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SOLAR PHYSICS

A study of the brightness fluctuations due to the different sizes of structures in the solar atmosphere as seen in the Balmer lines has been completed by Sivaraman & Venkitachalam. The analysis aims at finding the dependence of the relative rms brightness fluctuations with heliocentric angle and for different wavelength positions within the line. Selected spectra of $H\alpha$, $H\beta$, $H\gamma$ and $H\delta$ obtained on occasions of good seeing at the Kodaikanal solar tower have been used for the study. The spectra of each line cover the positions $\mu=1\cdot0$; $0\cdot8$; $0\cdot6$; $0\cdot4$ and $0\cdot3$. The intensity fluctuations at different wavelength positions $(\pm\Delta\lambda)$ within each line and similarly for each of the different positions of μ on the disc have been evaluated. A power-spectrum analysis of the brightness variations can be grouped into three sizes; 1200–6000, 6000–15 000 and 15 000–35 000 km. The entire intensity data are then treated with a band-pass filter with sine–termination function and the contribution due to each of the three size groups to the observed brightness fluctuation evaluated. Thus the rms intensity variations due to the three sizes of structures for the four Balmer lines are obtained as a function of $\Delta\lambda$ for each line and also of heliocentric angle. In all lines, the rms brightness variation increases from the smallest to the largest of the size groups with the chromospheric network showing the maximum spatial-brightness variation.

A plot of the rms intensity fluctuation with the heliocentric angle shows in general two maxima with a dip around $\mu = 0\cdot6$. Photospheric lines show, in general, a single maximum somewhere between $\mu = 0\cdot8$ and $\mu = 0\cdot6$. The D-lines of sodium also show a double maximum. It seems that the change in centre-limb aspect of this variation takes place in the low chromosphere. The plot of the rms brightness fluctuations (and hence the temperature fluctuations) for the different values of $\Delta\lambda$ shows maximum contrast at $\Delta\lambda = \pm0\cdot6$ Å for $H\alpha$, $\Delta\lambda = \pm0\cdot3$ Å for $H\beta$ and at the line core for $H\gamma$ and $H\delta$.

Sivaraman & Venkitachalam have commenced a detailed study of the time evolution of the profiles of the bright points of dimension 1000–1500 km seen in the H and K lines, with a view to understand the mode of propagation and dissipation of mechanical energy in the

chromosphere. The material for this study is an excellent time-sequence centred on the H line obtained by Beckers with the Sacramento peak Vacuum Telescope. Preliminary results based on the study of profiles of six bright points over a 25-min duration are summarized herewith. The commencement of a disturbance at the lower levels can be seen as an impulse in the neighbouring Fe I line in a location where there is no emission at H_{2v} or H_{2R}. The H_3 central intensity is high, possibly due to energy dissipation effects of an earlier impulse. After 48 s a brightening appears, first at H_1 and within 12–24 s that follow, the emission streak has already reached the H_2 level with H_{2v} showing enhanced intensity By $t = 85$ s both H_{2v} and H_{2R} show emission giving the familiar double peaked profile in the bright point. The H_{2R} emission is seldom seen when a dark condensation is observed in the H_3 core. At $t = 150$ s little remains of the H_{2v} emission streak that existed earlier; a dark streak prevails which also decreases in wavelength extent, finally disappearing within 100 s of formation. Six of the bright points studied have an average lifetime of 100 s with the dark streaks also having a similar duration of visibility.

A study is in progress by Raju aimed at finding line: intensity ratios that are sensitive to temperatures and electron densities, especially in the chromosphere–corona transition region. Line intensities from the lower ions in the carbon, nitrogen and oxygen sequences seem capable of being such indicators and a detailed quantitative study assuming multi-level atom model is in progress.

Fine scans over supergranular dimensions with the magnetometer, along with simultaneous K-intensity values, have been attempted on several occasions by Bhattacharyya, Saxena & Singh. These have been made in a search of very weak fields in the bright points of ionized calcium. Morphological studies of bright points and their association with the network as well as the dark condensations in K_3, as seen on calcium spectroheliograms, have been commenced by Bappu, Saxena & Singh.

