INDIAN INSTITUTE OF ASTROPHYSICS

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SOLAR PHYSICS

Sivaraman and Venkitachalam have completed the reduction of about 1500 profiles of the H-line of ionized calcium. They find preliminary evidence to show that the oscillations in the ratio of the intensities $\frac{H_{2V}}{H_{2R}}$ are related to the velocity oscillations in H_3. They intend to obtain a complete picture of the various types of profiles occuring in the different phases of evolution of the bright points. Such information will help derive the dynamical parameters relating to the bright points and their dark absorption counterparts seen in the spectra.

Venkitachalam and Jagdev Singh have obtained integrated K-line spectra of the sun with the solar tower telescope. Venkitachalam has obtained fresh plate material with the solar tower telescope to study the Evershed effect in bipolar spots.

Jagdev Singh and Bappu have completed their measures of areas of regular cells of the Ca^+ network at solar maxima and minima. These point out a definite decrease in mean size of the cell at maximum phase of the solar cycle. The observations cover all cycles in the Kodaikanal collection of calcium spectroheliograms, over the period 1907-1970.

Flare loops on the sum which exhibit eruptive phenomena, have often been observed prior to the flare and on a time scale which can vary from a few hours to as much as a day, and sometimes even more. The apparent stability of such structures is difficult to understand theoretically since the experience of laboratory plasmas suggests that they should be inherently unstable on the MHD time scale, which for flare loops is at the most a few minutes. Hasan is attempting to understand whether this apparent conflict can be resolved using a more elaborate MHD theory. Specifically, he has incorporated into his calculations, temperature and density equilibrium profiles within the loop and boundary conditions consistent with some recent observations. Preliminary results of these calculations indicate that it may be possible to achieve greater stability for the loops.

Vinod Krishan has investigated the problem of anomalous conductivity of plasma in the presence of ion-acoustic instability. Three new mechanisms for the saturation of the ion-acoustic instability have been suggested. These include (1) the indirect wave-particle interaction, (2) the scattering on density fluctuations and the (3) effects of energy renormalization of the particles. The first mechanism seems to

predict a value of magnetic field gradient in the magnetically neutral sheet, which is in good agreement with that observed by Skylab.

Gokhale and Venkatakrishnan have developed a phenomenological kinematical model of the gross structure and mean evolution of the coronal magnetic fields. According to this model the coronal magnetic fields consist of magnetic fluxtubes of flux amounts $\sim 10^{17} - 10^{18.5}$ Mx filling almost all the space in the corona and are maintained by such fluxtubes rising from the photosphere first forming arches of lengths comparable to the dimensions of supergranules. The arches keep on rising, often merging to form successively larger arches, that continue to rise further. The average rate ofrise is so slow that the arches may be considered to be rising in "quasi-equilibrium" at each stage. Yet, this rate would be adequate to account for the amount of poloidal magnetic flux transported away from the Sun over an eleven year cycle. The rising arches "open out" when their tops reach some "critical heights" which are ordinarily $\simeq 10^5$ km but which may vary from $\simeq 10^4$ to $\simeq 10^6$ km. One possible reason may be that at such heights the flux tubes become too thin compared to their lengths and so become vulnerable to the kink instability. Open fields in high latitudes may be provided by migration of fields opened elsewhere. The open-field configuration in coronal holes may result from a reduction in the supply of arches from the photosphere. In contrast to Parker's theoretical estimates for the spans of coronal magnetic arches, this model is consistent with the observed spans of chromospheric fibrils and coronal X-ray arches. It is also consistent with the number of flux tubes present above the photosphere as estimated from the observed abundance of spicules.

Venkatakrishnan has calculated the mean amplitude of magnetic field fluctuations produced In a magnetic fluxsheath due to incidence of sound waves on the wall of the sheath. The main result is the presence of maxima and minima in the frequency response. These frequencies of maximum response hold a clue as to the thickness of the fluxsheath. This behaviour might possibly be exploited to estimate the sizes of tiny magnetic structures in the solar atmosphere. Venkatakrishnan has also started computations on the stability of cylindrical polytropic layers with finite thermal conductivity and zero viscosity. The eigenvalues in the normal mode analysis are sensitive to boundary conditions. For a rigid base at constant temperature, the layer was found to be stable for a wide range of temperature gradients. Extension of these calculations to different boundary

conditions, and with inclusion of effects of slow rotation and finite viscosity will shortly be commenced.

Raju in collaboration with B. N. Dwivedi of Banaras Hindu University has investigated electro density dependence of solar emission lines from the oxygen-like ions, Ne III, Mg V, Si VII, S IX, and Ar XI. These are representative of the solar chromosphere-corona transition region and the corona. The emission lines considered in this study pertain to the various transitions between the first nine levels of these ions. The first five levels constitute the ground term. Transitions between the ground term levels give rise to forbidden lines.

