

## Uttar Pradesh State Observatory

REPORT FOR THE PERIOD 1987 JANUARY 1-1989 DECEMBER 31

### Solar physics

#### *Solar activity*

On an analysis of the locations of major flares and of type II radio burst regions on the solar surface, it has been found that there are about five zones in each hemisphere of the sun which produce such types of activities and they occupy 4% area on the sun. Also the latitudinal zone between  $11^\circ$  and  $20^\circ$  in each half is most prolific in producing solar activity. On finding a time lag between the onset times of microwave emissions, hard x-rays, gamma ray emissions and radio bursts, an effort has been made to understand the mechanisms responsible for these radiations at different heights in the solar atmosphere. A relationship between the occurrence of solar proton flares and associated microwave, x-ray, optical and radio emission has been found with a hope to predict the onset of proton flares.

Analysing data on major flares, type II radio bursts, white light flares, gamma ray bursts, hard x-ray bursts and coronal mass ejection during solar cycle 19, 20 and 21, it has been found that compared to the activity in the northern hemisphere during cycles 19 and 20, the southern hemisphere appears more active during cycle 21. Also the data on great hard x-ray bursts and solar radio bursts show a periodicity around 155-156 days but there is no such periodicity for sunspots. Relationship between coronal holes, coronal mass ejections and solar flares are being studied.

#### *Spectroscopy of the sun*

The calculated centre-to-limb behaviour of Balmer lines has been compared with the observations. Also similar behaviour for the Paschen and Brackett series lines has been studied and it is concluded that limb darkening data in the wings of hydrogen series lines can distinguish amongst various photospheric models. Centre-to-limb studies of the residual intensities in the wings of the above lines are also found useful for testing various facula models.

Faint molecular lines belonging to the molecules PO, PH and  $MgH^+$  are expected to show up in sunspots, photosphere and faculae.

#### *Instrumentation*

We have acquired two 15-cm Coude refractors from Carl Zeiss Jena for solar observations through CN,  $H_\alpha$  and K line filters, and for white light photography. A heat-

rejecting filter acquired from optical surfaces and fitted with the objective sends a cool beam down the telescope tube. The first results are encouraging. A TV camera alongwith VCR and Video analyser have been acquired and installed to record and analyse solar flare data.

#### *Visit to Antarctica*

Wahab Uddin, alongwith the scientists from the Indian Institute of Astrophysics, obtained useful spectroheliograms from an observing station in Antarctica.

#### *Doctoral theses*

V. K. Verma and P. Pant received their Ph.D. degrees during the period and K. R. Bondal submitted his Ph.D. thesis.

(This report has been compiled by Drs K. Sinha and B. M. Tripathi of Uttar Pradesh State Observatory).

### **Stellar and planetary physics**

#### *Physical study of comets and planets*

Spectrophotometric scans in the visible region have been obtained for comets Encke, Halley (1982i), Hartley-Good (1985l), Wilson (1986l) and Bradfield (1987s). Abundances and production rates of CN, C<sub>2</sub> and C<sub>3</sub> have been determined for those comets. The behaviour of the heliocentric distance has been investigated. Post perihelion observed emission fluxes at 388 nm (CN) and 516 nm (C<sub>2</sub>) of the coma of comets Austin (1982g) and Bradfield (1980t) are analysed in the framework of the Haser model. Production rates of CN, C<sub>2</sub> and nuclear diameters for these two comets have been determined. In each of the comets Austin (1982 g) and Bradfield (1980 t), the dust mass production rates as well as dust to gas mass production rates decrease with increase of heliocentric distance of comet.

Drift scans of the coma of comet Halley across the nucleus at the peak of CN, C<sub>2</sub> and C<sub>3</sub> emission bands have been obtained. It was found that the strength of C<sub>3</sub> decreases rapidly close to the nucleus of the comet; CN was found to be present at much larger distances from the nucleus as compared to C<sub>2</sub> and C<sub>3</sub>. Rapid irregular shortlived fluctuations in the brightness of comet Halley were noticed in UBV photometry. With the help of UBV photometry variations in magnitude, intensity and colour indices in the three circular zones from the centre of the cometary head of comet Bradfield (1987 s) have been estimated.

A re-analysis of the observations of occultation of MKE 31 by Neptune on 1983 September 12 shows that the possible ring system of Neptune extends from 64400 km to 64190 km.

#### *Clusters*

Integrated magnitudes and colours of population I synthetic clusters have been derived using the theoretical evolutionary tracks and age-dependent initial mass functions. Integrated parameters have been compared with the observational data of open clusters

in the Milky Way and clusters in LMC. Analysis of the observed data of star clusters indicates a decreasing trend in the total mass with age of the cluster up to about  $10^8$  yr, thereafter it shows an increasing trend.

