

KODAIKANAL OBSERVATORY, KODAIKANAL

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(Report for the year ending 1969 December 31)

SOLAR PHYSICS

Numerous improvements have been made to the prototype solar magnetometer which have increased its operational stability and versatility in the nature of information output. A new detector head has been installed with additional facility of accurate setting on the Fraunhofer lines with varying slit widths. Together with a servo-operated Doppler compensator and provision for intensity measures in the core of the line, the instrument yields simultaneously the values of the longitudinal component of the magnetic field, line of sight component of the velocity field and the intensity in the core of the line. Using the magnetometer in this form, several extended runs of the localized granulation-stimulated quasi-periodic oscillations of the solar atmosphere have been obtained over time intervals extending greater than four hours. The extension of these observations to several different lines, ranging from the magnesium 'b' lines of chromospheric origin to lines of atomic carbon that originate from appreciable depths in the photosphere, has enabled inference on the depth dependence aspects of these quasi-periodic oscillations. The results have demonstrated satisfactorily a shorter period of oscillation at high chromospheric heights and provide additional support for the theory that explains random phase changes of the oscillations in terms of random perturbations originating from the hydrogen convection zone. The statistical properties of the bursts of oscillation at different depths have been examined in detail with the CDC 3600. The results imply a more complicated structure of the energy dissipation mechanism than has been believed hitherto.

A controlled set of observations have also been made with the solar magnetometer to detect possible oscillations of the local longitudinal magnetic field component. Detailed coherence analyses of simultaneous records of magnetic and velocity fields fail to show a variation in the line of sight component of the magnetic field caused by the quasi-periodic oscillation. The result is contrary to the findings of the Crimean observers.

Three time-sequence spectra of excellent quality were obtained in a quiet region at the centre of the solar disc each lasting for nearly 40 min, with the 19-m spectrograph. The time-sequence spectra are around 6587 Å of *Cl*, 6347 Å and 6240 Å. These are under analysis to study

the spatial properties of the quasi-periodic photospheric and chromospheric oscillations.

A study of solar wind characteristics based on the sodium emission in cometary nuclei was completed. Seventeen comets, having information on sodium D-line emission during their apparition were examined. The heliocentric distances corresponding to the commencement or termination epoch of sodium emission are found to have a dependence on the phase of the solar cycle. Comets appearing during a solar maximum show detectable sodium emission to greater distances than comets appearing during a solar minimum. The sodium emission is also found to depend on heliographic latitude of the comet which shows that the change in spatial properties of the solar wind with the phase of the solar cycle is responsible for this observed dependence.

The study of the velocity field structure in a super-granule and its evolution was continued by obtaining additional spectra in the 4554 \AA Ba^+ line, of a specific location on the Sun for consecutive days. Near-simultaneous K-line spectra and spectra in line 6303 Fe I with a double-image prism arrangement provided a picture of the chromospheric network and the distribution of magnetic fields.

The eclipse photograph of the corona of 1963 July 20 has been analysed by Sabattier techniques for coronal isophotes. This study has enabled the derivation of brightness distribution for different position angles to $r = 4.2$ solar radii. Intensity gradients over a more restricted range in radius as well as the parameters of ellipticity have been derived.

A considerable amount of effort on the part of several individuals went into the task of fabricating the instrumentation needed for the eclipse expedition to Mexico for the 1970 March eclipse. The experiments planned are direct high-resolution photography of the corona and coronal spectroscopy at 30 \AA mm^{-1} covering the spectral region from 3300 to 8800 \AA .

The Sun was photographed in white light on 306 days. $\text{H}\alpha$ disc, K-disc and K-Prominence spectroheliograms were obtained on 263, 262 and 234 days, respectively. $\text{H}\alpha$ filtergrams of the disc and with the Lyot monochromatic heliograph were obtained on 84 days. Observations of the solar chromosphere were made on 278 days covering a total duration of 1309 hours of patrol. Eighty flares were observed during the year of which 24 were sub-flares, 37 were classified as belonging to types If, In and Ib, 18 of importance 2f, 2n and 2b, and one of importance 3b. The data provided by routine solar observations have been sent regularly to the World Data Centres.

Observing conditions were more or less as in the previous year. The average definition of the Sun's image was 3 on a scale of 5. The North

Dome recorded 6 days of seeing 5, 68 days of seeing 4 and 156 days of seeing 3.

The mean equatorial distance of northern hemisphere spot groups was $13^{\circ}7$ and of the southern hemisphere spot groups $15^{\circ}2$ as against $15^{\circ}9$ and $17^{\circ}5$ respectively in 1968. Details of the spot observations are given in Table I.