The behaviour of emission lines from these ions, with electron density, indicates that the intensity ratios of these lines can be used for direct determination of electron density in the emission regions. With the aid of Elzner's spherically symmetric model of the quiet sun, intensity ratios for different lines were calculated. These are found to be sensitive to electron density variation and give reasonable values of electron density for the various emission regions. The forbidden to permitted line intensity ratios can be particularly useful for density determination of active regions. Recent observations of active regions show forbidden lines belonging to oxygen-like ions. Based on theoretical intensity ratios. Raju and Dwivedi suggest the presence of some lines which are stronger than the forbidden lines observed hitherto, and which may be searched for, in the future. Absolute fluxes from the entire solar disk at earth's distance for various strong and weak lines have also been computed. The computed values are in reasonable agreement with the observed values. Except for Ar XI lines, the emission mainly comes from a narrow region having effectively uniform electron density and temperature.

Raju has in progress an investigation on the behaviour of carbon like ions for different values of electron density and temperature.

PHYSICS OF THE SOLAR SYSTEM

An analysis of the photoelectric record obtained at the cassegrain focus of the 102-cm telescope at Kavalur during the passage of Uranus, in front of SAO 158687, on 10 March 1977 has yielded indications of existence of a Saturn like ring system around the planet. It has also shown the existence of several other condensation features similar to the narrow ring system, discovered immediately after the event.

Sivaraman and Babu have completed the analysis of the observations on Comet West (1975n) made during its post perihelion phase with the Kavalur 1 metre reflector on 8 nights between March 12 and March 24, 1976, when the heliocentric distance varied from n = 0.588 to 0.81 a.u. Spectrum scans covering the range 3700-5300Å, with a 26 are sec entrance diaphragm centred at five successive locations commencing from the centre of the coma and proceeding outwards radially, have been used to study the radial distribution of the molecules and of the dust particles within the coma. The continuum energy distribution at each of these five locations show a progressive increase in reddening with increasing radial distance, the differential reddening being nearly 0.5 mag at 5265Å (with reference to 4465Å) between the extreme positions of the diaphragm. This feature provides evidence that the size of the dust particles in the coma varies with radial distance, the coarser particles being more confined to the inner regions of the coma than the finer ones. The number of molecules of the different species have been derived from the fluxes of CN (0, 0), C_3 (4050Å), C_2 (1, 0) and C_2 (0, 0) band intensities. The CN (0, 0) coma has the largest dimensions and that of C_3 (4050Å) the smallest.

The drift scans of the cometary coma in the light of C_2 (0, 0), CN (o, 0) and the continuum at 5000Å were used to derive the emission profiles. Those of C_2 (0, 0) when fitted to the theoretical brightness models of Haser, show clearly the existence of two different scale lengths for the parent molecules. The scale lengths of the two parent molecules of C_2 (0, 0) workout to 1.2×10^4 km and 2.2×10^4 km, corresponding to lifetimes of 3.3 hrs and 6.2 hrs respectively. For the C_2 (0, 0) molecules the scale length is 8.9×10^4 km or a life time of 24.7 hrs. A similar result is also seen in the case of the CN (0, 0) profile. The scale lengths of the parent molecules are 2.2×10^4 km and 3.8×10^4 km, the corresponding lifetimes being 6 hrs and 10.5 hrs respectively. The CN (0, 0) molecules have a scale length of 7.5×10^4 km and a lifetime of 21 hrs. This new result of the existence of two values for the scale lengths for the parent molecules of C_2 as well as of CN is interpreted as evidence for the existence in each case, of two different species of molecules, each one of which dissociates into the observed molecule.

The regular spectral scans of the cometary coma on 8 nights were used to study the variation of the flux in each of the emission bands of CN (0, 0), C_3 (4050Å) C_2 (1, 0) and C_2 (0, 0) and of Na I emission with the heliocentric distance r. These fluxes have been used to

calculate the abundances of the molecular species and of sodium atoms in the coma. The two spectral scans of the tail were used to derive the abundances of CO^+ ions in the tail of the comet.

STELLAR PHYSICS

The programme of photoelectric recording of selected lunar occulations was continued by Bhattacharyya at the 102-cm reflector. Out of about 30 selected events, good records for 10 were obtained during this period.

Kameswara Rao has commenced a programme of obtaining the near infrared spectra of R Corona Borealis stars at dispersions of 80Å and 120 A/mm in order to systematically classify their carbon class and the effective temperatures as well as to weed out the non-members in the objects classified as R CrB stars in GCVS. He also has in progress statistical equilibrium calculations of HeI for a variety of physical conditions in an attempt to explain the absence of the HeI 5876Å line emission in the R CrB spectrum at minimum light.