The age distribution of open clusters has been obtained as a function of Trumpler's central concentration and range in brightness classes. Lifetime of the clusters have been obtained. It is found that the rich clusters have a relatively higher central concentration than the medium and poor clusters. Published literature has been surveyed to compile a bibliography of CMD studies of star clusters in the Magellanic Cloud. Relations between age, metallicity and other structural parameters of star clusters have been compared with those of star clusters of our galaxy.

Photographic photometry of about 900 stars down to  $V = 17$  mag, has been carried out in the region of open cluster NGC 2301. Statistical criteria yield only  $96 \pm 17$  cluster members. Star counts indicate a diameter of  $\sim 20$  arc min. The data suggest mass segregation in the cluster.

#### *Variable stars*

Effective temperatures and luminosities of DT Cyg and SZ Tau have been determined from spectral scans. The pulsation masses of the stars have been discussed. Light curves of Epsilon UMa show light variations of varying amplitude. Colour indices also show small colour variations.

#### *Eclipsing binaries*

Photometric studies have been done for the eclipsing binaries UM Boo, AY Cam,  $\sigma$  Cap, XX Cas, RW Ceti, XY Ceti, RW Com, RS CVn, RZ Eri, HZ Her, ST Per and ER Vul. Orbital periods of a number of eclipsing binary systems have been discussed based on the available times of minima in the literature. The continuum energy distribution of GG Cas at phases  $0^p.903$  and  $0^p.003$  in the wavelength range  $\lambda\lambda$  3200-7600 Å have been discussed. The spectral type of the systemic component have been found to be as B4 + KO. Spectrophotometric observations of V711 Tau and UX Ari have been obtained. Magnitude of V711 Tau fluctuates between  $5^m71$  to  $5^m79$ .

A number of binary systems have been investigated to study their power output by gravitational radiation and spiralling time relation.

#### *Stellar atmospheres*

Molecular dissociation calculations for model atmospheres of DA and non-DA white dwarfs show that  $\text{He}_2^+$  and  $\text{HeH}^+$  appear as most abundant in the atmospheres of non-DA white dwarfs while  $\text{H}_2$  and  $\text{H}_2^+$  are most abundant in DA white dwarf's atmospheres.

#### *Stellar model*

The unrestricted second-order virial formalism has been used to calculate the characteristic frequencies of linear adiabatic oscillations of a composite stellar model having an isothermal core and a polytropic envelope in presence of a weak poloidal magnetic field. The frequencies of the transverse shear mode and the non-radial pulsation mode for both a radiative and a convective envelope (corresponding to polytropic index 3 and 1.5 respectively) alongwith that of the toroidal mode for the radiative envelope get

increased in presence of the magnetic field. The frequency of the toroidal mode for the convective envelope registers a decrease in presence of the field.

### *Site survey*

From an analysis of the measurements of the total precipitable water vapour content in the atmosphere, the relative-humidity, and the temperature at ground level, made during 1981 November-1983 December, it has been found that the precipitable water vapour content is maximum during the months of May and June, and a minimum of 2.5 to 3.5 mm during November to March. The precipitable water vapour shows a poor correlation with the ground absolute humidity.

### *Instrumentation*

Microprocessor-controlled data logger, CCD system and Micro VAX system were acquired and installed. Microprocessor controlled data logger has been used since April, 1988, to acquire and print photometric data from the 104 cm telescope → UBV filter → photomultiplier → photon counter system. CCD system was installed in 1989 October at the Cassegrain focus of the 104-cm telescope. It consists of a CCD chip having  $576 \times 384$  pixels (mounted inside a liquid nitrogen cooled dewar), a camera controller, a computer, and a magnetic tape drive. Photometry of clusters and galaxies is being done with this system. For image processing Micro VAX was installed in 1989 June. Micro VAX system consists of 8 MB main memory, 159 MB hard disk, magnetic tape drive, cartridge tape drive, dot matrix printer, four VT 320 terminals, VMS operating system and FORTRAN compiler.

A low light level close circuit TV system has been acquired and installed at the Cassegrain focus of the 104-cm telescope. The system is being used to guide the telescope from the console room of the CCD system.

### *Doctoral theses*

P. S. Goraya (now at Punjabi University, Patiala) received his doctorate degree; M. Singh, A. K. Pandey, and B. B. Sanwal submitted their theses.

(This report has been compiled by Dr J. B. Srivastava and Sri B. B. Sanwal of Uttar Pradesh State Observatory.)

