INDIAN INSTITUTE OF ASTROPHYSICS

Annual Report for the year April 1,1975 to March 31,1976.

SOLAR PHYSICS

An investigation on the emission line width in the K-line of ionized calcium in the chromospheres of the Sun and the late type stars has been completed by Bappu and Sivaraman. Micrometer measures of the emission line width on the integrated spectra of the sun yield a near value of 38.2 km/sec. From similar measures of the spectra of 22 other stars and from their K-line profiles, a definition is proposed whereby the emission line width is a measure in km/sec at the e^{-1} value of the difference between the intensity of the brighter K_2 peak over the K_1 background reckoned from the latter level. The K-line profile of the integrated spectrum of the sun possess a width in excess of the widths seen in the averaged spectra over different parts of the solar disc. The increase in width of the K line profiles near the limb over those at the centre of the disc can account only for a minor share of this excess. The principal contributor is the solar rotation, since the regions farther away from the centre will contribute more to the integrated behaviour than the centre itself. This shows the imperative need to use a solar value derived from a truly integrated spectrum for any calibration of width with absolute magnitude. It is shown that the K-emission profile observed in other stars is that of the typical bright mottle, which is a very important entity in the derivation of the parameters pertaining to the chromosphere. The displacement of the K_3 minimum influences the relative intensities of K_{2V} and K_{2R}. If K_3 has a contribution from an agency similar to the dark condensations seen on the sun, then intensities with V>R will be associated with positive values of K_3 displacement and vice versa. From a measurement of the

Doppler displacements K_2 and K_3, for 32 stars, it is seen that 29 stars, follow the above criterion, 3 stars being exceptions. From the considerations it is concluded that "dark condensations" similar to in the case of the sun also exist in Stellar Chromospheres.

A detailed study of the time evolution properties of the profiles of the bright points and their dark counterparts seen in the CaII H and K line spectra of the sun, by Sivaraman and Venkitachalam was in progress. Preliminary results of such a study covering only a few bright points over a short interval of time(25 minutes) showed that it is necessary to extend study to cover a larger number of the bright points and a longer duration. It will then be possible to relate the kinematics of the instabilities that occur at the lower levels in the solar atmosphere with the time evolution properties of the profiles of these bright points at the chromospheric level. The material for this study is an excellent time sequence of spectra obtained at the Sacramento Peak Vacuum telescope.

Sivaraman and Venkitachalam have commenced a long range observing programme to study the penumbral waves simultaneously at the photospheric level and at the level of H_α in order to measure the propagation parameters of these waves and to understand their nature. Venkitachalam and Jagdev Singh have continued to obtain the integrated K line spectra of the sun on a regular basis. Jagdev Singh and Saxena have obtained a number of time sequence spectroheliograms in K_3, K_{2V} and K_{2R} using the 4.3m spectroheliograph and 34cm diameter solar image. A study of the lifetimes of the fine structures in the solar chromosphere and their evolutionary properties

has been commenced using this material. Singh has also obtained on a number of occasions simultaneous spectrograms and spectroheliograms in the K-line with the 34cm solar image using a new reflecting slit jaw arrangement at the solar tower telescope. Jagdev Singh has commenced a detailed examination of the K spectroheliograms to detect a possible correlations between the Ca II network and the phase of the solar cycle. A first study of over a thousand supergranules in the period January 1912 to March 1912 shows a most probable size of 22600 kms. The mean value of a thousand five hundred of them during the period November 1916 to March 1917, corresponding to solar maximum, is 21750km. Very many more measures need to be done to establish the reality of this phenomenon.

Saxena has finalised an experimental arrangement to measure the instrumental polarisation of the solar tower telescope for different hour angles, using a Babinet compensator - polaroid combination. Bhattacharyya has set up an image converter system with an S-1 cathode to enable visual monitoring in the spectral region of 1 micron.

Spectral line intensities are influenced primarily by two plasma parameters, electron temperature and electron density. An ideal diagnostic measurement would be sensitive to one of these and independent of the other. Thus, line intensity ratios could serve as sensitive indicator of electron density and temperature in the solar atmosphere. Uptil now, detailed investigations have been carried out only for He-like, Li-like, Be-like, and Boron-like ions. Preliminary studies by Raju indicate that spectral intensities belonging to one ions of C, N, and oxygen iso-electronic sequences are also sensitive to electron density and temperature.

At the present phase of the project, assuming multilevel atom model, Raju has completed the computations for the ions: NeIV, Mg VI, Al VII, Si VII, P IX, and S X belonging to the nitrogen isoelectronic sequence. The results are being analysed. The ions under consideration are representative of the chromosphere-corona transition region and solar corona. The lines fall in the UV, visible and IR region of the solar spectrum. In addition to indicating electron density and temperature in the solar atmosphere, such calculation would also be of help in line identifications.