Rao has scanner observations of the strengths of the G band of CH at 4300Å and of the NH bands at 3360Å in weak G-band stars (wG stars) along with similar measures for normal field giants of spectral types G to K. The differential strengths of these bands in wG stars relative to the field giants indicate that the weakness of the G-band is linearly related to the enhancement of the NH band strength, thus leading to the conclusion that the atmospheric material of the wG stars is processed by the CNO cycle. Spectrograms at H are being obtained by Rao with the Varo image tube for weak G-band stars to obtain the absolute magnitude from H widths and to check whether D 5876Å of HeI could be detected in them.

Prabhu has obtained low dispersion spectra and photoelectric spectrum scans of Nova Sagitarii (1977) soon after its discovery. Bright lines of the Balmer series and of FeII, CaII, SiII and TiII were also observed along with the sodium D lines in emission. The last observation obtained was on May 19, 1977. Spectra have also been obtained at different dispersions of Nova Serpentis (1978). The observations of the H-alpha emission line at high dispersion show a complex structure in the line profile.

Spectra of two stars in M8, shown earlier by Parthasarathy from microspectra to be very red, have been obtained in the near infrared

with a dispersion of 80Å/mm. They are clearly early M giants. Sushma Mallik has obtained a few spectra of K supergiants in the red region at high dispersion for a study of atmospheric parameters.

Babu has photoelectric spectrum scans of 20 Ap, 6 Am and 2 normal A stars made with the Kavalur automated scanner. These form an extension of his earlier efforts to derive effective temperatures, radii and bolometric magnitudes of these stars. Pati and Rajamohan find the origin of Ap stars to be related to a supernova explosion in or around the vicinity of dense clouds, with the Ap stars located at the interface between the expanding shell and the dense interstellar clouds. Observations to verify this conjecture are currently being planned.

Parthasarathy, in collaboration with Lambert and Tomkin of the Mc Donald Observatory, has used the 2.7 metre telescope and Tull coude spectrometer to obtain 1.9Å resolution Reticon spectra of the secondary component of the close binary system U Cep (B7V + G8 III). The spectra were centered at 6329Å and 8620Å and extend over a spectral interval of 430Å. From a differential spectrum synthesis relative to k Gem, the metal abundance in the secondary compoment of U Cep is found to be normal [Fe/H] = 0.0 ± 0.3. The abundance of s-process elements also appears to be quite normal. Since the U Cep system is a result of case A mass exchange the observed abundances in the secondary component are consistent with that expected from theory. The CaII infrared triplet lines are found to be very weak in the spectrum of the secondary components of U Cep and U Sge. Weak CaII IR triplet lines are also noticed in σ Gem, a single lined spectroscopic binary with strong K line emission. Enhanced chromospheric emission in the H and K lines seems to be accompanied by a weakening of the infrared absorption lines of CaII. The secondary components in U Cep and U Sge appear to have active chromospheres as a result of tidal effects.

Parthasarathy, Reveendran and Mekkaddan have observed HR 1099 through B and V filters with the 34-cm reflector, over the 2.8 day orbital period. Available orbital data and the light curves indicate that HR 1099 is not an eclipsing variable. The observed light variations are similar to that found in the spotted star BY Dra. The light curves are asymmetric, with changes in amplitude and shape, from cycle to cycle. No correlation with phase is found between the variable radio emission and optical light variations. During the period of observation at Kavalur the star brightened on three occasions. These can be described as flare-like events that lasted several hours. More recently, soft X-ray

emission has been detected from HR 1099. The coincidence of X-ray emission with radio outburst enhanced $H\alpha$ and $Ly\alpha$ emission indicate extensive active regions on the stellar surface and a hot and extensive corona.

Parthasarathy has found IR excess in HR 1099, and HR 4665 (a new member of the RS CVn type systems) from an analysis of Reticon spectral scans, covering the spectral region 0.5μ to 1.0μ obtained by him with the 91-cm reflector of the McDonald Observatory.

Bappu and Scaria have completed a high dispersion study of Wolf-Rayet spectra. Intensity tracings of the spectra reduced to the continuum are published as an atlas-adjunct. Sunetra Giridhar and Bappu have used this material to examine possible superposition of the diffuse interstellar bands on the violet edges of the CIV lines at 5800Å. Both contributions can be evaluated separately in stars with suitable absorption velocity characteristics. Sunetra Giridhar has measured the velocity curve of HD 214419, the well known WR eclipsing binary, in the light of 5411Å of HeII, on low dispersion prismatic spectra. The velocity curve has properties close to those exhibited by NIV 4058 rather than HeII 4686Å.