### **List of publications**

(Asterisks denote authors not from the Observatory)

#### **Solar physics**

- Bondal, K. R., Gaur, V. P. & Pande, M. C. (1987) *Bull. Astr. Soc. India* **15**, 13.  
 Bondal, K. R. & Gaur, V. P. (1987) *Bull. Astr. Soc. India*, **15**, 65.  
 Sinha, K., Tripathi, B. M., Atalla, R. M. & Singh, P. D. (1988) *Solar Phys.* **115**, 221.  
 Uddin, W., Pande, M. C. & Verma, V. K. (1988) *Kodaikanal Obs. Bull.* **9**, 223.  
 Verma, V. K. (1987) *Solar Phys.* **114**, 185.  
 Verma, V. K. (1987) *Ind. J. Radio Sp. Phys.* **16**, 281; 384.  
 Verma, V. K. & Joshi, B. C. (1987) *Solar Phys.* **114**, 415.  
 Verma, V. K., Pande, M. C. & Uddin, W. (1987) *Solar Phys.* **112**, 341.  
 Verma, V. K. (1988) *Ind. J. Radio Sp. Phys.* **17**, 45.

- Verma, V. K. & Joshi, G. C. (1988) *Kodaikanal Obs. Bull.* **9**, 215.  
 Verma, V. K. & Pande, M. C. (1988) *Ind. J. Radio & Sp. Phys.* **17**, 8.  
 Verma, V. K. & Pande, M. C. (1988) *IAU Coll. No. 1041*. Solar and stellar flares, p. 239.  
 Verma, V. K. (1989) *IAU Coll. No. 152*. Basic plasma processes in the sun, p. 450.

### Stellar and planetary physics

- Ashoka\*, B. N., Seetha\*, S., Marar\*, T. M. K., Padmini\*, V. N., Kasturirangan\*, K., Rao\*, U. R., Pande, M. C. & Mahra, H. S. (1989) *IBVS No. 3352*. Detection of new short period oscillations in PG 1711 + 336 (V 795 Her).
- Bhatt, B. C. & Mahra, H. S. (1987) *Bull. Astr. Soc. India* **15**, 116 Atmospheric precipitable water vapour over Manora Peak, Naini Tal.
- Bhatt, B. C., Pandey, A. K. & Mahra, H. S. (1989) *Bull. Astr. Soc. India* **17**, 35. The age distribution of open clusters as a function of Trumpler's classifications.
- Chaubey, U. S. & Singh, M. (1989) *Ap. Sp. Sci.* **151**, 335. A spectrophotometric study of GG Cassiopeiae.
- Jayanta Kar (1987) *Ap. Sp. Sci.* **133**, 29. On the oscillations of a composite stellar model with a weak magnetic field.
- Gaur, V. P., Tripathi, B. M., Joshi, B. C. & Pande, M. C. (1988) *Ap. Sp. Sci.* **147**, 107. Molecules in white dwarfs
- Ghosh\*, T. K., Iyengar\*, K. V. K., Verma\*, R. P. & Srivastava, R. K. (1989) *ACTA Astr.* **39**, 69. On infrared excess omission from HZ Herculis.
- Goraya, P. S., Rautela, B. S. & Sanwal, B. B. (1987) *Earth, Moon and Planets* **37**, 53. Study of periodic comet Encke during its apparition in 1984.
- Goraya, P. S., Wahab Uddin & Srivastava, R. K. (1987) *Earth, Moon and Planets* **38**, 53. Rapid changes of brightness in comet P Halley
- Goraya, P. S., Wahab Uddin & Srivastava, R. K. (1987) *J. Br. Astr. Assoc.* **97**, 201. Variations in P/Halley, 1986 January.
- Goraya, P. S., Tur\*, N. S. & Rautela, B. S. (1987) *IBVS No. 3052*. Variable shell strength of Pleione (BU Tau).
- Goraya, P. S., Srivastava, R. K. & Wahab Uddin (1988) *Earth, Moon and Planets* **40**, 109 Brightness changes in P Halley.
- goraya, P. S., Sanwal, B. B. & Rautela, B. S. (1988) *Earth, Moon and Planets* **42**, 113. Extension of the coma of P Halley
- Goraya, P. S., Rautela, B. S. & Sanwal, B. B. (1988) *Earth, Moon and Planets* **40**, 221. Scanner observations of P Halley (1982 i)
- Goraya, P. S., Duggal\*, H. K., Srivastava, R. K. & Wahab Uddin (1989) *Earth, Moon and Planets* **44**, 197. Variation in comet P Halley.
- Goraya, P. S., Sanwal, B. B. & Rautela, B. S. (1989) *Earth, Moon and Planets* **44**, 243. Spectrophotometry of P Halley (1982 i).
- Gupta, K. G. (1989) *Bull. Astr. Soc. India* **17**, 120 Yake effects in various telescope mirrors.
- Iyengar\*, K. V. K., Ghosh\*, S. K., Rengarajan\*, T. N., Verma\*, R. P., Joshi, S. C. & Srivastava, R. K. (1989) *Astr. Ap.* **221**, 250. Near-infrared observations and optical identifications of a few unassociated IRAS sources with dust shells.
- Joshi, S. C., Srivastava, J. B., Kandpal, C. D., Padalia, T. D., Sanwal, B. B., Chaubey, U. S. & Singh, M. (1987) *Earth, Moon and Planets* **38**, 249. Photographic observations of comet P/Halley (1982 i).
- Joshi, S. C. & Sanwal, B. B. (1987). *Earth, Moon and Planets* **39**, 203. Brightness distribution in the coma of comet Halley (1982 i).
- Joshi, S. C. & Rautela, B. S. (1987) *Bull. Astr. Soc. India* **15**, 179. On the ultraviolet fluxes of Be stars.
- Joshi, S. C., Srivastava, R. K. & Srivastava, J. B. (1987) *IBVS No. 3116*. Rapid variations in H-alpha emission of Gamma Cassiopeiae.
- Joshi, S. C., Srivastava, J. B., Padalia, T. D. & Kandpal; C. D. (1988) *Earth, Moon and Planets* **40**, 217. Astrometric positions of comet Wilson (1986 l).
- Joshi, S. C., Srivastava, R. K. & Srivastava, J. B. (1988) *Ap. Sp. Sci.* **152**, 85. Spectrophotometry of V711 Tauri.
- Joshi, S. C., Sanwal, B. B. & Rautela, B. S. (1989) *Proc. of the National Symposium on Comet P/Halley* (eds: K. R. Sivaraman and G. S. D. Babu), 11A Bangalore Spectrophotometry of comet P/Halley.