Gokhale had found earlier that a large variety of phenomena associated with solarmagnetic fields may be inter-related phenomenologically in terms of movements of magnetic fluxtubes of flux $\sim 3 \times 10^{18}$ Mx. Using certain plausible assumptions, which need subsequent detailed verification, he has attempted to explain the amount of magnetic flux in these fluxtubes, their production in the convection zone and their emergence above the photosphere. Gokhale finds that such fluxtubes may provide most efficient longitudinal transport of energy that is introduced into them transversely by convective flows at large depths in the convection zone. Generation of such fluxtubes in clusters of thousands may take place at several solar longitudes where convective flows in large depths diverge or converge. Over a portion of such fluxtubes, the longitudinal energy transport may be interrupted or may become temporarily inadequate compared to the energy input, and this may lead to the emergence of such portions above the photosphere. Portions which may remain in large depths might last for at least a few years.

Gokhale has also studied the limitations imposed by the

filamentary nature of the solar magnetic fields on the applicability of the turbulent diffusion theories by Leighton and by Steenbeck, Krause and Radler. He finds that in spite of these limitations, the two theories can be applied to the diffusion of solar magnetic fields on scales > 1000 km. The crude theoretical estimates of the magnetic diffusivity are smaller than the observational estimates, but the difference may be attributed to the presence of stronger-than-average field gradients and/or to the presence of systematic flows overand above the turbulence. The aforementioned limitations do not allow the explanation of sunspot decay in terms of convective motions which may exist in the sunspot fluxtube. However, if the sunspot fluxtube is a bundle of fluxtubes of magnetic flux ~3 x 10^{18} Mx, then the sunspot decay can be interpreted as a random-walk diffusion of the thin fluxtubes due to the turbulent motions suggested by Krause and Rudiger. There is some possibility that such a model for sunspot decay may also lead to a model for the energy balance in the sunspots.

INTERSTELLAR MEDIUM

The calculations of colours and polarization that can be caused by core-mantle grains in the form of concentric spheres as well as mixture of spherical grains of various types in a reflection nebula have not been considered in the literature. Shah has included these features in further calculations for the case of reflection nebula with the star in the rear. In composite grains, the core consisting of either graphite, silicon carbide or silicate has radii in the range 0.04 (0.04) 0.12 micron and ice mantle is chosen such that the ratio of mantle-to-core volumes is 4.4, 11 (11) 88 percent. Similar

calculations for mixture consisting of graphite, silicon carbide, silicate and dirty ice grains in different proportions have been undertaken. All the materials are now considered with the measured wavelength dependent refractive indices. In the case of mixture of grains, the size distribution function for each species has been incorporated.

The extinction efficiencies for small smooth homogeneous spherical metallic particles (granules) have been calculated using rigorous Mie theory of electromagnetic scattering. The plot of extinction versus size-to-wavelength parameter $x = 2\pi a/\lambda$ indicate strong size-dependent resonance-like features for spheres composed of sodium, potassium and calcium. A detailed calculation using wavelength dependent refractive indices have revealed some unusual profiles by the small metallic particles in the domain of Rayleigh scattering. For sodium granules with radii in the range 80Å to 300Å, all the profiles of extinction versus wavelength have full widths at half maximum in the approximate wavelength range $0.35\mu \leq \lambda \leq 0.45\mu$ for Na and $0.5\mu \leq \lambda \leq 0.6\mu$ for potassium. If one assumes that Na granules play a role in producing the interstellar diffuse band at $\lambda 4430$, the present result leads to an estimate of 0.5 percent of the total surface of the grain occupied by Na granules with radii 120Å. The number density of granules per grain turns out to be 9.36, 0.89 and 0.44 for sodium granules with radii a_o=80Å, 200Å and 300Å respectively. The total number of Na atoms on this basis is $\simeq 5\times10^{-8}$ to 10^{-7} cm^{-3}, whereas the cosmic abundance of Na is 2.4×10^{-6} cm^{-3} according to Cameron. It may also be possible to explain the depletion of atoms in the interstellar medium by considering granules locking up the missing atoms. These granules may be the condensing nuclei for fully grown grains in the interstellar medium. The unusual extinction profiles mentioned above can

have implication structure in the observed interstellar extinction curve and for cometary spectra also.

In a review article on 'Some Aspects of Interstellar Grains', Shah has summarized recent measurements on interstellar extinction, infrared astronomy and linear and circular polarization. The problems of electromagnetic scattering by particles of various shapes and orientation of grains are also considered. Some interesting laboratory experiments on grains have been described in view of a number of uncertain factors; for example, composition , shapes, grain formation mechanism, sticking coefficient, molecular formation on the surface of the grain, etc. In particular it has been thought essential to measure both the real and imaginary parts of indices of refraction as function of wavelength for various materials proposed for interstellar grains.