Spectra of Canopus at high dispersion in the K-line region have been obtained for a study of the chromospheric emission. There are fluctuations of emission intensity from epoch to epoch; the intensity level in any case has not, since 1974, reached that seen on Warner's spectrum of 1965. Bappu and Mekkaddan have a search programme at 4Å/mm for the HeI 5876 line in stars with enhanced K emission and HeI 10830 intensity.

Murty has calculated band positions and intensity factors for the bands of the infrared A-X transition of AlO. These suggest that a study of bands in the 1 to 5 region along with those of the B-X system, in the spectra of the Mira stars, may be helpful in elucidating the Mira phenomenon. There is need for additional laboratory investigations of the infrared transitions of this molecule. Murty has also evaluated band intensity factors and r-centroids for the A-X band system of No^+.

Peraiah has commenced work at the Institute on problems of the solution of Radiative Transfer in spherical media. The effects of frequency redistribution on the formation of spectral lines in a static, spherical medium with angle averaged and angle dependent partial

redistribution functions R_I and R_{II} have been completed. These calculations have been done for an optical depth of 10^3 at line centre and for a geometrical extension of 2 and 10 times the stellar radius. It is found that substantial differences exist between the line profiles formed in an atmosphere treated with plane-parallel approximation and those formed in a spherical medium, since the ray effects are correctly taken into account in the spherical approximation. Further, more photons seem to be scattered into the line wings when profiles in complete redistribution, either due to Doppler or Voigt mechanism, are replaced respectively by R_I and R_{II} functions of partial frequency redistribution. The angle dependance of the partial redistribution functions increase the number of the emergent photons toward the surface of the atmosphere simply because of the coupling of the two angle dependencies in the spherical Radiative Transfer and in the profile functions. Computations of line profiles in a spherical moving medium, in the rest frame of the star, and in co-moving frame are in progress.

Kochhar has studied the stability of an infinitely conducting incompressible inviscid infinite cylinder with non-parallel helical velocity and magnetic field. The system is found to be stable if the energy in the ϕ component of the velocity field is larger than that in the ϕ component of the magnetic field.

Mallik has continued to work on Planetary Nebulae. In a paper presented at IAU Colloquium No. 45 in Torun on Chemical and Dynamical Evolution of our Galaxy he computed a simple mode of galactic enrichment through the planetary nebula phenomenon. Since the progenitors of planetary nebulae are believed to be stars in the Double Shell Source (DSS) phase of their evolution and since these stars undergo surface abundance changes through deep mixing following He-shell flashes, the particular effect of the flashes on ^{14}N enrichment through the planetary nebula phenomenon was calculated and incorporated in a model of Chemical Evolution of our Galaxy. This model yields the gradients d log X/dR/ of N/H and O/H in the plane of the Galaxy that is in good agreement with observed values. Mallik has also been investigating the distribution of masses of planetary nebulae and of their progenitors in an effort to obtain tne variation of star formation rate in the Galaxy.

INTERSTELLAR MEDIUM

The study of model reflection nebula in the far ultraviolet (UV) in view of the ANS satellite observations of the Merope nebula has been undertaken by Shah in collaboration with Krishna Swamy of the Tata Institute of Fundamental Research, Bombay. The geometrical models include the three cases of the illuminating star behind, within and in front of the nebula, and which is in the form of a homogeneous plane-parallel slab containing singly scattering dirty-ice grains. Shah and Krishna Swamy have compared the calculated nebular surface brightness distribution directly with ANS satellite observations. A close agreement can be obtained if one considers the geometrical case of the nebula with the star in the front. However, the case of a configuration with the star close to the front surface, but within the nebula, needs further careful consideration. The surface brightness curves, for the size distribution parameter of the dirty-ice grain in the range 0.1 μm to 0.6 μm, all match with the observations for all the four wavelengths viz. $\lambda = 1550$Å, 1800Å, 2200Å and 2500Å. It is therefore, difficult to discriminate precisely among the sizes. For this, one must study other observational features such as, polarization for which, at present, there are no data available in the far UV. The interpretation indicates that as one goes in the far UV, one is concerned with scattering domain near the geometrical optics limit ($x = \frac{2\pi a}{\lambda} >> 1$). The particle then presents itself as a mirror or wall ; mainly back scattering would prevail in such a case. In fact, as one goes from visual to far UV, in the direction of increasing x, the phase function would become increasingly anisotropic.

GALAXIES

The intensity distribution in the vicinity of the nuclei of hotspot galaxies is being studied by Prabhu. Several photographs of eleven of these systems have been obtained with an F/4 camera in the Meinel transformation unit. A Varo single stage image tube camera has also been used to photograph the nuclei of 43 such galaxies with graded exposures in integrated light. The inner structure resembles the outer aspects of the galaxy in most cases with a rotation of position angle about the major axis. A few of these obtained in red light show the nuclear region to contain a high concentration.