The collection of basic solar data with the solar telescope has been continued. For the year ending 1975 March 31, white light photo heliograms were obtained on 312 days, Hα disc spectroheliograms on 282 days, K_{232} spectroheliograms on 273 days and K prominence pictures on 241 days. The spectrohelioscope was used for 918 h of observation and 17 flares were observed. Solar data have been sent each month to various agencies in India and also to the World Data Centres.

STELLAR PHYSICS

Spectra of five bright members of the Scorpio–Centaurus association have been obtained by Rajamohan at high dispersion with an echelle

spectrograph at the Coudé focus. These spectra have been utilized to derive helium abundances using the He I lines 4009, 4026, 4143, 4388 and 4471 Å. *UBV* data and the observed Hγ line profile give θ_e and log g and the mean value of N_{He}/N_H for the five objects is 0·096, as derived from the equivalent widths. Available data in the literature, together with the values derived above, show that no discernible differences are noticed between the values obtained of the two main subgroups of the association; the upper Centaurus–Lupus and the upper Scorpius groupings. The observed line profiles of He I 4026, 4388 and 4471 Å of the three sharp lined stars τ Sco, μ^2 Sco and κ Cen fit well the theoretical non-LTE profiles, especially in the line core, where differences between LTE and non-LTE profiles are most pronounced.

Parthasarathy has analysed the two-colour observations of UW Canis Majoris made earlier at Kodaikanal by Doss. The ratio of radii is 0·813 and in combination with the spectroscopic elements of the system derived by Struve and collaborators, the masses of the components are found to be 24 and 29 $M_\odot$ for the primary and secondary stars respectively.

Many other spectroscopic binaries are under study spectroscopically. Rajamohan has completed observations of HD 65041 at 47 Å mm^{-1}. Parthasarathy has complete coverage of ϵ CrA, HD 2421 and HD 5638 and HU Tauri. The Hα observations of this last system obtained at 17 Å mm^{-1} show cyclical variations of emission intensity. Parthasarathy has also monitored in the blue and at Hα the X-ray binaries, X Per, HD 77581, HD 206267 and HD 153919. Bappu, Nandy, Parthasarathy & Rajamohan have scanner observations of HD 77581 which show the reddening law derived from this star in the wavelength range 3300–6600 Å to be essentially the same as the normal law observed in most other regions of the sky.

The equilibrium structure of a tidally-distorted rotating gaseous mass with a magnetic field has been examined by Kochlar. Toroidal and poloidal fields affect the gas mass differently, if its shape is that of an ellipsoid. The toroidal field tends to decrease the orbital period of the binary, while the poloidal field tends to increase it. The component of the magnetic field normal to the orbit plane has a value less than the corresponding value for a single star and cannot exceed a critical value determined by the geometry of the configuration.

Bappu & Parthasarathy have continued the search for red objects in the direction of the Large Magellanic Cloud with the aid of ultra-low-dispersion spectra. Several additional fields were covered during the winter season. Many red stars and reddened early-type stars have been picked out on very low-dispersion spectra of regions in and around Carina OB1, Carina OB2 and Mon OB1.

Scaria has continued his study of isophotes of globular clusters using the Sabattier technique. Isophotes for about ten clusters derived from V photographs are now complete. Additional photographs in the B and infrared regions are being obtained for the brighter clusters.

INTERSTELLAR MEDIUM

Simple models of a reflection nebula in the form of a plane parallel slab containing smooth, spherical, solid particles in submicron size range have been considered by Shah. Single scattering has been assumed and the case of the star behind the nebula examined. The effects of varying the composition and size distribution function of the grains have been brought out in the calculations using Mie theory of scattering. The analytical part of the geometry of the problem has been treated quite rigorously and the resulting expression for nebular intensity presented in a new form.