Mallik has carried out a preliminary analysis of monochromatic photographs of selected portions in the Orion Nebula. These nebulargrams were obtained in a slitless arrangement with the 102cm reflector. The optical filament near σ^2 A Orionis was seen in (S II),(NII) and H_α. HeI 6678A was conspicuously weak on the spectrograms. From the intensities of the (SII) lines, electron densities were computed at various points of the filament and at points away from it. The density showed an increase across the filament. Mallik plans to do photoelectric scans in this region during the coming winter.

Model Ionization fronts were computed with the help of an IBM 370 system. These fronts all had weak D characteristics. Different shock velocities and oxygen abundances were used as inputs to study the variation in the Front structure due to a change in these two parameters. The data are being analysed.

A theoretical investigation was started on the number of planetary nebulae and their birthrate in the Galaxy. Assuming all stars between 1.0 - 4.0M to produce planetary nebulae and choosing a suitable model of the Galaxy the birthrate function of planetary nebulae as a function of mass was derived. In view of the recent work by Ostriker et al on two-zone models of galaxies this work is being revised.

STELLAR PHYSICS

A major addition to the facilities available at the 102cm telescope has been the commissioning of the coude spectrograph and the automated spectrum scanner. The coude spectrograph with camera A of 61cm focus yields dispersions of 12.8A/mm in the blue and 20A in the red. Camera B of 285cm focus gives 2.8A/mm in the blue region. The collimator-camera ratio for camera A is 10, thus leading to good efficiency. The automated scanner is coupled on-line to the TDC-12 computer and, with cold boxes containing photomultipliers of different spectral response, is capable of scans from 3300A to 11000A. Both these new facilities provide major new avenues of opportunity to the researcher at Kavalur.

Spectra of Canopus at 2.8A/mm have been obtained by Bappu for detection of the K emission line from the chromosphere of the star. Warner had reported earlier in 1967 from spectra of 6A/mm that Canopus had indeed K emission but with a width that differed from what would be expected for its luminosity on the basis of the K-line width $-M_V$ relationship. Spectra obtained at Kavalur at 4A/mm in 1975 with an echelle spectrograph at the coude focus failed to show any trace of emission. The 1976 spectra obtained with even higher dispersion shows no trace of it. This is explained by the fact that plage activity must

prevail on the star and that the 1975 and 1976 spectra have been obtained at a minimum phase of activity on the star. The fact that the 1967 measures of width disagree with the width-luminosity relationship is another point in support of this conjecture, since emission widths for plages are narrower than those that are characteristic of the properties of convection in the outer layers of the star.

A programme of study of abundances and kinematical properties of CH-poor, G-K giants has been commenced by Kameswara Rao. The main interest is to obtain the strength of the CH, CN, NH molecular bands and thus measure the enhancements and/or deficiencies of C and N. Spectra in the blue of some of these stars have been obtained at dispersions of 26A/mm and 168A/mm for radial velocity measurement. The molecular band strengths are measured by the automated spectrum scanner. Preliminary results from scanner data show that in CH-poor stars, NH is enhanced (as expected from theoretical considerations) indicating carbon deficiency and nitrogen enhancement. Rao has also commenced work on building synthetic spectra for different abundances.

Parthasarathy and Venkatakrishnan have observed UV ceti, AD Leo, YZ CMa photoelectrically through standard UBV filters to study the correlation of flare phenomenon in the optical and radio region, and to detect a possible periodic behaviour in their light variations. Flares ranging from $^{m}1.0$ to $^{m}0.1$ were observed in UV Ceti, and YZ CMa. Analysis of the data is completed.

Parthasarathy has used a near infrared photometer with an ITT-FW 118 photomultiplier and intermediate band filters that isolate wavelengths at 7014 A, 8601 A and 10223 A, to

study the interesting close binary system BM Orionis. Observations have been obtained on several nights. The study aims at a determination of the dimensions of the secondary component and to establish the wavelength dependence of the reflection effect. Such a dependence would be weaker for a disk of scattering particles than for a relatively cool secondary star. It is expected that a study of the secondary eclipse over a wide wavelength baseline will yield valuable information on the nature of the secondary component. Spectrum scans in the ultraviolet-blue-yellow region have also been obtained of this system both during totality and outside eclipse. A preliminary analysis indicates that the contribution by the secondary to the total near infrared light is significant. There is also an indication of the variation in depth of the secondary eclipse with wavelength. Analysis of this data is in progress.

Several close binaries have been observed by Parthasarathy with 50A and 100A band pass, in the continuum wavelength regions from 3300A to 6600A. All these have been done with the automated scanner. These scans at different phases will provide flux values that can be compared with those derived from model atmospheres and synthetic light curves.

Rajamohan has commenced a programme to find new emission-line objects from amongst fast rotation of B stars. Since some of these objects may show transient emission, it is likely that earlier low dispersion surveys may have missed many objects. One of the objects examined, HR 1289, has been found to show double emission at H_{α}.