Prabhu has also obtained with the new cassegrain image-tube spectrograph, slit spectra of some of these galaxies. Some of the observed

galaxies have emission features in the spectra that permit radial velocity measurement.

Bappu, Parthasarathy and Scaria have continued their survey of red stars in the Large Magellanic Cloud using microspectra. Several fields covering the bar of the Cloud have been photographed and evaluated. Parthasarathy has discussed, at the IAU Symposium on the HR diagram, the densities of blue and red stars in different regions of the Large Cloud, as inferred from studies of Kavalur microspectra.

Alladin and Parthasarathy have studied the tidal force effects in binary stellar systems. Estimates are made for the rate of increase of the binding energy of a component and the rate of decrease of the energy of the orbital motion of the binary under the simplifying assumption that the motion of the stars in the stellar systems may be neglected in comparison with the orbital motion of the binary system. The time of disruption of a component and the time of coalescence of the pair are obtained as functions of the separation and mass ratio of the binary for different as well as close overlapping pairs. Applications are made to globular clusters and binary galaxies. For a pair of identical galaxies the rate of coalescence of the pair is faster than that of the disruption of the components. A study of the tidal effects at the median radius indicates that a pair of contact spherical galaxies moving in circular orbit will merge and form a single system in a time interval less than three periods of revolution. The rate of disruption of the components is six times slower. As the separation decreases, the rate of disruption increases faster than the rate of coalescence. The rates of disruption and coalescence have been derived from the properties of the stellar systems at the median radius. The tidal force effects will be greater in the outer parts than in the interior portions. For contact and overlapping pairs of galaxies, the variation of the disruptive effects over the spatial extent of the galaxies will have important consequences. The outer envelopes of individual galaxies will lose their identity much sooner and form a common outer envelope of the pair while the two nuclei will retain their identity for a considerably longer time. Thus galaxies with double nuclei will be formed in the process of the dynamical evolution of a close pair. The supergiant D galaxies in rich clusters have extensive envelopes and often exhibit multiplicity of nuclei. Merging of galaxies due to tidal force effects appear to be a likely mechanism for the formation of these galaxies.

Das has attempted to explain the absorption features in the spectra of quasi-stellar objects with the aid of static, spherically symmetric configurations that have isothermal cores and adiabatically stable envelopes. He finds that the absorption systems can occur within the object in very thin shells with densities negligible as compared to the typical densities of the object. The effect of radiation pressure on such shells, due to a small central source of luminosity, has been investigated and it is found that stable equilibrium positions are possible due to a balance between the gravitational and radiation forces. One can explain the few quasi-stellar objects in which the absorption redshift exceeds the emission redshift, on the basis of collapsing shells, falling towards the centre. Das has made some illustrative numerical calculations for a few typical cases.

According to the Conformal Gravitation Theory of Hoyle and Narlikar for any pair of associated objects showing anomalous redshifts, the object showing higher redshift will be younger. The redshift difference can then be expressed in terms of the ages of the two objects. Assuming that the younger object has been created at a later epoch within the lower redshift parent, and ejected subsequently from it, a relation between the observed small angular separation in the two objects and their redshifts can be obtained. The preliminary analysis by Das of the observational data shows that the observed angular separation redshift plots for these objects can be adequately explained on the basis of this scenario.

The initial density fluctuations in the earliest period of the big bang cosmology are understood to lead to the formation of black holes of masses $\geq 10^{-5}$ gm. The general belief is that, in the present conditions, black holes with masses exceeding the Oppenheimer-Volkoff mass limit ($\sim$2-3M$\odot$) only can be formed in the gravitational collapse of a massive star. However, except for a difference in scale, a white hole explosion resembles the big bang. Thus drawing an analogy from the big bang, Kapoor has postulated the production of black holes of masses $\geq 10^{-5}$ gm in a white hole explosion. Immediately after their formation, the black holes start accreting white hole material and a fraction would evaporate away. Since formation of black holes over a large mass range is possible, strong accretion on to massive black holes can have a marked effect on the evolution of a white hole. Thus, rather than being a shortlived phenomena (few years) a white hole can remain 'white', i.e., a source of high energy radiation, for a much longer period.

Vinod Krishan in collaboration with N. Kumar of the Indian Institute of Science has examined the stability of a non-rotating neutron star against black hole formation. The complete general relativistic expression for total energy of self-gravitating spherically distributed matter is employed and along with the minimum energy principle, the upper limit on the mass of a neutron star is found to be 3.1 $M\odot$. The approach is based on global energy considerations and might be more relevant in a study of overall stability against collapse than considerations based on the analysis of the local metric.

