Reports from astronomical centres

Indian Institute of Astrophysics

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Solar physics

Much effort was centred around the analysis of the data obtained from the experiments of the 1980 total solar eclipse. The analysis of the high resolution multislit spectra of the forbidden line of Fe x (6374Å) was completed by Jagdev Singh to derive coronal temperatures and line-of-sight velocities. These measurements were made at 236 locations in the corona extending from 1.1 to 1.7 $R_\odot$. The observed line profiles have a spatial resolution of 10 × 22 arcsec, and give half-widths that vary between 0.6 and 2.4 Å. A large number of locations have half-widths around 1.3 Å corresponding to a temperature of 4.6×10^6 K. If temperatures of the order of 1.3×10^6K are typical of the regions that emit the forbidden red line, then turbulent velocities of $\simeq$ 30 km s^{-1} need to be invoked for the enhanced line broadening. The line-of-sight velocities mostly cluster around 5 km s^{-1} though they show a range of values ranging from -14 to $+14$ km s^{-1}. The rotational velocity determined from the eastern and the western locations has a value of 2.1 km s^{-1} and indicates that the corona corotates with the sun. Sivaraman & Jayachandran using one set of photographs, consisting of 4 images of the corona corresponding to polaroid positions that differ by 45°, have evaluated the polarization of the corona in the radial direction every 30° in position angle and out to a distance of 3 $R_\odot$. They have also examined in detail the polarization around the south pole in a region between position angles 140° and 250° that covered two streamers. The results show the existence of a coronal hole near the south pole and enhanced polarization values inside the streamers at position angles 130°, 215° and 250°. A more detailed analysis is possible from the four different exposure sets for which Sivaraman has done the densitometry using the computer microdensitometer system at Kitt Peak. The evaluation of the data is in progress. Scaria has completed the task of isophotometry of the large scale photographs obtained at the 1980 eclipse. These results will be combined with the polarization data with a view to evaluating coronal density gradients.

Sivaraman had several runs with the Kitt Peak solar telescope and magnetograph to search for an association of the sub-arcsec magnetic features in the interior of the network and the bright points seen on Ca^+ spectroheliograms. Each run consisted

of a series of intensity scans in the Ca^+ K line at 3 min intervals lasting for an hour, on a region $10' \times 5'$ at the centre of the solar disk, and sandwiched between two sets of magnetic scans of the same region using the line Fe I 8688 Å.

At Kodaikanal, Bagare & Gupta have secured spectra of the Ca^+ K line over many plages of varying activity to study the nature of the width of K emission. Jayachandran has obtained high dispersion spectra of the Zeeman insensitive line Fe I 4912 Å, for a dozen bipolar spots in order to study the Evershed velocities associated with these spots. The Ca^+ K line continues to be monitored in integrated sunlight as part of a long range program related to solar cycle variations.

Regular exchange of solar data and spectroheliograms with the Meudon observatory continued as in the previous years. As a part of the program for the solar maximum year, rapid sequence of K_{2s2} spectroheliograms at 30 s intervals and sequences lasting for several hours was obtained for active regions. These additional observations have been made as a part of our contribution to the international program drawn up by the scientific committee on solar terrestrial physics (SCOSTEP). This international cooperative effort is carried out under two different programs—the study of energy release in flares (SERF) and the flare build up study (FBS). A large amount of high quality observations has been secured, which awaits further reduction and analysis.

Gokhale & Sivaraman completed the analysis of the frequency distribution, of sunspot groups with respect to their maximum area A_* for spot groups observed since 1889. They find that during each of the eight cycles the distribution $f(A_*)$ has two distinct components, as expected on the basis of the shock-transition model of the solar cycle proposed earlier by Gokhale. They also find that one component $f(A_*)$ varies as $\exp(-b_1\sqrt{A_*})$ and is responsible for spot groups with all possible values of A_*. The other component varies as $\exp(-b_2 A_*)$. Its contribution is confined to spot groups with $A_* < 50$ m.h. and exceeds that of $f_1(A_*)$ for $A_* < 30$ m.h. The values of b_1 and b_2 are fairly constant from cycle to cycle. Gokhale & Venkatakrishnan have examined the basic postulate of the shock transition model that in a solar type star, thin flux sheaths of intense, *reverse* magnetic field are produced by nonlinear dissipation at the nodes of azimuthal magnetoacoustic waves near the base of the convection zone. They consider perturbations of an initially uniform rotation across an externally closed and weak uniform magnetic field. They find that under the constraint of the spatial periodicity imposed on such perturbations by the finiteness of space in the azimuthal direction, the MHD equations allow nonlinear solutions of a wave form involving MHD shocks, so long as a certain function $G(M, \Pi, \Sigma, \Phi)$ of the total mass (M), the total momentum (Π), total energy (Σ), and the total magnetic flux (Φ), remains negative. As Φ decreases as a result of the fields rising by buoyancy and leaving the star, and as the wave grows due to the increase of Σ by the radiative energy accumulation, the magnetic field on one side of each shock takes the form of a thin flux sheath of an intense reverse field. Thus, Gokhale & Vekatakrishnan establish the validity of the basic postulate in the shock transition model.