A comparison of the theoretical results with the observations of the Merope nebula shows that the dirty-ice grains with index of refraction at $1 \cdot 3 - 0 \cdot 1$ i and size parameter $a = 0 \cdot 5$ μm give reasonable agreement with the colours. Simultaneously, the polarization in the visual and blue wavelength bands agree approximately up to offset angle of 6 arcmin. The larger offset angles pose an intriguing problem. The general trends of nebular colours and polarization, with variation of real and imaginary parts of index of refraction and the size distribution parameter, have been tabulated to serve as a guide for further study of reflection nebula with the star in the rear. The thermal emission by circumstellar or nebular grains in modifying colours and polarization has not received attention hitherto. On the basis of observations available, a factor of this kind may play an important role in models of certain reflection nebulae. The difficulty encountered in matching observation and theory also indicates the need of use of bimodel or multivariable size distribution functions.

The problem of the reflection nebula with star in rear is directly applicable to the calculation of intensity and polarization of X-ray halo associated with certain sources produced by interstellar grains. Shah & Manchanda are investigating this problem. Observations on polarization of X-rays scattered by interstellar grains are not available, but this lacuna will undoubtedly be rectified before long.

Shah has also commenced a study of the circular polarization produced by interstellar grains. Theoretical models with obliquely-oriented, homogeneous, circular cylinders composed of the pure as well as dirty ices have been constructed. In a representative calculation Shah has demonstrated that ice grains can reproduce the interstellar-circular polarization from the Crab Nebula within the present large limits of observational error.

Mallik has extended the scope of earlier models computed by him of weak D-type fronts to include the emission line structure in the fronts along with the temperature and velocity structures. The model fronts have been used to explain the forbidden line observations of singly-ionized sulphur in the light of dynamical processes at the edges of gaseous nebulae. The models of ionization-fronts provide a ready explanation for the inner H II regions being of lower excitation than the outer H II regions, without invoking abundance anomalies or peculiarities of radiation fields in the nuclei of galaxies. Details of the ionization of disk galaxies are presently being worked out in an attempt to match recent high resolution image tube spectra.

Although most of the ionization-front models are of the weak D-type the detailed structure of strong D-type models remains to be worked out. Preliminary calculations by Mallik show that for a smooth transition from subsonic to supersonic flow, the velocity of the gas should tend to the adiabatic sound velocity at the point where heating and cooling balance each other exactly. In other words the sonic point has to be located within the ionization structure although its exact position is not determinable.

Mallik & Venkatakrishnan have worked out a theoretical line profile programme to analyse available high resolution Fabry–Perot observations. This involves a deconvolution of the observed profile taking into account effects of thermal Doppler broadening, turbulence and systematic motion. Information on the spatial variation of turbulence inside a H II region and or radial motion thus becomes available; the procedure has been successfully applied to the H and [N II] line profiles in Orion and shows the turbulence to increase marginally from centre outward.

LOW FREQUENCY ANTENNA SYSTEM

An antenna system is under construction at Gauribidanur under Sastry's supervision which is designed to yield a circular beam of about one degree and a capability of detecting radio sources of flux densities above 30 Jy. The system is expected to detect brightness temperature variations of the order of 1000 K and will be used for the detection and study of H II regions in the Galaxy.

QUASI-STELLAR OBJECTS

A collaborative study of Kapoor with Narlikar & Chitre has shown that gravitational synchrotron radiation emitted in the forward direction by charged particles moving in highly-relativistic circular-equatorial orbits of radii slightly in excess of 1·5 times the Schwarzschild radius of a highly-collapsed mass situated at the centre, is strongly blue-shifted

when it reaches a distant detector. A ring shaped emitting region composed of such orbiting particles has a power law spectrum of the form ν^{-1} as seen by a distant stationary observer. The astrophysical consequences of such a model have been mentioned briefly with reference to quasi-stellar objects, since the ν^{-1} spectral characteristic is common to many extragalactic radio sources and quasi-stellar sources.

Microspectra of 10 000 Å mm^{-1} dispersion have been obtained of a few fields in the south galactic pole in a search for quasi-stellar objects This survey is being extended to the blue objects of the Luyten star survey for the identification of QSOs.