Rajamohan and Kochhar find that definite evolutionary tracks of pulsars can be distinguished from their observed periods and period derivatives and that the secular magnetic field decay proposed by Lyne, Ritchings and Smith is consistent with the observations. The characteristic decay time of the magnetic field is found to be 10^{14} sec. Pulsars with drifting sub-pulse, show that at first the sub-pulse drifts from the leading edge to the trailing edge, then in both directions and finally changes its original direction.

Carried out jointly with the Raman Research Institute is a programme to identify dormant X-ray binaries. If the first supernova explosion does not disrupt the binary system, it leads to an X-ray source, as the second star evolves away from the main sequence. In order to identify such sources in which the second star is still on the main sequence, microspectra have been obtained of about twenty radio supernova remnant regions in the hope that blue objects detected thereby may on further scrutiny turn out to be binaries with neutron star companions.

RADIO ASTRONOMY

The decameter wave Radio Telescope at Gauribidanur, jointly operated with the Raman Research Institute, is now fully operational. It is one of the largest radio telescopes in the world and one of the few which is capable of mapping the background radio emission from our galaxy. The radio telescope can resolve objects separated by about 30 arc minutes in the sky and it can detect sources having flux densities of the order of 10 to 20 janskys.

The telescope is being used to study the absorption of the background radio emission from our galaxy by ionised hydrogen regions. Also included for study are the aspects of scintillation of radiation from galactic and extra galactic radio sources by virtue of the interplanetary medium.

The telescope output is at present recorded digitally on paper tape. Under construction currently, is a multichannel digital magnetic tape recording system which is expected to be operational shortly. Much work has been done on the construction of binary diode phase shifters with which it will be possible to change the direction of maximum response of the radio telescope almost instantaneously.

SOLAR-TERRESTRIAL RELATIONSHIPS

Sastri and Murthy have studied the behaviour of the F-region at the time of the onset of spread-F. The onset and maintenance of equatorial spread-F does not uniquely depend on the height of the F-region. The study also showed that fluctuating east-west electric field (inferred from h' F values scaled from 5 min interval ionograms) is not a prerequisite for the onset of equatorial spread-F.

Sastri has examined in detail the behaviour of spread-F at Hobart (a station inside the midlatitude ionospheric trough zone) and the latitude gradient in ionization around the equatorward edge of the trough during selected geomagnetic storms, using published data. It is found that there is a conspicious and rather consistent increase in the depth of the trough either during the same night or the next night of the storm sudden commencement, with a similar pattern of enhancement in the occurrence of spread-F at Hobart. Hence, it seems likely that the cause of the occurrence of spread-F at higher midlatitudes is the formation of the midlatitude ionospheric trough and the possible multiple reflections from the steep ionization gradients at the edges of the trough.

Sastri, Murthy and Sasidharan have examined the occurrence characteristics of night sporadic-E (Es) at Kodaikanal during geomagnetic storms. The study, based on ionogram data obtained at Kodaikanal, covers periods of both low and high sunspot activity For a majority of the storms, there is a definite increase of appreciable magnitude in the occurence of night Es along with changes in characteristics within 0-3 days of the initiation of the storm. There is also no preferential occurrence of any particular type of Es configuration during storm conditions. These findings suggest a possible role of charged particle precipitation in the behaviour of night Es at equatorial latitudes, following geomagnetic disturbances.

Sastri and Murthy studied the occurrence of 'Abnormal Quiet days' at Kodaikanal using H-field data that covers a 26 year period (1950-1975). The results, when considered in the light of earlier work at middle latitudes,

show distinctive differences in the morphological behaviour of AQD at equatorial and midlatitudes.

The nature of crochet (s.f.e.) associated solar microwave bursts with crochet data from Kodaikanal and microwave burst data obtained at Toyokawa, Japan and covering the period 1966-70 has been examined by Sastri. A majority (54.5%) of the crochet associated microwave bursts at 2000 MHz are of the complex type.

A critical study has been made of the occurrence of equatoriol spread-F in relation to the level of geomagnetic activity, using Kodaikanal ionogram data for a 24 month period corresponding to high sunspot activity conditions Sastri finds that the widely reported inhibiting influence of geomagnetic activity on equatorial spread-F occurrence manifests only when Kp index reaches the range 6^- to 6^+ during the local time period, 1800-0200 hours, and that too in equinoctial months.

Murthy in collaboration with Deshpande, Vats, Sethia of the Physical Reasearch Laboratory, Ahmedabad, has observed an interesting behaviour of the equatorial F-region, wherein irregularities produced at night have vanished and manifested again after sunrise. These new irregularities have been noticed to cause spread-F on ionograms at Kodaikanal and scintillations of 40, 140 and 360 MHz transmissions from ATS-6 satellite recorded at Ootacamund. The irregularities are considered to be associated with a geomagnetic storm (GC type).