Hasan & Venkatakrishnan have developed a time-dependent model for the flow of gas in a spicule, a preliminary account of which was contained in the last report. They have investigated the time-dependent interaction of the granular velocity fields with a magnetic flux tube and find that when the magnetic field line is displaced normal to itself, simulating the buffetting action of granules, a flow of gas is initiated along the field. Choosing a lateral velocity field consistent with observations they find that there is a downward gas motion with a velocity compatible with the downflows in isolated photospheric flux tubes. They have commenced an investigation to study the response of the solar wind to a flow geometry which changes in time. The aim is to understand the temporal effects that changes in the geometry of flux tubes can have on the solar wind. It is already known that for a steady polytropic flow there is a continuous solution for the velocity which is subsonic close to the sun and supersonic away from it. The consequences of a non-radial expansion of the flux tube where the cross section area A increases faster than r^2 are interesting. They have chosen a form for A which simulates a coronal hole and are investigating the pattern of flow in the flux tube. If the area change is not too rapid, a final steady state is found to occur in which the sonic point is much closer to the sun. In certain cases a rapid change in geometry leads to situations were shock-like transitions provide the only single-valued solutions. They have extended the investigation to study the effect of mass addition to the base of a flux tube and have visualised the flow in the flux tube in relation to the mass injection function.

The H-alpha line emission seen in coronal spectra obtained during total solar eclipses by teams sent by the Institute in recent years has become an important problem demanding explanation. Some of the currently prevailing explanations that attribute the emission to processes like diffusion of the prominence radiation in the earth's atmosphere or scattering of chromospheric and prominence radiation by F-corona, are not quite plausible on physical considerations. Another suggestion is the possibility of the existence of a cooler component of the corona. Raju has attempted to interpret the emission as caused by residual neutral hyrogen atoms in the corona. Assuming a spherically symmetric model atmosphere for the corona, he has calculated the line-of-sight intensities for H-alpha (6563 Å), the red coronal line (6374 Å) and the green coronal line (5303 Å) for various heights above the solar limb, taking into account the resonance excitation of the residual neutral hydrogen atoms by disk Lyman-beta, electron collisional excitation of the third quantum state, and the recombination processes to the third quantum state. During the de-excitation of the excited hydrogen levels, about half the number decay radiatively to the second quantum level giving rise to the H-alpha line. In order to get a better agreement between the observed and computed fluxes, Raju is now refining his calculations by incorporating many more levels for the model hydrogen atom. The physical processes populating these levels are : electron collisional excitations of the levels for the permitted and forbidden transitions, photoexcitation of relevant levels by solar disc fluxes of Lyman-alpha, Lyman-beta, H-alpha and H-beta, de-excitation of the excited levels by radiative mode except for the $2s$ level which gets depopulated to $2p$ level by proton collisions, and collisional processes involving redistribution of angular momentum between sub-levels of a given total quantum number state.

The Gauribidanur radio telescope operated jointly by the Indian Institute of Astrophysics and the Raman Research Institute, Bangalore was used by Sastry and his collaborators to map the two-dimensional brightness distribution of the slowly varying component of the sun. These maps are being compared with the x-ray pictures and helium 10830 Å synoptic maps of the sun to see if there is any correlation between the two. The telescope was also used to study the time and frequency structure of decameter radio bursts from the sun. Several new types of weak radio bursts have been observed. These include pulsating patterns in the time profiles of short duration bursts and extremely short-duration spike bursts with slow drift. Sastry, Krishan & Subramanian give a tentative physical model for these bursts based on the nonlinear development of waves interacting in a turbulent medium. They have also studied the time structure of drift pair radio bursts at decameter wavelengths.

Cometary tails

Sivaraman & Krishan have analysed the helical structures in the tail of comet Ikeya-Seki (1965f) from a series of photographs of the comet obtained at Kodaikanal. They interpret these structures in terms of the helical forms of the magnetic field in the ionic tail of the comet. The fact spin that the nucleus of this comet experienced during its close approach to the sun is considered to have imparted the helical form of the magnetic field. The CO^+ ions in the tail follow the magnetic field and thus exhibit the helical structure.