SOLAR TERRESTRIAL RELATIONSHIPS

Geomagnetic crochets (SFE) observed at Kodaikanal during the period 1966–1971 have been studied in relation to Solar X-ray bursts (observed by NRL satellite-SOLARAD 9 in the bands 0·5–3, 1–8 and 8–20 Å) and microwave bursts in the frequency range 1000–17 000 MHz. It was inferred that large X-ray flux enhancements are necessary to produce SFE's compared to other SID's and this accounts for the relatively low frequency of occurrence of SFE's compared to other SID's, SWF, SCNA, SPA, SEA and SES. The amplitude of SFE is linearly correlated with the peak flux of X-ray burst in the 1–8 and 8–20 Å bands. The single frequency correlation of SFE's with solar microwave bursts is a flat maximum in the frequency range 2000 3750 MHz. SFE's are mostly associated with A type burst spectra and show poor correlation with G, C and M-type spectra (following AFCRL classification of microwave bursts). The above features of the association of SFE's with solar X-ray and microwave bursts differ from those of other SID's reported earlier. A comparative study of the characteristics of SFE's associated with proton flares (PCA events) with those of normal flares showed the former are characterized by larger rise time and slower decay compared to the latter.

Using the Watson magnetogram data for the period 1973 January December it was found that the occurrence of Pi2 micropulsations at Kodaikanal is a broad maximum around local midnight. The dependence of the occurrence of Pi2 micropulsations on magnetic activity is of a composite nature in that the occurrence is positively correlated with K_p index in the range 0^+ to 2 and negatively correlated with K_p index in the range 2–5.

A qualitative explanation was proposed for the difference in the recovery nature of LF field strength in simple and complex SFA patterns observed on the Tashkent–Delhi path. The recovery nature is mainly governed by the range of heights over which the excess flare induced ionization is produced. Following this argument, simple SFA

patterns (TYPE II and IV) may be understood as due to extensive ionization at heights below 60 km (due to hardening of X-ray flux in the 1–20 Å band) and above 75 km (due to X-ray flux enhancement 1–20 Å band, without hardening of the spectrum) respectively, while the complex SFA patterns (Types I, Ia and III) are due to excess ionization in the height range 60–70 km. Thus the recovery in complex SFA patterns is controlled by the negative ion chemistry of the disturbed D-region and the relatively slow recovery nature of complex SFA patterns is due to the slow release of electrons from negative ions by photo-detachment process.

A careful examination of normal run magnetogram data of Kodaikanal showed several instances during night time when there are conspicuous short-lived perturbations in geomagnetic elements. These perturbations were noticed to occur (75 per cent of the cases) in concurrence with both solar X-ray flares and SID's in the sunlit hemisphere, lending support to the earlier observation of Ohshio (1964) that geomagnetic effects of solar flares do occur even in the dark hemisphere. A detailed study of these night-time geomagnetic effects of solar flares (referred to as NTSFE) at Kodaikanal for the period 1969–1971 was made. It is noticed that the occurrence of NTSFE is a maximum around midnight and NTSFE starts after the beginning of solar X-ray flare (1–8 Å) and the maximum of NTSFE usually occurs after the maximum of the solar X-ray flare. The time difference (usually lag) between NTSFE maximum and solar X-ray flare maximum varies over the wide range of 1–52 min and no definite trend is seen in the variation of this time lag with the time of occurrence of NTSFE. Further NTSFE's are characterized by longer rise time and slower decay compared to SFE's (day time effects) observed at Kodaikanal over the 3-yr period mentioned. A more direct approach made later, consisting of a comparative study of the characteristics of NTSFE's at Kodaikanal in relation to the simultaneous SFE's at Huancayo over the same period of 1969–1971 confirmed this feature.