Photoelectric photometry of Nu Centauri on two nights in April 1975 with the 38cm reflector shows that the light variation

if any does not exceed 0.02 magnitudes. This object was discovered by Rajamohan to be a beta cephei variable from spectroscopic criteria. On two nights Kameswara Rao has obtained spectra in sequence of this object for radial velocity measurement. The velocities show an amplitutde of 25km/sec and the period of 0.17499 days derived from these spectra agrees with the earlier value given by Rajamohan.

Several spectra of Nova Cygni 1975 have been obtained during the period September to December 1975. These cover the spectral region from the blue to the near infrared at dispersions ranging from 17A/mm to 410A/mm. Prabhu has studied the emission profiles derived from the spectra of the early nebular stage of the nova. The velocity structure of the profiles and the time variation of both the velocities and intensities of the emission peaks of H_{α} are interpreted as due to an expanding system of rings at different latitudes with respect to a common polar axis. The envelope was optically thick during the period of observation. There is evidence for the stratification of ions with different ionization potentials and also for an ionization gradient for hydrogen.

Rajamohan has derived stellar rotation on the Zero age main sequence as a function of mass. He assumes that the envelope of highest rotation of main sequence stars as a function of spectral type in a cluster represents its true distribution of rotational velocities. From the known ages of the clusters and published evolutionary models in mass range 1-15$m_{\odot}$, stellar rotation on the zero age main sequence was derived based on the assumption that angular momentum is conserved in shells.

Kochhar has investigated the problem of the points of bifurcation along the sequence of rotating axisymmetric mass

and considered the effect of a general magnetic field on them. He finds that the points of bifurcation belonging to the third harmonics along the sequence of Maclaurin spheroids, viewed from an inertial frame of reference, are distinct from the corresponding points along the Maclaurin sequence that is considered stationary in a rotating frame. A toroidal magnetic field leaves these points unaffected, while a poloidal field may either raise or lower these points.

The structure of the Gum Nebula and of the Vela supernova remnant are being examined by Kochhar, Rajamohan and Prabhu. The picture of the interstellar medium towards the Gum Nebula as it emerges from their interpretation of the data of the scattering of solar lyman alpha radiation by interstellar neutral hydrogen and that of the southern parts of the Gum Nebula appear to be consistent with the observed column densities of different ions.

They also find the possibility of an interpretation of the shell structure of the Gum Nebula and the filamentary structure of the vela region in terms of two supernova explosions; one occuring $\sim 10^6$ years ago accounting for the Gum Nebula, and the second occuring $\sim 10^4$ years ago accounting for the Vela supernova remnant. The observed Hα, radio and x-ray emitting regions are produced as a consequence of the interaction of the shock waves originating from the explosion, with the dense interstellar clouds in the region that are already under the influence of ionizing radiation from γ^2 Vel and zeta Pup.

Bhattacharyya has commenced a programme with the Kavalur 102cm reflector of lunar occultation observations for study of diameter of nearby stars and components of unresolved binaries. The equipment is capable of time resolution better

than 1 millisecond, thereby enabling measurement of stellar diameter of 0.001 second of arc or so under suitable occultation conditions. Among the stars for which occultation light curves were obtained were a few K-giants and close binary systems; the structure of the latter systems could be clearly seen in the light curves. A computer programme for determination of the brightness differences of the components and their separation is being developed. This is based on the model fitting technique, where the luminosities and separations of components projected along the time of occultation can be determined. The observational programme is being further intensified to cover all measurable objects.

An occultation of Spica (α-Vir ginis) by the moon was observed at Kavalur on March 18, 1976, using this equipment. The immersion event was at the bright limb and hence the light curve was obtained, by observing in the core of the solar K-line, using a 5Å exit slit in the monochromator. The observed light curve shows clearly the presence of the two components and is currently being analyzed.

GALAXIES

Alladin and Parthasarathy studied the rate of disintegration of double galaxies due to tidal effects. The relative motion of double galaxies differs from that of double stars in an important respect. The stars in the double galaxies are accelerated due to tidal effects with the result that the energy of the orbital motion of the two galaxies is continually decreased. Thus double galaxies will revolve around each other with mean separation that will continually decrease in time. If the two galaxies are of comparable mass they may

finally merge into one another and become one massive stellar system. On the otherhand if one of the two galaxies is considerably more centrally concentrated than the other or more massive than the other, the less massive or less centrally concentrated system may be disrupted.

Alladin and Parthasarathy have considered two spherically symmetric galaxies of masses M and M' revolving around each other in circular orbits. Using the "impulsive approximation" of Spitzer they have obtained an analytical expression for the time of disruption t_d defined as the time at which the internal energy becomes zero. Disruption times have been calculated for double galaxies with differing mass ratios and different separations. They find that the time needed for the galaxy to double its radius is comparable or smaller than the disruption time. Thus double galaxies will revolve around each other with mean separation that will continually decrease in time. Galaxies with comparable mass finally merge into one another and become one massive stellar system. Supergiant galaxies which have large mass and which are centrally located in rich clusters of galaxies might have formed according to the above mentioned process. Many of these galaxies have extended envelopes and often contain multiple nucleii, secondary galaxies, condensations and companions. Their large mass and multiple nucleii support the above mentioned hypothesis.