- Joshi, S. C., Ojha, D. K. & Srivastava, J. B. (1989) *J. Ap. Astr.* **10**, 113. Spectrophotometric observations of HR 8107.
- Mohan, V. & Creze\*, M. (1987) *Astr. Ap. Suppl.* **68**, 529. Stellar Photometry with Schmidt Plates.
- Mohan, V., Bjavui\*, A., Creze\*, M. & Robin\*, A. C. (1988) *Astr. Ap. Suppl.* **73**, 85. UVB Photometry in two fields in anticentre direction
- Mohan, V. & Sagar\*, R. (1988) *Bull. Astr. Soc. India* **16**, 159. Field contamination in open star cluster NGC 2301.
- Ojha, D. K. & Joshi, S. C. (1989) *Earth, Moon and Planets* **44**, 1. Spectrophotometry of comet Bradfield (1987 s).
- Padalia, T. D. (1987) *Ap. Sp. Sci.* **129**, 413. Intrinsic light variations in the eclipsing binary RW Ceti.
- Padalia, T. D. (1987) *Ap. Sp. Sci.* **137**, 191. Gravitational radiation and spiralling time of close binary systems.
- Padalia, T. D. (1988) *Ap. Sp. Sci.* **149**, 379. Gravitational radiation and spiralling time of close binary systems (II).
- Padalia, T. D. (1989) *Earth, Moon and Planets* **44**, 25. Photoelectric photometry of comet Bradfield (1987 s).
- Pandey, A. K., Bhatt, B. C. & Mahra, H. S. (1987) *Ap. Sp. Sci.* **129**, 293. Age distribution of open cluster as a function of their linear diameter and age dependence of cluster masses.
- Pandey, A. K. & Mahra, H. S. (1987) *M.V.R.A.S.* **226**, 635. Interstellar extinction and galactic structure.
- Pandey, A. K. & Mahra, H. S. (1987) *Earth, Moon and Planets*, **37**, 147. Possible ring system of Neptune.
- Pandey, A. K., Bhatt, B. C. & Mahra, H. S. (1988) *Astr. Ap.* **189**, 66. Open clusters and galactic structure.
- Pandey, A. K., Bhatt, B. C., Mahra, H. S. & Sagar\*, R. (1988) *M.V.R.A.S.* **236**, 263. Integrated parameters of open clusters.
- Ram Sagar\* & Pandey, A. K. (1989) *Astr. Ap. Suppl.* **79**, 407. A bibliography of colour magnitude diagram studies of star clusters in the magellanic clouds.
- Rautela, B. S., Goraya, P. S., Sanwal, B. B. & Gupta S. K. (1988) *Earth, Moon and Planets* **40**, 21. Spectrophotometric observations of comet Hartley Good (19851).
- Rautela, B. S. & Sanwal, B. B. (1988) *Earth, Moon and Planets* **43**, 221. Spectrophotometric study of comet Bradfield (1987 s).
- Rautela, B. S., Goraya, P. S., Sanwal, B. B. & Gupta, S. K. (1989) *Earth, Moon and Planets* **44**, 233. Spectrophotometry of comet Hertley Good (1985 l).
- Sanwal, B. B., Rautela, B. S. & Joshi, G. C. (1988) *Ap. Sp. Sci.* **140**, 131. An analysis of the spectrum of Alpha Ursae Minoris.
- Sanwal, B. B. & Rautela, B. S. (1988) *Observatory*, **108**, 164. Scanner observations of the comet Wilson (1986 l).
- Sanwal, B. B. & Rautela, B. S. (1989) *Ap. Sp. Sci.* **151**, 209. Spectrophotometric study of the cepheids DT Cyg and SZ Tau.
- Singh, M. & Chaubey, U. S. (1987) *Ap. Sp. Sci.* **129**, 251. Spectrophotometric observations and evolutionary status of ten Be stars.
- Singh\*, P. D., Sinha, K., Tripathi, B. M. & Roberty\*, H. M. B. (1989) *Earth, Moon and Planets* **47**, 231. An analysis of spectrophotometric observations of comet Austin (1982 g) and Bradfield (1980 t)
- Srivastava, J. B. & Srivastava, R. K. (1987) *Ap. Sp. Sci.* **129**, 415. CU Eridani—a suspected variable.
- Srivastava, J. B. & Kandpal, C. D. (1987) *Ap. Sp. Sci.* **133**, 291. Eclipsing binary UW Boo.
- Srivastava, J. B. & Kandpal, C. D. (1987) *IBVS No. 3005*. On the primary minimum of eclipsing binary AY Cam.
- Srivastava, J. B. & Kandpal, C. D. (1988) *Ap. Sp. Sci.* **147**, 355. UVB photometry of eclipsing binary RZ Eridani.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **127**, 345. Period study of XX Cassiopeiac.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **129**, 143. A new period and period trend of IZ Persei.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **129**, 221. Period variation of the eclipsing system EE Aquarii.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **129**, 409. Period variation of BZ Eridani.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **132**, 125. Spectral luminosity classification, colour variations and suspected Beta canis majoris type variability in IZ Persei.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **133**, 71. A new period and period changes in VZ Hydrae.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **132**, 331. A new period and period changes of GG Cassiopeiac.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **134**, 177. Period study of GH Pegasi.
- Srivastava, R. K. (1987) *IBVS No. 3001*. Photoelectric elements and revised spectral Types of XX Cas.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **135**, 229. Period changes in EI Cephei.