Physics of stars

Bhattacharyya continued the lunar occultation observing program and recorded 29 occultations with the 102-cm Kavalur reflector. He has also made photoelectric observations of the two x-ray sources Sco X-1 and X Per. He & Shylaja continue to collect photometric data of cataclysmic variables.

Kameswara Rao and Bappu, in collaboration with K. Nandy of the Royal Observatory, Edinburgh, obtained low resolution spectra of XX Cam, MV Sgr and high resolution spectra of R CrB with the IUE satellite 1980 October. They have detected emission in the cores of the Mg II resonance lines of R CrB, a behaviour akin to the normal F8Ib supergiant γ Cygni. The width-absolute magnitude relation for Mg II valid for normal supergiants is follwed by R CrB and this establishes the presence of a chromosphere at maximum light, which was suspected from preliminary ground based observations during minimum light phase. An interesting aspect is that although R CrB is chemically peculiar being carbon rich and hydrogen deficient, it still seems to possess a chromosphere similar to one in a normal star. Rao investigated the mass loss of R CrB during visual light minimum, using Herbig's 16 Å/mm coude spectrograms obtained with the 120-inch reflector of Lick observatory. The changes in the profiles of Ca II H and K and He I λ3889, as the minimum progressed, indicate expansion velocities of $\simeq$ 250 km s^{-1} for the gas producing these lines. The He I emission lines show anomalous line intensities. Rao has studied the physical conditions of the gas producing these broad emission lines.

Infrared photometry in *J, H, K, L* bands of R CrB stars is being continued by Rao in collaboration with P. V. Kulkarni and N. M. Ashok of the Physical Research Labaratory, Ahmedabad. SU Tau was observed in January, February and March, during its emergence from a deep visual minimum. Observations of R CrB and XX Cam have also been made in the infrared bands.

The program of study of late type stars with hot companions by Rao in collaboration with D. P. Gilra of Kapteyn Astronomical Institute was continued. They have obtained both high and low resolution IUE spectra of ϵ Aur and HD 62001, supported by coordinated ground based photometric observations of HD 62001, made simultaneously from Chile, Hyderabad and Kavalur. From several direct photographs of the field of HD 62001 and the nebula V-V1-7, taken both at Kavalur and elsewhere, they notice that, in addition to the nebula V-V1-7, another stellar object that is present in the blue Palomar observatory sky survey plate (epoch 1953) has disappeared in later photographs. Even an earlier 20-inch Lick astrograph plate (epoch 1948) does not show any trace of the nebula or the stellar object. They find that within a small positional uncertainity the stellar object seems to coincide with a weak radio source discovered by Milne & Aller. The two possibilities regarding the nature of this stellar object seem to be that it is either a flare star or a QSO, the latter being more likely. In view of the observations of HD 62001 which show the star to be a binary, they interpret the disappearance of the nebula V-V1-7 in terms of the cut-off of radiation from the central star (HD 62001) consequent to the formation of a transient gaseous disk around the primary star.

A variety of observations (*UBV* photometry, IR photometry scanner) of the B5III star HR 2947 were obtained by Rao in collaboration with Kulkarni and Ashok. They find that the fluxes obtained with the scanner in the range $\lambda\lambda$ 3200-6000 together with available UV flux values follow the theoretical energy distribution for a model with $T_{\rm eff} = 13500$ K and $\log g = 3.5$. The old catalogues show that the star varied in brightness by one magnitude and the present V mag is fainter than the value listed by Cowley *et al.* (1968) by 0.3 mag. If the brightness variability in the past is real, they feel that the star might be a shell star.

Scanner observations weak G band stars, particularly those with known lithium abundances, are in progress at the 120-cm reflector. Rao finds a linear relationship between lithium abundance and carbon deficiency; stars with less lithium are more deficient in carbon. Probably in the post-main sequence stage a fresh production of lithium seems to be needed to account for the high lithium present in these stars.

Bappu & Rajamohan have carried out a detailed evaluation of the orbital characteristics of the Wolf Rayet binary γ Vel. They have obtained several spectra in the blue, green and red regions on high contrast emulsion. These spectra cover nearly two cycles of the binary orbit during the period 1980 December through 1981 May. Visual inspection of the spectrograms indicate the sharpening of the violet-shifted He I 3888 line at zero phase and its splitting into two components at phase close to 0.25. This confirms that there is no change in the 78.5 day period of the binary orbit, first determined by Ganesh & Bappu in 1965.