PHYSICS OF BLACK HOLES

Kapoor has studied the propagation of photons emarating from an isotropic source moving about a black hole. This study is an extension of his work on gravitational synchroton radiation done in collaboration with Narlikar and Chitre. Thus, rather than considering exactly tangentially emitted

photons in the plane of the orbit of the emitting particle about the central black hole, arbitrary emission of photons in any direction was considered using geometrical optics. The work suggests that one does not see the isotropic point source as such, and in fact, as the source orbits the black hole, the remote observer(assumed to be situated in the plane of the orbit) sees a sort of Laue diffraction pattern about a central invisible body, i.e. multiple imaging. This is a natural consequence of the gravitational lens effect, i.e. aberration. As the source moves about the black hole, the pattern of images keeps changing shape, degenerating into hornlike images first and then into concentric rings of different redshifts corresponding to the cases of near and perfect alignment respectively of the source, black hole and observer.

COMETARY PHYSICS

Bappu and Parthasarathy have carried out extensive scanner observations on Comet West (1975n) in March 1976 during its post perihelion passage. Scans with exit slots of 5A and 10A with the computer controlled scanner in the pulse counting mode have been obtained of the head of the comet over a range of heliocentric distances of the comet. Sodium emission was last seen on March 17, at a heliocentric distance of 0.685 astronomical units. This is in conformity with our expectations of solar wind behaviour near sunspot minimum. Scans have also been obtained of the ionic spectrum of the tail at different distances from the cometary nucleus. Drift scans of the cometary coma in the light of C_2, CN and the continuum have been obtained to study the brightness distribution in the coma and molecular lifetimes.

LOW FREQUENCY ANTENNA SYSTEM

Work on the construction of the decameter wave radio telescope has progressed satisfactorily. The completed antenna system consists of four East-West lines of dipoles of 1.1 kilometers in length and 25 meters in width. The total number of dipoles in the E-W array is 528. Each line has its own branching feeder system to preserve bandwidth. The total physical area of the E-W array is 27,000 square meters. When the array is used without apodization it produces a beam of 0.5°/30°. In the North-South direction there are 90 rows of dipoles. Each row consists of four collinear (E-W) dipoles. The four dipoles are connected in a branching feeder system. The total number of dipoles in the N-S array is 360. The physical area of the N-S array when completed will be 18,000 square meters. It will have a beam of 0.75°/25°. When the signals from the E-W and the N-S lines are correlated, an elliptical beam of the order of 0.5°/0.75° will be produced.

In order to obtain the predicted theoretical beam shape and low sidelobe level, the phases and amplitudes of the currents in each individual dipole have to be adjusted accurately. Due to the large extent of the antenna these adjustments are difficult to make and have involved many technical problems. A RMS phase deviation of 10° and amplitude variation of $\pm$ 1.0 dB have been achieved.

A correlation receiver has been designed and built for use with the antenna. The receiver has input noise temperature of about 500°K and a predetection bandwidth of 500 KHz. The time constant can be varied from 0.1 to 10 seconds.

Observations on the interplanetary scintillation of the compact sources in the Crab Nebula, have been made. The results of these observations will yield information on the size and structure of the compact radio sources.

We are also designing a digital machine for real time Fourier transform computation. The idea is to bring the 90 N-S signals separately into the receiver building and then individually correlate with the output of the E-W array. The 90 complex correlations after Fourier transformation will give the same beam of the complete "T". This method has the advantage of completing the sky survey in a very short time and also increases the sensitivity of the whole system.

This project is being carried out in collaboration with the Raman Research Institute.

SOLAR TERRESTRIAL RELATIONSHIPS

Sastri and Murthy have examined the possibility of a correlation between an X-rayflare from Sco X-1 detected in the course of a balloon flight on 1967 October 15 and an increase in the horizontal component of the magnetic field observed at the equatorial station at Kodaikanal. Their examination of the available evidence shows that the observed geomagnetic perturbation at Kodaikanal was not due to a sudden impulse(SI) or a solar flare effect (SFE) but was a genuine effect of the x-ray flare from Sco X-1.

Sastri undertook a statistical survey of the data on crochets observed at Kodaikanal during 1966-1970 and on the solar microwave bursts monitored at 2000MHz at Toyokawa, Japan, with a view to find a correlation betwen the two. He has found that out of the 72 crochets observed during this period, 44 are

associated with microwave bursts at 2000MHz. Further, these crochet-associated microwave bursts are mostly of "Complex" (54.5%) and "Gradual Rise and Fall" (34.1%) type.