- Srivastava, R. K. (1987) *IBVS No. 3008*. Delta Cap: A possible RS CVn binary.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **137**, 63. Photoelectric observations and wave minimum of RS CVn.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **138**, 197. Analysis of the light changes of the eclipsing binary XY Ceti in the frequency domain.
- Srivastava, R. K. (1987) *Ap. Sp. Sci.* **139**, 373. RS CVn binary RW Com : A possible three-body system.
- Srivastava, R. K. (1988) *Ap. Sp. Sci.* **143**, 175. ST Persei: A possible multibody system.
- Srivastava, R. K., Srivastava, J. B. & Joshi, S. C. (1988) *Ap. Sp. Sci.* **143**, 107. Spectrophotometric observations of delta Cap.
- Srivastava, R. K. (1988) *Ap. Sp. Sci.* **140**, 337. Disc system delta Cap.
- Srivastava, R. K. (1988) *Ap. Sp. Sci.* **147**, 355. Detailed period study of delta Cap.
- Srivastava, R. K. (1988) *Ap. Sp. Sci.* **150**, 173. Period study of XY Ceti.
- Srivastava, R. K. (1988) *IBVS No. 3217*. Eclipsing binary signatures in Zeta Capricorni.
- Srivastava, R. K. (1989) *Ap. Sp. Sci.* **152**, 343. A note on the BBSAG visual observations.
- Srivastava, R. K. (1989) *Ap. Sp. Sci.* **154**, 336. Light variability in epsilon UMa.
- Srivastava, R. K. (1989) *Ap. Sp. Sci.* **154**, 179. Period study of AW Uma.
- Tur\*, N. S., Goraya, P. S. & Chaubey, U. S. (1987) *Ap. Sp. Sci.* **139**, 257. Continuum energy distribution in 48 Persei