Rajamohan & Kameswara Rao have commenced a study of the variability of H-alpha emission in stellar associations and in particular the Scorpio Centarus

association. They find thar γ' Cen which did not show any H-alpha emission in the spectra taken in 1974 now shows a variable emission feature. They have also commenced a program to investigate the infrared excess of the peculiar stars in the upper Scorpius region. If the spectral peculiarity is produced by magnetic accretion in such stars, youthful members of galactic clusters can be expected to show infrared excess and a possible filling-in of the H-alpha line by weak emission. They find from several spectra of HD 147010 that the H-alpha line strength is variable and that the spectral type and infrared colours can be matched only if the ratio of the total to selective absorption is about 4.2. Of a dozen other peculiar stars examined, they find that HD 147933 is a double-lined binary, that HD 139160 shows an emission component in the H-alpha line and that others do not exhibit any variability in H-alpha line strengths.

Ravindran with Mekkaden and Mohin have observed photometrically several known RS CVn stars. They used the 34-cm reflector for this purpose on 60 nights to obtain light curves for the known variables HR 1099, HD 86590, BD + 61°1211, EQ Vir, BY Dra, and HD 224085. Other suspected variables included in the program for detailed light curve examination are HD 22403, HD 27130, HD 31738, HD 71071 and BD +25°2511. Their observations of HD 81410 show that the star exhibits the RS CVn type of variability. A preliminary analysis of the light variation indicates a photometric period of 12.7 days which is to be preferred to the value of 25.4 days ascribed earlier by Eggen. The amptitude of light variation in 1981 was about 0.15 mag, a value much less than the 0.5 mag value found by Eggen in 1972.

Scaria & Bappu find, from equidensitometry of the cluster 47 Tuc, an increase in ellipticity associated with an increase in the blueness of the cluster. All globular clusters studied so far for ellipticity properties show similarity in the distance dependence of the ellipticity, with small values near the centre as well as in outer regions, and with a maximum value for the bulge in between. They suggest that the red stars in globular clusters have a near-spherical distribution. They have also completed an investigation of the distribution of blue horizontal branch (BHB) stars in the cluster ω Cen.

Mahipal Singh has commenced a long range program to study time variations of the H-alpha profile in several O and B stars, particularly in the southern hemisphere.

Galactic clusters especially those containing O and early B stars are a very important means of delineating spiral structure within the Milky Way. Many of the brighter clusters in the solar neighbourhood have been evaluated by photoelectric techniques for distance moduli and age. Little information exists for faint galactic clusters especially in the anticentre region to distant parts of the galaxy. Such studies will be useful not only for a better picture of spiral structure but also for star formation characteristics within the galaxy. Bappu & Babu have commenced a program of galactic cluster photometry in the Monoceros, Puppis and Vela regions. The first phase of the program involves selection of clusters with brightest stars of spectral types earlier than B_3, in order to ensure that the clusters chosen for subsequent detailed photometry are representative of a young population. These spectral determination are carried out by the use of slitless transmission grating spectra obtained at the f/13 Cassegrain focus; the intensity spread of the continuum to shorter wavelengths is a useful index of spectral evaluation. A selection of stars for photo-

metric assessment of the distance modulus is made by approximate V magnitude-spectral class diagrams from Palomar blue and red plates using Sabattier techniques for magnitude determination.

From an analysis of the observations of 87 Ap and Am stars, Babu & Shyalaja have evaluated the T_{eff}, radii, bolometric magnitudes and bolometric corrections and compiled these into a catalogue. They find that the hotter Ap stars are apparently bluer than their normal counterparts and ascribe this characteristic to the broad continuum feature at $\lambda 5200$ present only in some of them.

Stellar atmospheres (theoretical)