From a study of quarter hourly ionogram data of Kodaikanal on 1958 October 28 around the sunrise period with a view to investigate the nature of irregularities, or, kinks, as they are called, which are seen to move up in the equatorial ionosphere, Sastri finds that, at least on this occasion, the upward moving kinks are due to moving ionisation irregularities, caused probably by atmospheric gravity waves, which when they reach the overhead position of the ionosonde are lifted up by the E x B drift.

Sastri and Murthy have started a systematic study of the characteristics of travelling ionospheric disturbances (TID) at Kodaikanal, a low dip latitude station. The ionosonde recorder was used for continuous monitoring of f_0F_2 at 1 minute intervals. An examination of the data showed small scale fluctuations superimposed on the diurnal trend in f_0F_2 characteristic of equatorial stations, which they have attributed to atmospheric gravity waves. They find that the spectral features of the observed fluctuations in f_0F_2 exhibit maxima and minima while theoretical calculations predict continuous spectra. This feature could be due to anyone or combined effect of the following: (1) the equation used for obtaining the fractional perturbation in electron density is deduced from a rather idealized treatment, wherein the equations of motion are linearised by assuming the variables to be of only perturbation magnitude (2) the atmosphere is considered to be isothermal (3) the wave propagation is assumed to be meridional.

Sastri has investigated the characteristics of the sudden

commencement geomagnetic storm (SC) of 1961 July 13, associated with the solar flare of 1961 July 11. This SC was found to be unique in the sense that its amplitude increases with increasing magnetic dip - a behaviour opposite to the one commonly observed. This image latitudinal variation in amplitude (with a significantly reduced amplitude in H-component at jet stations compared to non-jet stations) has been interpreted as being due to the existence of a counter-electrojet (Westward) current system around the time of occurance of the SC.

An examination of the SFE of 1968 July 6, by Sastri reveals that it is characterized by a decrease in the H-component at electrojet stations and has an increase in the H-component at stations outside the electrojet. A study of relevent ionospheric and magnetic data of Kodaikanal, a station under the electrojet, for this day indicates the existence of a counter-electrojet just prior to and after the occurrence of SFE. The characteristic features of the SFE have been interpreted in terms of the presence of a counter-electrojet at the time of occurrence of this SFE.

Sastri has scanned the normal run magnetogram data from Huanacayo, Kodaikanal and Kakioka to study the characteristics of the day time-and the night-time - geomagnetic effects of the solar flares. An investigation of the sample of 5 events observed during the three year period 1969-1971 reveals that the maxima of the day-time and the night-time SFE do not always occur simultaneously, and that the night time amplitude is 10% to 50% of the day time amplitude. A comparison with theoretically predicted results leads him to suggest that some of the assumptions inherent in theoretical models, may be incorrect. In particular, the assumptions that the electric

conductivity of the sunlit hemisphere increases suddenly and that the ionospheric conductivity is small, may be an over simplification.

Field strength measures of LF transmissions from Madras on a frequency of 292 KHz continue to be monitored for the study of solar flare effects. Murthy and his collaborators have also recorded Faraday fading of beacon transmissions from INTASAT at a frequency of 40.01 MHz.

INSTRUMENTATION

Mahipal Singh has made studies on the theory of holographically recorded plane diffraction gratings (HRPDG) and its mountings. He finds that the self focusing property of HRPDG can be usefully exploited for designing new types of spectrograph and monochromators. As a result of the study one new stigmatic mounting of HRPDG has been proposed. In this mounting the observation is to be made about a normal direction and different regions of the spectrum are to be brought into the field by changing the angle of incidence by rotation of the grating. The plate holder moves on a straight railing and is to be positioned for different regions of the spectrum. Mahipal Singh has also worked out a system that employs the HRPDG and gives an aberration-free spectral image.

Several small accessories for the various telescopes have been designed and constructed in the electronics laboratory. Among them mention may be made of the drive system consisting of a crystal controlled frequency generator and power amplifier replacing the old mains operated synchronous motor of the 50cm Cassegrain telescope at Kodaikanal and two power supplies for operation of arc and discharge lamps. Work on the design of the 75cm telescope driving system was started: the

telescope has been totally designed and is being fabricated in our optics, electronics and mechanical workshops and is expected to be commissioned by the end of this year.

A 1300mm optical grinding and polishing machine was designed and the construction of the machine is on hand. The machine is designed for optical working of all optical surfaces upto a diameter of 1300mm. The 1250mm Hindle sphere for testing and figuring of the Cassegrain Hyperboloid of the 90-inch telescope is plannedto be worked on this machine. Much of the effort of the optical shop has been devoted to building Schmidt and Maksutov systems for the coude and cassegrain spectrographs. A Schmidt camera of 175mm focus is complete and will be used in an image tube spectrograph. A Maksutov camera of focus 79mm has been completed for the cassegrain spectrograph now under construction. Work is in progress on the 850mm diameter mirror of 2435mm focus to be used in a coude spectrograph. A smaller Schmidt system of 190mm clear aperture and Focus 205mm is currently under construction. This camera will be used for low dispersion values in the present coude spectrograph.

