and A.K.Pati attended the annual meeting of Indian Academy of Sciences, Pune, 1983 November 7-9. A.K.Pati has been elected a young associate of the Academy for five years.

C.Sivaram participated in the Sir Arthur Eddington Centenary International Symposium, Nagpur, 1984 January 21-28. V.Krishan attended IAU Symposium No.107 on 'Current Sheet Instabilities in Astrophysical Plasmas', Maryland 1983 August 8-11. G.Thejappa participated in the 2nd International Workshop on Nonlinear and Turbulent Processes, Kiev, 1983 October 10-23.

J.C.Bhattacharyya acted as Chairman of the Design Review Committee of the Infrared Astronomical Telescope Project and participated its meeting on 1983 November 26-27 at Sriharikota.

J.C.Bhattacharyya attended the Golden Jubilee Celebrations of the Indian National Science Academy in New Delhi 1984 January 15-17.

VISITING SCIENTISTS

Scientists who visited the Institute include Drs Brandon Carter (Meudon), Henry Hill (University Arizona), W.C.Saslaw (University of Virginia), C.Madsen (European Southern Observatory), W.I.Axford (Wellington, New Zealand), Murray Dryer (NOAA, Boulder), W.Kundt (University of Bonn), R.J. Tayler (University of Sussex), A.Fabian (University of Cambridge), W.C.Livingston (Kitt Peak National Observatory), R.N.Smartt (Sacramento Peak Observatory), Robert Howard (Mount Wilson Observtory), S.M.Alladin, K.D.Abhyankar, M.B.K.Sarma (Osmania Unviersity) V.I.Makarov and M.N. Stroyannova (Pulkova Observatory, Leningrad), N.Visvanathan (Mt Stromlo and Siding Spring Observatories), W.C.Erickson (University of Maryland), F.Biraud (Meudon Observatory) K.V.K.Iyengar (TIFR, Bombay), N.A. Narasimham (BARC, Bombay).

Rajan