Peraiah and his collaborators have been working on different aspects of the line formation problem in stellar atmospheres. They have arrived at consistent solutions of line transfer with partial frequency redistribution and statistical equilibrium equation in a variety of physical conditions such as different gas velocities, geometrical extensions, complete, partial frequency redistribution functions with isotropic and dipole scattering. They have been able to detect the differences which these scattering functions introduce in the radiation field. Voigt profile function has been employed to represent the complete redistribution and correspondingly the R_{II} function has been employed in the partial frequency redistribution. They have used only the angle averaged redistribution functions instead of the angle dependent functions. They have compared the probabilities of photon escape from the expanding stellar atmospheres using the scattering functions of partial frequency redistribution and complete redistribution and find that the former type of redistribution scatters more than the latter. A comparison of the number of scatterings by dipole with the isotropic scattering functions shows that twice as many photons escape by isotropic scattering as compared to those escaping by dipole scattering and that more photons are back scattered in the case of dipole scattering than in the case of isotropic scattering. Large radial motions of gas reduce the mean number of scatterings and increase the mean escape probabilities. They have also examined the way these functions change the level population density (N_2 and N_1) ratios in a two-level non-LTE line. In almost all situations it is found that the velocities of gases in the extended spherical medium do not influence the ratio N_2/N_1 as much as the combination of gas velocities and the geometrical extension. However, in the case of dipole scattering the velocity gradients influence N_2/N_1 more than the combinantion of large radial velocities of gas and extension of the medium. They have investigated the change in the line source functions associated with surface distortions due to rotation in an expanding atmosphere with uniform rotation and employing the flux, predicted by von Zeipel's theorem as the boundary condition. Dilution of the source functions with increasing velocities and geometrical extensions is found to be a major consequence of the rotation. They have also computed lines formed in thin spherical and cylindrical (rotating) shells. Several important changes have been noticed between the profiles formed in rotating and non-rotating media. The work on the problem of hydrodynamics in a non-LTE line is in progress. They are able to obtain a convergent solution for a given set of physical parameters. However, the solution is not consistent. Numerical techniques of Lax, Wendroff are employed for this purpose.

Nova, supernovae and supernova remnants

Prabhu has obtained spectrograms of the supernovae (SN) in NGC 1316 and 6946. The spectra were recorded at a dispersion of 400 Å mm^{-1} with the image tube spectrograph on the Kavalur reflector during 1980 December and 1981 January. SN 1980 in NGC 6946 is a type II SN with an expansion velocity of 6300 ± 375 km s^{-1} as determined from the P Cygni profiles of H_α, H_β, Na I D and Mg I b lines. SN 1980 in NGC 1316 is a type I SN with its characteristic dip at 6175 Å. Its envelope has an expansion velocity of 7675 ± 800 km s^{-1} as determined from the widths of the emission lines of Fe II (4700 Å — 4910 Å), Fe II + N II (5040 Å), N II (5570 Å) and Si II (6175 Å). Prabhu obtained on 1981 January 4.61 UT the spectrum of a suspected nova in Cygnus, at a dispersion of 65 Å mm^{-1} in the wavelength range of λλ 4200–6200. This object was discovered by Honda 1980 November 29 at a brightness of tenth magnitude. The early Kavalur spectrograms of this object were obtained at a dispersion of 400 Å mm^{-1}. Prabhu & Mekkaden have analyzed the intermediate dispersion spectrum and have identified this object to be a long period variable of spectral type M4e, characterized by narrow emission at H_α and H_β and absorption bands TiO.

Kochhar and Prabhu have attempted to explain the observed properties of extragalactic supernovae in terms of the hypothesis that all SN, of type I as well as type II, come from short-lived stars—SN I from stars in the mass range 4–7 $M_\odot$ and SN II from more massive stars. They have proposed that spiral arms are necessary for the formation of the progenitors of SN II. IO galaxies, which have so far produced only SN I, are morphologically a heterogenous group. While NGC 3656, 4753 and 5253 resemble E/SO galaxies, NGC 2968 and 5195 resemble spirals. Furthermore their peculiarities arise from different factors. NGC 4753 is isolated, 5253 is in a loose group, and 2968, 5195 and 3656 are tidally interacting. All these show signs of star formation but do not possess spiral arms. The fact that IO galaxies have produced only SN I lends support to the hypothesis that SN I come from short-lived stars. Among spiral galaxies the rates of both SN I and SN II increase with an increase in the number of H II regions, with the increasing dustiness of the parent galaxy, and with the increasing diameters of the largest H II regions in the parent galaxy. The correlation of SN I with the above indicators of on-going star formation lends further support to the hypothesis that the progenitors of SN I are also short-lived stars. However, the rate of occurrence of SN I does not increase as rapidly as that of SN II implying that the proportion of SN II among the total number of SN is higher in the galaxies with larger H II regions. Thus galaxies with larger H II regions should contain a higher proportion of massive stars as compared with those with smaller H II regions.

Kochhar has presented a hypothesis which relates together the morphology of the supernova remnants (SNRs), the type of the SN, and the presence or otherwise of a compact star. According to this conjecture, stars in the mass range 4–7 $M_\odot$ exploding as SN I are totally disrupted by the explosion and form shell type SNRs. More massive stars explode as SN II and also give rise to shell-type SNRs, but in this case a compact star, a blackhole or a neutron star, is left behind. If the neutron star is active, the SNR has a filled centre. The first SN explosion in a close binary gives rise to a shell-type SNR. A Crab-like SNR is formed by the second SN explosion in a close binary.