Two cassegrain systems of 300mm aperture are under fabrication for the Vikram Sarabhai Space Sciences Centre. Technical help has been given to the Aeronautical Development Establishment; the Tata Institute of Fundamental Research, the National Aeronautical Laboratory and the Defence Research and Development Laboratory.

THE 234CM TELESCOPE

There has been much progress in the initial design of the telescope. The telescope is to be mounted on a yoke at the centre. The north bearing is of the horseshoe type.

The primary mirror is to be a paraboloid and there will be a cassegrain and a coude focus. The focal ratios at these three locations are f/3.25, f/13 and f/46. Provision is made in the building for a large coude laboratory that can accommodate large and heavy equipment of the future besides the conventional spectrographs and monochromators. The drive is to be computer controlled. A spur gear drive using torque motors is envisaged. The declination axis will be at a height of about 16 metres above ground level. The dome will be of 21 metres internal diameter. Prime focus guiding will be from a remote station on the observing floor.

The site survey at Chickamagulur continued through most of the year. Site testing at Horsley Hills is to commence shortly.

OBSERVING CONDITIONS

The solar tower at Kodaikanal was used on 180days during the year. Observing condition in general were below average both from the point of view of cloudiness and seeing. The tower records of 1 second of are seeing cover 10 days while seeing of 2" prevailed on 63 days. White light photoheliograms could be obtained on only 270 days while calcium flocculus and prominence spectroheliograms were taken on 241 and 206 days respectively..

At Kavalur, these were only 1428 Hours of observing of which photometry could have been carried out for 813 hours or 57 percent of the time. On 118 of these nights spectroscopic work was carried out for a duration of 9 hours or greater. The table below shows the monthwise distribution of these features.

Month	Hours of Spectroscopic work	Hours of possible photometry	Number of nights when spectroscopic work 9hrs or greater was done.	Number of nights with average seeing better than 1.5"
1975 Apr	270	188	24	21
May	103	30	7	10
Jun	41	8	3	2
Jul	19	4	1	2
Aug	23	-	1	2
Sept	48	-	3	2
Oct	39	-	1	8
Nov	108	23	10	6
Dec	138	62	10	2
1976 Jan	138	76	10	11
Feb	231	178	23	15
Mar	270	244	25	20
Total	1428	813	118	102

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24. Sivaraman K.R. Venkitachalam, P.P. — Intensity fluctuations in the solar chromosphere, Kodaikanal Observatory Bulletin, 1976.

STAFF

Academic Staff in position during the year were as follows:

1. M.K.V. Bappu, Ph.D.	- Director
2. J.C.Bhattacharyya, D.Phil.	- Associate Professor
3. A.P.Jayarajan, M.A.	- Reader
4. P.K.Raju, Ph.D.	- Reader
5. Ch.V.Sastry, Ph.D.	- Reader
6. G.A.Shah, Ph.D.	- Reader
7. K.R.Sivaraman, Ph.D.	- Reader
8. R.K.Kochhar, Ph.D.	- Fellow
9. D.C.V.Mallik, Ph.D.	- Fellow
10.N.Kameswara Rao, Ph.D.	- Fellow
11.J.Hanumath Sastri, Ph.D.	- Fellow
12.Mahipal Singh, ~~Ph.D.~~ Phil.	- Fellow
13.R.C.Kapoor, M.Sc.	- Research Associate
14.B.S.Murthy, Ph.D.	- Research Associate
15.T.P.Prabhu, M.Sc.	- Research Associate
16.M.Parthasarathy, M.Sc.	- Research Associate
17.K.C.A.Raheem, B.Sc.	- Research Associate
18.R.Rajamohan, Ph.D.	- Research Associate
19.A.K.Saxena, M.Sc.	- Research Associate
20.K.K.Scaria, M.Sc.	- Research Associate
21.Jagdev Singh, M.Sc.	- Research Associate
22.P.Venkatakrishnan, M.Sc.	- Research Associate
23.P.P.Venkitachalam, M.Sc.	- Research Associate
24.N.K.Srivastava, Ph.D.	- Post-doctoral Fellow

The technical, administrative and non-technical maintenance staff number 119.

BUILDINGS & GROUNDS

An amount of Rs.14,37,668 has been deposited with the

C.P.W.D., for works connected with the Main Laboratory and the Optics Laboratory at Bangalore. The work on the Optics Laboratory and Main Laboratory have made good progress.

As in previous years the fire lines at Kodaikanal and Kavalur were kept in good condition. The work on the road within the Koramangala campus was started. The construction of the hutments at Koramangala was completed. The Institute moved over in December 1975 to the temporary accommodation at its Koramangala campus, from the Raman Research Institute. The main portion of the Library has been shifted to Bangalore from Kodaikanal.

COUNCIL MEETINGS

The Governing Council of the Institute met twice and the Finance Committee once during the year at New Delhi.