A detailed study was made of the various aspects of equatorial spread-F using the quarter-hourly ionogram data of Kodaikanal for the period 1964–1969. An interesting aspect of equatorial spread-F brought to light is the observation of several instances when spread-F condition suddenly disappears and subsequently reappears over a span of a couple of hours or even less, during a night. Detailed analysis of such events show that this feature of equatorial spread-F is not associated with systematic height changes of the layer as expected on the basis of the existing theories which invoke height as the controlling factor. There does not seem to be any threshold height for the irregularities responsible for the spread-F, below which they may not sustain. An investigation of the characteristics of the two basic forms of

equatorial spread-F revealed that both range and frequency spread configurations at Kodaikanal show a positive correlation with solar activity and the monthly occurrence patterns of the same show significant correlation. In view of the controversy on the case of the two basic forms of equatorial spread-F and since the present study shows a close similarity in the statistical behaviour of both range and frequency spread configurations, a preliminary study was made of the transition from range to frequency spread for a number of nights. It was found that on many occasions, range spread gradually decays into frequency spread, lending support to the contention of King (1970) that frequency spread is a decay product of range spread. However on some occasions the transition from range to frequency spread was noticed to occur with a rather abrupt discontinuity in spread-F activity, indicating no association between the two. Definite conclusions on this aspect of equatorial spread-F await the completion of a detailed study that is in progress.

The effect of solar activity on the relative trends in the asymmetry of the noon 'bite-out' effect in foF2 (represented by the ratio $P_1 : P_2$) at Kodaikanal during quiet and disturbed magnetic conditions was studied. It was found that around the period of moderate solar activity, the ratio $P_1 : P_2$ is high during disturbed conditions compared to quiet conditions, while the behaviour is exactly opposite around the period of low solar activity. This feature defies even a qualitative understanding in terms of vertical drift and subsequent horizontal diffusion of ionization along field lines considered to be responsible for the afternoon peak in foF2 at equatorial latitudes.

The characteristics of night sporadic-E(E_s) at Kodaikanal have been studied using both ionogram and published ionospheric data. It is noticed that night sporadic-E on Kodaikanal ionograms usually manifests in two other configurations: blanketing type and multiple-layered structure type, besides the well-known flat and low-blanketing type. A consideration of the occurrence of night sporadic-E in relation to the variation of the horizontal component of the magnetic field showed that there is no threshold limit for the night-time electrojet for the occurrence of night sporadic-E. These observations were discussed in the light of the relevant theoretical considerations for the origin of night sporadic-E. It was further observed that the blanketing frequency as well as the transparency range of night E_s is independent of solar activity, and the distribution of the virtual height of night E_s shows a distinct local time variation that is dependent upon solar activity. A comparison of these results with those of earlier workers supports the existing view that the characteristics of night sporadic exhibit a longitude dependence.

Field strength of LF transmissions from Madras on a frequency of 292 kHz is being recorded to minitor the solar flare effects (SFA), besides study the response of the equatorial lower ionosphere to other geophysical events. Faraday fading of beacon transmissions from the satellite-INT A SAT on a frequency of 40·01 MHz is being recorded since the launching of the satellite, on 1974 November 15. The Faraday fading data will be used for the studies of latitudinal variation of total electron content, large scale ionospheric irregularities and scintillations.

INSTRUMENTATION

Optics for the two Coudé cameras of focal lengths 61 and 285 cm have been completed by Jayarajan. The former has a 30-cm aperture glass corrector and has performed well in star field photography. The longer focus camera will function without a corrector. A Maksutov camera with a meniscus of aperture 70 mm, for use in the cassegrain spectrograph, was also completed during the year.

An analogue system for recording rapid changes in intensity for use in lunar occultation observations has been designed and constructed in the electronics laboratory. Several other pieces of electronic control for use with the scanner and microphotometer have been fabricated by the same team.

Mahipal Singh has shown that holographically recorded gratings have a self-focusing property when used with curved grooves and variable spacing. Proper choice of design parameters can reduce considerably the aberrations and improve resolution. Singh & Raheem have designed a monochromator utilizing the self-focusing property.

THE 234-CM TELESCOPE

A Zerodur glass blank 236 cm in diameter has been received from Messrs Jenaer Glaswerk Schott, Mainz, West Germany. A firm of consulting engineers has been entrusted with the task of designing the mounting and control systems of the telescope.

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