Krishan in collaboration with C. Sivaram (Indian Insititute of Science, Bangalore) and R. K. Varma (P. R. L., Ahmedabad) has suggested an electron beam plasma instability as the mechanism for generating electromagnetic bursts from the atmosphere of a neutron star. The source of energy is the kinetic energy of the plasma blob flowing outward from a normal star and accreted by the neutron star. The estimates of the rise time of the burst and the duration between consecutive burst are in good agreement with observation.

The Gauribidanur radio telescope was used by Sastry and his callaborators to map several extended supernova remnants, including the Cygnus Loop, IC443, HB 9, HB 21, and the Monoceros nebulosity. For the Cygnus Loop, they have determined the spectra of the total integrated flux and also the flux densities of the individual regions NGC 6992/95, 6960 and 6974. They find that the total flux of the nebula at low frequencies cannot be explained by the enhanced volume emissivity of the interstellar medium resulting from the compression of the supernova shock. The difference in the break frequencies in the spectra of various individual regions could be due to their expansion in interstellar media of varying densities. In the case of IC443 the spectrum of the total integrated flux curves down at very low frequencies. This is attributed to the absorption of the radiation in the interstellar medium.

Interstellar grains

Shah has in progress the development of techniques for calculating the spherical Bessel and related functions of complex variable lying in any quadrant of the complex z-plane and of arbitrary orders. The method applies to real, pure imaginary or complex arguments. Sample results obtained for a range of arguments and selected orders in the interval 0 to 500, show that these functions for various quadrants are inter-related. The following result, not obvious analytically, has been noticed : provided that $|\ \mathrm{Im}\ Z\ |$ is large compared to unity and $|\ \mathrm{Re}\ Z\ |$ is not too near zero, the functions $J_{n+(1/2)}(Z)$ and $Y_{n+(1/2)}(Z)$ are interdependent in the sence that one can be derived from the other. This pair of Bessel functions constitutes the solution of a certain second order differential equation. It may be recalled that a second order differential equation has, in principle, two independent solutions. Furthermore, if Z lies on positive or negative Y-axis, it is seen that the corresponding Bessel functions satisfy certain simplifying special properties.

Ionized hydrogen regions in our galaxy

Sastry and his collaborators have used the Gauribidanur array to map several galactic thermal sources. Detailed observations are available for W40 and W51, and radio maps of these regions are under preparation. A detailed map of the Galactic-centre region between RA limits 17 to 19 hr and Dec limits $-10°$ to $-35°$ is being made.

Galaxies

Prabhu has continued to monitor photographically the central regions of Sersic-Pastoriza galaxies. He has obtained photographs of NCC 2903 and 5236 in B, V and

R bands at the f/13 cassegrain focus of the 102-cm reflector. He plans to repeat the photography at frequent intervals to detect long-term variability of individual hot-spots. Such variations can be caused by SN explosions in the hot-spots. The observations at 6 cm imply a high rate of SN ($\sim$ 1 per yr) in the past, within the central few hundred parsecs of the hot-spot galaxies.

Mallik re-evaluated the current rate of nucleosynthesis in the solar neighbourhood taking into account the effects of mass loss from massive stars and a steep initial mass function (IMF) observed by Lequeux. The low rate of nucleosynthesis thus obtained indicated a higher birthrate of the massive stars in the past. This constraint being in conflict with the evidence obtained from the age-metallicity relation of stars, he has suggested the alternative of a steepening of the IMF in the early history of the Galaxy. Mallik was also involved in studies of (a) planetary nebulae and their role in element enrichment of the interstellar medium, (b) carbon abundances of planetary nebulae and (c) nitrogen 14 synthesis in galaxies.

High energy astrophysics

Conformal gravity QSO models developed by Das in collaboration with J. V. Narlikar (Tata Institute of Fundamental Research, Bombay) were shown to be fairly successful in explaining the observed angular separation *versus* redshift diagrams and also in providing a natural interpretation of the phenomena of redshift bunching and alignment of quasars, like the triplet pair discovered by Arp & Hazard. Das is now examining the different possible astrophysical tests for these models on the following lines: (i) In their model the particle masses in the quasars are age-dependent and this can be used as age determination criterion for the quasars. (ii) The redshift dependence of particle masses in the quasars shows up in the luminosity of the quasar. Assuming that the continuum emission from the quasar is due to synchrotron mechanism, quasar luminosities can be estimated. (iii) The work of Arp Stockton seems to indicate two classes of quasars—one local up to 30 Mpc and the other distant up to $\simeq$ 3000 Mpc. The quasar number-magnitude counts should be able to settle this aspect. (iv) According to their theory, the quasar redshifts are assumed to be non-cosmological and therefore the quasars are nearer than their Hubble distances. Information of the column density of the intervening medium will be useful to list the validity of the "local" hypothesis.