TABLE I

Solar Data 1969

	No. of spot groups		Mean daily No. of spot groups	Kodaikanal daily relative sunspot number
	N	S		
Jan.	15	6	5.5	101.9
Feb.	18	11	6.5	134.3
March	19	11	7.3	146.3
April	15	8	6.2	125.8
May	23	14	7.7	130.8
June	11	10	5.0	102.5
July	13	7	5.6	103.1
Aug.	15	11	4.6	91.4
Sept.	13	17	5.6	98.0
Oct.	12	12	5.4	119.3
Nov.	15	9	5.0	111.3
Dec.	12	17	6.5	124.0
Total mean	181	133	5.9	115.7

STELLAR PHYSICS

Spectra of the members of the Scorpio-Centaurus association are being obtained at 45 \AA mm^{-1} primarily for the study of rotational velocities. Over 58 members have two spectra each. The plates constitute, in addition, a source of homogeneous information on line intensities of the higher members of the Balmer series and of the neutral helium lines of a genetically related group of young stars in our galaxy.

Spectra of δ -Orionis have been obtained and measured for radial velocity to determine the elements and the apsidal motion. Spectra of the WR spectroscopic binary γ_2 Vel continue to be taken.

The 40-inch Zeiss telescope was received from Germany in 1969 March and is now stored at the field station at Kavalur. The construction of the tower for housing the telescope is in progress.

Spectroscopic analysis of Nova Delphini and Nova Vulpeculae were continued. The microphotometer traces obtained have been reduced to intensity for a study of line profiles at different phases of the nova development. Several striking changes have been noticed.

Eclipsing variables continue to demand a fair share of our observational effort. Photoelectric observations of R Canis Majoris, FT

Orionis, δ Librae and RS Canum Venaticorum have been obtained at Kavalur.

RADIO ASTRONOMY

A phase-switching interferometer at a frequency of 25 MHz is in operation. The antenna system of the interferometer consists of two arrays—one with 72 full-wave dipoles and the other with 36 full-wave dipoles. The interferometer is being used for studies of occultation of radio sources by the solar corona, ionospheric and interplanetary scintillations and time variations of radio sources.

A multi-channel receiving system for recording solar and Jupiter radio bursts with a time resolution of the order of 10 ms is in operation. The three channels are centred around 25.000, 24.800 and 24.600 MHz. A polarimeter capable of receiving R.H. and L.H. circular components on a 10 ms time scale at 25 MHz is under construction. The multi-channel solar radiometer was operated during periods of enhanced solar emission and a large number of storm bursts were recorded. It is found that the duration of the bursts ranges from less than $\frac{1}{2}$ s to several seconds. The band width of the bursts was found to be less than 100 KHz in some cases. Two new types of bursts were recorded. It is also found that the enhanced radiation sometimes exhibits distinct periodicities with periods of the order of 4–8 s.

The design of an interferometer for medium resolution studies of the Sun at 300 MHz was completed. The construction of the instrument is in progress.

The 3000 MHz radiometer has been in regular operation for solar patrol on a tracking 2-metre paraboloid. The recording of sporadic radio emission from Jupiter at 22.2 MHz has been continued whenever possible. Regular recordings of solar noise flux on frequencies 50, 100 and 220 MHz were continued.

An investigation of the homologous characteristics of solar microwave bursts and associated flares was completed. The results indicate that the homologous bursts are associated with homologous optical flares and vice versa.

SOLAR-TERRESTRIAL RELATIONSHIPS

The main theme of the investigation in Solar-Terrestrial Physics has been the estimation of the *XUV* spectra of the Sun, during and outside flares, from the measured parameters of the ionosphere. Aided by the recently acquired knowledge about the nature of the solar ionizing radiation from the various space probes, more exact formulations of the continuity equations of the ionization balance in the upper strata of the terrestrial atmosphere have been possible. Combining these

with the precise measurements of the physical and chemical properties of the ionosphere recently obtained from rocket studies, it has been possible to estimate XUV fluxes from the Sun during several solar events.

The correspondence between the solar XUV fluxes thus determined and other visible emission features of the Sun was also investigated. The relative quietness of the Sun during the IQSY was taken advantage of for this purpose. A series of Lyot filtergrams containing a single plage was photometrically analysed, and the intensities correlated to the corresponding ionization densities at different heights. The result indicates that the ionization densities at lower ionospheric heights are weakly correlated with $H\alpha$ flux.

The temporal variation of the red oxygen lines at 6300 Å and 6364 Å was studied from several nights' records obtained at Kodaikanal. The corresponding $N(h)$ profiles derived from a series of ionograms obtained at the same location were also studied alongside. It was seen that maximum correlation between the airglow intensity and the slab electron content occurs at a height of 260–270 km over Kodaikanal, and has much less variability than the virtual heights of ionization peaks.

OPTICAL WORKSHOP

The construction of the 25-cm under-corrected hyperboloidal secondary for the 61-cm Ritchey-Chrétien telescope and the 30-cm hyperboloidal secondary for the 70-cm Cassegrain telescope were completed.

The optical shop has also completed the construction of the principal telescope for eclipse coronal spectroscopy as well as several off-axis elements for the spectrographs.

PUBLICATIONS

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