The correlation of ionospheric scintillations in the VHF/UHF bands with the signatures of the irregularities on bottom side ionograms in the electrojet region have been studied, with amplitude scintillation data at 40. 140 and 360 MHz recorded at Ootacamund by the PRL group and ionogram data obtained simultaneously at Kodaikanal. The scintillations are associated with irregularities that cause (i) either range or frequency type spread-F (ii) night Es (iii) any type of sporadic-E other than the usual day time Esq and (iv) G layer. There is also evidence from Faraday rotation measurements of the existence of an irregularity belt and its movements, during a magnetic storm. The boundary of the belt in the equatorial region moved towards north during the storm conditions, a result different from that observed in higher latitudes.

INSTRUMENTATION

Major efforts in the electronics instrumentation laboratory during the year were centred around development of direct data handling procedures

in photoelectric observational programmes and design of computer controlled telescope systems. Two separate systems for digital registration of photoelectric data, one employing a teletypewriter and the second incorporating a matrix printer was under development during this period. These two are meant for use with the smaller photoelectric telescopeps at Kavalur, and employed hardwired logic. Direct recording of photoelectric data obtained on the 102-cm telescope is done on magnetic tapes via the TDC 12 on-line computer. A computer control system is under fabrication for the 75-cm cassegrain reflector.

A preliminary version of a Fourier transform spectrometer has been designed and fabricated for the visible and near IR regions The resolution which can be achieved is .015 cm^{-1}. The motion of the mirror of the Michelson interferometer is achieved by a stepper motor.

A new grinding machine for mirrors of size 125cm has been completed in the Kodaikanal machine shop and installed at the Optics Laboratory in Bangalore. The optical work on the 43/60cm Schmidt has been completed. tinow awaits fabrication of a mechanical mount. Smaller optical systems completed, include the optics of a 40cm parabolic reflector and several optical flats of assorted sizes, besides a wide field viewing device for the 102cm coude focus. Work was also in progress on the optics needed for two Schlieren systems by the National Aeronautical Laboratory.

OBSERVING CONDITIONS AT KAVALUR AND KODAIKANAL

There were 1512 hours of observing at Kavalur. Photometry could have been done on 429 hours. On 105 nights, spectroscopic work was carried out for a duration of 9 hours or greater. Average seeing better than 1.5 seconds of arc was available on 66 nights. The table below shows the month-wise distribution of these features.

At Kodaikanal, white light photoheliograms were obtained on only 268 days Hydrogen and Calcium disc Spectroheliograms were taken on 249 and 250 days respectively. Prominences could be photographed with the spectro heilograph on 214 days Observing conditions were therefore much below averge. The solar tower was used on 190 days but seeing better than 2 arc seconds could be had on only ten of these occasions.

Month	Hours of Spectro-scopic work	Hours of possible photometry	Number of nights when spectro-scopic work 9 hrs. or greater was done	Number of nights with average seeing better than 1.5''
1977 Apr	164	42	12	6
May	99	22	4	3
June	42.5	6	2	1
July	51	0	2	0
Aug	29	5	1	1
Sept	67	6	1	2
Oct	94.5	45	8	6
Nov	64.5	5	2	7
Dec	209	29	15	9
1978 Jan	252	127.5	21	15
Feb	203	89.5	15	9
Mar	236.5	52	22	7
TOTAL	1512.0	429.0	105	66

THE 234cm TELESCOPE PROJECT

There is much progress to report on the building and dome for the 2.34 metre telescope. The building is nearly complete. Designs of the dome and its drive systems were available during the middle of the year and the contract awarded for its fabrication. The grinding machine for the primary mirror is now under construction. This should be ready for installation at Bangalore by December 1978. At Kavalur a new power station has been built for housing the standby diesel power supply and the high tension transformer. The Bhabha Atomic Research Centre have been entrusted with the work of fabricating the 2.8 metre aluminizing tank for the primary. There is also satisfactory progress to report on the design engineering of the telescope mount, drive and control system.

LIBRARY

During the year 1977-78, 317 books and 60 reports were added to the Library. It subscribed to 120 journals and continued to receive publications from other Institutions on an exchange basis.

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H. Chandra
M. R. Deshpande
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R. K. Rai
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H. S. Gurm
A. R. Jain
V. M. Patwari
B. S. Subbarao

On the equatorial irregularity belt and its movement during a magnetic storm - Nature 272, 345.