Das is examining the possibility of a large velocity magnification produced by *in-situ* gravitational bending of light to explain the apparent superluminal expansion of QSO radio components. The velocity magnification for *in-situ* bending in the case of weak gravity turns out to be small. Since the central regions of radio sources are believed to be locations of energy mechanisms for generation of fast particles, it is likely that there are dense mass concentrations in these regions which can produce substantial velocity magnification.

Non-spherical gravitational collapse of a supermassive star in the nucleus of a galaxy leads to the formation of a blackhole that can recoil from the nucleus with a certain speed due to anisotropic emission of gravitational waves. Using this idea, Kapoor had proposed a hypothesis of the ejection of a supermassive blackhole from a galactic nucleus that captures stars and gas as it moves out and eventually emerges as a quasar-like object. The blackhole that fails to emerge out of the galaxy oscillates

through the galaxy, and exercises considerable tidal influence on the structure of the latter. Kapoor has in progress the study of the effect of dynamical friction on the oscillatory motion of the blackhole.

Solar terrestrial relationships

Hanumath Sastri has studied in detail the morphological aspects of the occurrence of M and N echoes in the equatorial region, using Kodaikanal ionograms. He finds a significant season-dependent influence of sunspot activity on the diurnal occurrence pattern of M and N echoes on equatorial ionograms. Further, from high time resolution ionogram data, he has obtained evidence to show that isolated N reflections occasionally occur on equatorial ionograms in association with short-lived secondary sporadic-E (E_s) layers at an altitude of about 140 km, well above the height domain (95–100 km) of regular E_s layers.

Sastri continued his studies of the sudden post-midnight onset of spread-F in the equatorial regions. He has obtained evidence to show that the presence of an elevated F region with reduced peak electron density does not always result in the occurrence of spread-F condition in the post-midnight period, and that this behaviour is noticeable during quiet as well as disturbed geomagnetic conditions. This finding implies that the nature and magnitude of the electron density gradient rather than the presence of an eastward electric field plays a critical role in the post-midnight onset of spread-F, if it is due to a gradient drift instability. Detailed case studies are in progress to clarify and provide a better understanding of the physical mechanism(s) and factors underlying the sudden post-midnight onset of equatorial spread-F, under varying geomagnetic conditions.

Sastri examined the origin of the highly localised nature of the occurrence of abnormal $S_q(H)$ phase in the equatorial regions. He finds that, on days with an abnormal $S_q(H)$ phase limited to the equatorial electrojet belt, perturbations in the electrojet electric field characteristic of complete or partial counter electrojet (CEJ) prevail around the normal time interval of the diurnal maximum of H field, resulting in a shift of the $S_q(H)$ phase. The observed perturbations in the electrojet field have been explained by him in terms of time varying vertical winds of limited geographical extent in the equatorial region.

Sastri completed reduction of high time resolution ionogram data obtained at Kodaikanal during the 1980 solar eclipse to $(N - h)$ profiles. Further analysis of the $(N - h)$ profiles is in progress to infer the presence of any eclipse induced AGW in the ionospheric F-region.

234-cm telescope project

Erection of the dome for 234-cm telescope project has been completed. Commissioning trials are scheduled to follow shortly. Dome-shutter opening and closing trials have been conducted. Primary mirror blank has been ground to the profile after polishing the back side and trepanning the central hole. The front surface has been polished to a sphere of 15,015 mm radius. Parabolization of the mirror has commenced. Work on the coude flats is in progress. HT electric supply sub-station at

Kavalur has been commissioned. Airconditioning system has also been tested and commissioned. Busbar erection is completed; testing and commissioning is planned in the following months. The 2.8-m aluminizing chamber has been tested and is now available at site. Commissioning of the plant will be taken up 1981 December. The telescope mount fabrication has commenced at Walchandnagar. The design of drive and control system is progressing well at BARC and at Bangalore.

A Hartmann screen has been designed to test the primary mirror. The design makes use of a square grid pattern of holes to achieve high sampling frequency and uniformity.