SCIENTIFIC MEETINGS

Dr.B.S.Murthy attended the following symposia:
1."Equatorial Geomagnetic Phenomena" at Indian Institute of Geomagnetism, Bombay. May 14-15, 1975.
2."Ionosphere and Magnetosphere", at the Physics Department, AndhraUniversity, January 7-9, 1976.
3."Solar Planetary Physics" at Physical Research Laboratory, Ahmedabad. January 20-24, 1976.

Dr.M.K.V.Bappu attended the Meeting of the Indian Academy of Sciences held in Nagpur on November 7-9, 1975 and the INCA meeting held at Bangalore on February 10, 1976. He and Prof.Bhattacharyya also attended the Council meeting of the Astronomical Society of India at Bangalore on February 10,1976.

Dr.Bappu also inaugurated the symposium on Solar Physics at Udaipur.

Dr.M.K.V.Bappu has been elected President of the Physics Section of the Indian Science Congress to be held at Bhubaneswar in January, 1977.

Dr.R.K.Kochhar, M/s P.Venkatakrishnan, T.P.Prabhu, R.C.Kapoor, and Mrs.Sushma Mallik attended the Winter School on High Energy Astrophysics at the TIFR during January (4-16),1976.

FINANCES

Statement of Expenditure for the year 1975-76.

NON-PLAN

Receipts

Opening Balance.	Rs.	1,22,311-65
Grants-in-aid received		
1st Instalment on 30-5-1975	Rs.	4,12,000-00
2nd Instalment on 27-9-1975	Rs.	6,20,000-00
3rd Instalment on 18-12-1975	Rs.	7,67,000-00
4th Instalment on 3-2-1976	Rs.	5,50,450-00
Institute Receipts	Rs.	57,705-76
Total.	Rs.	25,29,467-41
Expenditure until March 31, 1976.	Rs.	24,45,997-73

Details of Expenditure

Sl.No.	HEADS	Amount approved by Governing Council.	Actual Expenditure
		Rs.	Rs.
I.	Pay & Allowances.	12,73,000	11,63,822-76
II.	Rent,Rates,Taxes,etc.,Office and Laboratory Expenditure.	7,59,000	7,84,631-06
III.	Travelling Allowance.	75,500	78,867-10

1	2	3	4
IV.	Books and Publications.	1,40,000	1,45,191-68
V.	Capital Expenditure.	2,25,000	1,62,792-13
VI.	Interest bearing advance.	75,000	66,352-00
VII.	Non-interest bearing advance.	10,000.	2,980-00
VIII.	Grant-in-aid to Recreation Club	1,000	366-00
IX.	G.P.F. advance initially paid from Institute funds to be recovered from the Accountant General, Madras.	20,150	40,992-00
		25,78,650	24,45,997-73

PLAN

Opening Balance.	Rs.	3,000-00
Grants-in-aid received		
1st Instalment on 30-5-1975.	Rs.	6,16,000-00
2nd Instalment on 27-9-1975.	Rs.	6,75,000-00
3rd Instalment on 18-12-1975.	Rs.	14,87,250-00
4th Instalment on 3-2-1976.	Rs.	7,16,500-00
Total.	Rs.	34,97,750-00
Expenditure until March 31,1976.	Rs.	33,67,998-99

DETAILS OF EXPENDITURE

Sl.No.	HEADS	Amount approved by Governing Council	Actual Expenditure
		Rs.	Rs.
I. T	Salaries and Allowances.	1,75,000	1,15,061-40
II.	Operational Expenses.	2,00,000	1,99,563-74
III.	Capital Equipment.	17,50,000	15,68,931-85
IV.	Capital Works.	15,50,000	14,84,442-00
		36,15,000	33,67,998-99

LIBRARY

The number of books purchased during the year is 175. 100 journals were on the subscription list. Exchange of publications with other institutions was continued.

VISITING SCIENTISTS

Dr.M.H.Gokhale worked as a Visiting Scientist from October 1975 till March 1976.

Dr. S.M.Alladin, Osmania University, Hyderabad was at the Institute as a Visiting Scientist for about three months.

Dr.D.C.Nadyozhin, Institute of Applied Mathematics, Academy of Sciences, USSR who came to India under the Indo-Soviet Cultural Exchange Programme, visited the Institute on April 12, 1975.

Dr.R.Giovanelli of the CSIRO, Australia and President IAU Commission 12 (Solar Physics) visited Kodaikanal in September 1975.

Dr.Frank Kerr of the University of Maryland visited Kavalur in October 1975.

Dr.J.Hanumath Sastri, Fellow was granted Special study leave for taking up a post-doctoral Fellowship on "Ionospheric studies using satellite beacon transmissions" in the University of Auckland.

DISTINGUISHED VISITOR

The Hon.Minister for Tourism & Civil Aviation, Shri Raj Bahadur visited the Institute at Kodaikanal on September 28, 1975.