STAFF

Academic Staff in position during the year were as follows :

M. K. V. Bappu, Ph. D.	— Director
J. C. Bhattacharyya, D. Phil.	— Associate Professor
M. H. Gokhale, Ph. D.	— Reader
A. P. Jayarajan, M. A.	— Reader
A. Peraiah, Ph. D.	— Reader
P. K. Raju, Ph. D.	— Reader
J. H Sastri, Ph. D.	— Reader
Ch. V. Sastry, Ph. D.	— Reader
G. A. Shah, Ph. D.	— Reader
K. R. Sivaraman, Ph. D.	— Reader
P. K. Das. Ph. D.	— Fellow
S. S. Hasan, Ph. D.	— Fellow
R. C. Kapoor, M. Sc.	— Fellow
R. K. Kochhar, Ph. D.	— Fellow
V. Krishan, Ph. D.	— Fellow
D. C. V. Mallik, Ph. D.	— Fellow
B. S. Murthy, Ph. D.	— Fellow
M. Parthasarathy, M. Sc.	— Fellow
R. Rajamohan, Ph. D.	— Fellow
N. Kameswara Rao, Ph. D.	— Fellow
M. Singh, D. Phil.	— Fellow
G. S. D. Babu, M. Sc.	— Research Associate
R. Chandramohan, M. Sc.	— Research Associate
T. P. Prabhu, M. Sc.	— Research Associate
K. C. A. Raheem, B. Sc.	— Research Associate
A. K. Saxena, Ph. D.	— Research Associate

K. K. Scaria, M. Sc.	— Research Associate
J. Singh, M. Sc.	— Research Associate
K. R. Subramanyan, M. Sc.	— Research Associate
A. Sundareswaran, B. E.	— Research Associate
P. Venkatakrishnan, M. Sc.	— Research Associate
P. P. Venkitachalam, M. Sc.	— Research Associate
N K. Srivastava, Ph. D.	— Post-doctoral Fellow

The Technical, Administrative and Non-Technical Maintenance Staff numbered 110.

BUILDINGS AND GROUNDS

The construction of the tower for 234-cm telescope was started and substantial progress was made during the year. The Main Laboratory at Bangalore was completed and occupied during the year. As in the previous year, the fire lines at Kodaikanal and Kavalur were kept in good condition.

A dome and building to house the 75 cm reflector was completed at Kavalur The Technical Physics Laboratery was built during the year to accommodate the 1.5 metre aluminizing tank.

SCIENTIFIC MEETINGS

Dr. M K. V Bappu continued as President of Commission 12 on the Solar Atmosphere of the International Astronomical Union, as well as Chairman of the Indian National Committee of Astronomy. Dr J.C. Bhattacharyya continued as council member of the Astronomical Society of India. Dr. J. C. Bhattacharyya visited the University of Texas, Austin U.S.A for discussions on the computer controlled drive system for the 234-cm telescope. He also visited the Kitt Peak National Observatory, Mount Wilson Palomar Observatories and the Lick Observatory in connection with familiarization of several aspects of control systems and instrumentation for optical telescopes. Dr. Bhattacharyya also attended a workshop on "Training requirements of Astronomers in India" at Hyderabad held on 27-30 December 1977.

Participants from the Institute at the Ooty meetings of the Astronomical Society of India, included Drs. Gokhale, Kameswara Rao, Vinod Krishan, Peraiah and Singh as well as Mr. Babu. Drs. Das and Hasan took part in the winter school on "Close Binaries in Astrophysics" held at the Tata Institute of Fundamental Research, Bombay. Mr. M. Parthasarathy attended IAU Symposium 80 at Washington D. C. on the Hertzsprung Russell Diagram followed by several weeks of observing at the University of

Texas. Dr. D. C. V. Mallik attended IAU Colloquium 45 at Torun, Poland on "Chemico-Dynamical Evolution of our Galaxy". Dr. B. S. Murthy attended the workshop on "Equatorial electrojet and associated phenomena" held at the Physical Research Laboratory. Both he and Dr. J. H. Sastri participated in the symposium "Space Science 1978" held at the Andhra University, Waltair.

Fellowship: Dr. R. K. Kochhar was awarded a German Academic exchange service fellowship to work at the University of Gottingen for two years.

VISITING SCIENTISTS

Scientists who visited the Institute and its field stations and who gave colloquia include Prof. C. Dewitt, University of Texas, Austin, Dr. V. I. Makarov, Kislovodsk station of the Pulkova Observatory, Leningrad, Dr. A. V. Tutukov, Astronomical Council, USSR Academy of Sciences, Moscow, Prof. E. P. J. Van Den Heuvel. Astronomical Institute, University of Amsterdam, Amsterdam, Prof. N. R. Lebovitz, University of Chicago, Dr. R. Wehrse, University of Heidelberg, Prof. K. Narahari Rao, Ohio State University, Prof. M. R. Kundu, University of Maryland, U.S.A., Dr. K. Desikachary, University of Western Ontario. Prof. S. K. Trehan, Department of Applied Mathematics, Panjab University, Dr. K. S. Krishna swamy, Tata Institute of Fundamental Reasearch and Dr. A. R. Prasanna of the Physical Research Laboratory, Ahmedabad.