There is much to report on the progress in the design of electronic control and display system. The scheme of display of the sky as well as various parameters of the observing system on the TV screen have been designed, developed and tested in the laboratory.

Instrumentation

The program of development of image processing systems was continued in the electronics laboratory. Various power supplies and video amplifiers for real-time display of images were built. The work on digitizer and integration of digital images on separate memory blocks is in progress. A new photon counting system employing thermoelectrically-cooled photo multipliers and pulse amplifier-discriminator was completed in the electronics laboratory.

Jayarajan has designed an f/2 folded Bouwer system with unvignetted flat field of wide angle. The fabrication of the optical components was completed. He has commenced the fabrication of a very fast (f/0.95) folded solid Schmidt camera in fused silica for use as a spectrograph camera.

Saxena & Jayarajan have developed a new method for testing concave aspheric surfaces using two crossed Babinet compensators. The method makes use of a very general two-dimensional fit of the interference fringe data to obtain the actual wave front represented by a Zernike polynomial. This, in turn, gives the values of surface departures and the amount of abberation present in the mirror.

The 1.5-m vacuum-coating plant is now in regular operation. It was used for aluminizing the optics of the 48-in reflector of the Japal-Rangapur observatory and of the Kavalur 102-cm reflector.

Hanumath Sastri has commenced work on the development of a HF coherent phase path sounder, for operation at the solar terrestrial relationships laboratory, Kodaikanal. The instrument consists of a wideband pulse transmitter of the C4 type, a bank of phase coherent receivers, a frequency synthesizer and analog recording devices. The sounder will provide continuous and simultaneous information on the amplitude and phase variations of ionospheric reflections. The construction and testing of the prototype of the frequency synthesizer unit has been completed. Fabrication of the final version of the unit is in progress.

Scientific meetings

Dr M. K. V. Bappu attended the meetings of the IAU executive committee at Amsterdam. He also visited the observatories at Herstmonceux, Oxford,

Cambridge and Manchester during the year. Dr T. P. Prabhu attended IAU Symposium No. 96 on 'Infrared astronomy' in June at Kaiwa Kona in Hawaii and spent three weeks visiting observatories in Japan. Dr. Kameswara Rao attended IAU Colloquium No. 59 on 'The effects of mass loss on stellar evolution' in September at Trieste. Dr K. R. Sivaraman was on a visiting program at the Kitt Peak National Observatory, Tucson, Arizona and at Sacramento Peak National Observatory, New Mexico, in March and April 1981. He also attended IAU Colloquium 61 on 'Comets, gases, ices, grains and plasma' at Tucson during his stay at Tucson. Dr Parthasarathy continued with his Fellowship at the McDonald Observatory. Dr J. C. Bhattacharyya attended the meetings of the Indian National Science Academy at Varanasi, Indian Science Congress and the International Symposium on Time and Frequency in New Delhi. Drs Kameswara Rao, R. K. Kochhar and R. Rajamohan participated in the workshop on 'Nucleosynthesis' held in May 1980 at Tata Institute of Fundamental Research, Bombay. Dr Bappu, Dr Sivaraman, Dr Raju, Dr Kameswara Rao, Dr Hasan, Dr Kochhar and Messrs Jagdev Singh and Jayachandran attended the meeting of the Astronomical Society of India in November 1980 at the Physical Research Laboratory, Ahmedabad. Dr Bappu with Dr Bhattacharyya, Dr Sivaraman, Dr Raju, and Mr Jagdev Singh attended the International Symposium on Total Solar Eclipse of February 16, 1980 at New Delhi in January 1981.

Visiting scientists

Scientists who visited the Institute and its field stations and gave colloquia include Dr Muza Stoyanova of the Pulkova Observatory, Leningrad; Dr O. B. Dluzhnevskaya of the Astronomical Council of the U. S. S. R. Academy of Sciences, Moscow; Dr L. Mestel, University of Sussex; Prof. K. R. Ramanathan of the Physical Research Labaratory, Ahmedabad; Dr S. Ramadurai, Tata Institute of Fundamental Research, Bombay; Dr C. S. Shukre, Raman Research Institute, Bangalore; Dr C. R. Subramanya, Radio Astronomy Centre (T. I. F. R.) Bangalore; Dr T. Nugis, Tartu Astrophysical Observatory, Tartu, U. S. S. R.; Prof. K. D. Abhyankar, Osmania University, Hyderabad; Prof. J. B. Zirker, Sacramento Peak Observatory, New Mexico; Prof. R. K. Varma, Physical Research Laboratory, Ahmedabad; and Academician Ginzberg, P. N. Lebedev Physics Institute, Moscow.

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