INTERSTELLAR GAS :

Although neutral atomic hydrogen is the most dominant gaseous matter in interstellar space, it is very hard to observe, as there is no easy way of detecting it. It was actually detected in 1951 from the hyperfine structure in the ground state which gives rise to a transition at 21 cm, which lies in the radiofrequency region. Most of our knowledge about structure of our Galaxy and other galaxies has come from an analysis of these 21 cm observations of neutral hydrogen (Kerr 1969). In addition to neutral hydrogen, interstellar space is also sprinkled with other atomic species like Ca, Na, K, Ti, Fe etc. It is believed that all the elements that exist in our solar system are also present in the interstellar medium and with abundances comparable to it. However, lines from only a few elements have been detected, as the strongest lines of most of the elements lie in the ultraviolet region of the spectrum. Already many new lines arising from various elements have been detected and more will come within the next few years. The great importance of determining the abundances of individual elements and their isotopes, particularly those which can be destroyed at temperatures obtaining in the interior of stars, is obvious. I would not like to go into a detailed discussion of each one of them, except to say a few words about deuterium. Deuterium has also a ground-state hyperfine transition at 91.6 cm, similar to 21 cm line of hydrogen. This line was looked for by many observers but with negative results until recently. For the first time the line of deuterium seems to have been detected from the Galactic center (Cesarsky et al 1973). In addition, molecules containing deuterium, for example DCN, have also been detected. The deuterium present in interstellar space has to be primordial as there is no way of producing it. The observations however seem to be consistent with the production of deuterium in the big bang theory. There is also the possibility that it may be produced by some unknown phenomena.

CONCLUSIONS :

The whole subject of interstellar matter has to be looked upon on a new perspective. Until a few years ago, all of the information came essentially from the study in the visible and radio wavelength regions. The extension of observations to ultraviolet, infrared, and also millimetre wavelength regions has given us a vast amount of unexpected and new information about the various aspects of interstellar matter, and have posed difficult problems for an astrophysicist. Here I have tried to stress some of these. We should however keep in mind that all the results obtained so far are based on the present day techniques, where there is a lot of scope for improvement. Therefore, we may hope to expect many more results of fundamental nature in the years to come. In the end, it may be pointed out that it is also important to carry out laboratory work under physical conditions appropriate to that of interstellar space. Such studies may help us in our understanding of some of the existing puzzles in this field.

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While concluding this article, we note that astronomy is a neglected field in most Indian universities. This is a sorry state of affairs in the present space age when every scientist, at least every physicist, should have a basic knowledge about our astrophysical environment. The universities have therefore a special responsibility in the task of spreading the message of astronomy among the academic community. We hope that with the continuing support of the Osmania University authorities and the University Grants Commission, the Centre of Advanced Study in Astronomy will be able to play a positive role in the near future.

CENTRE OF ADVANCED STUDY IN ASTRONOMY

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GENERAL:

Three institutions of Osmania University viz., the Nizamiah Observatory, the Rangapur Observatory, and the Astronomy Department, together constitute the Centre of Advanced Study in Astronomy. This article briefly describes the facilities and principal activities of these institutions.

NIZAMIAH OBSERVATORY:

The Nizamiah Observatory located at Begumpet, Hyderabad (longitude $5^h\ 13^m\ 48^s.98$ E, latitude 17° 25′ 54″.3 N, altitude 554 m) was established in 1908 from the instruments donated to the Nizam's Government by a rich amateur Nawab Zafar Jung. It was transferred to Osmania University in 1919. The principal instruments and activities of this observatory are as follows:

(a) **The 8-inch Astrograph** has a photovisual doublet Cooke lens of aperture 20.3 cm and focal length 350 cm. Its guide telescope has a Grubb lens of 25.4 cm aperture and 350 cm focal length. On 16×16-cm plates, a 2°×2° field of sky is photographed at a plate scale of 1′/mm, and stars upto 13th magnitude are recorded in about 10 minutes of exposure.

The astrograph was used for the photography of −17° to −23°, and +39° to +36° zones of the Astrographic Catalogue between 1914 and 1937. Positions of about 800,000 stars measured on these plates were published in 11 volumes of the Hyderabad Astrographic Catalogue. A programme of taking repeat plates of Hyderabad zones was started in 1924 and a Blink Comparator was acquired in 1933 from the Yale University Observatory to facilitate detection of large proper motion objects. A number of stars having large proper motion and a number of star pairs having common proper motion were also discovered by comparision of the Hyderabad Astrographic Catalogue with those published by other observatories.

Lately, the astrograph has been used for photographic observations of the X-ray source Sco X-1 to study the nature of its light variations and their correlation with their variations in the X-ray region. An Eichner Astrophotometer is available for the photometry of star images and a Gaertner measuring engine with rotable plate carriage for position measurements on photographic plates upto 25×25-cm in size.

(b) **The 15-inch Refractor** has a Grubb lens of aperture 38.1 cm and focal length 490 cm. In the past, this telescope was used for visual observations of long period and irregular variable stars, and lunar occultation of stars. Now it is being used for photoelectric photometry of variable stars with a locally fabricated photometer containing an 1P21 photomultiplier.

(c) **A Hale Spectrohelioscope,** made by Howell and Sherburne, Pasadena, was acquired in 1939 for visual observations of flares, filaments, prominences etc. on the surface of the Sun.

(d) **A Transit Circle** of aperture 7.5 cm and focal-length 90 cm, two Wild-2T theodelites, and a filar micrometer are used for practical training of students.

RANGAPUR OBSERVATORY:

In 1955 plans were initiated for the procurement of a moderate size optical telescope with a grant received from the United States Government under the India Wheat Loan Exchange Programme. The order for a 1.2-m (48-inch) reflecting telescope was placed in 1957 with J. W. Fecker and Co. of Pittsburgh. After a survey of a number of sites around Hyderabad for good seeing conditions, the present site (longitude $5^h\ 15^m$ E, latitude 17° 6′ N, altitude 695 m) near Rangapur village, about 60 km south-east of Hyderabad, was selected in 1961. Two hundred acres of forest land was acquired from the State Government and construction work for Rangapur Observatory was started in 1963 with the financial assistance from the University Grants Commission, New Delhi. Besides the telescope house, an observers' lodge, a workshop building and ten staff quarters have been constructed. Although the telescope parts were received in India in 1964, due to delay in construction of the dome and buildings, the installation of the telescope could be completed only in December 1968.

The 1.2-m reflector, which is at present the largest telescope in India, has an English equatorial type mounting. The entire rotating mass of the telescope structure, weighing about 10 tons, rests on precision preloaded ball bearings at the north and south ends of the polar axis. The hemispherical dome of the telescope house is 9 metres in diameter and has two shutters which open sideways to provide a maximum slit opening of about 2.4 m.

The primary mirror of the 1.2-m telescope was made out of a 20 cm thick disc of specially annealed Pyrex glass. The mirror has been figured as a paraboloid of focal length 484.82 cm with an accuracy over the entire surface of better than λ/8 in sodium light. Four optical systems are provided with this telescope:

(a) **In the Baker system,** a Baker corrector assembly consisting of a Ross lens, a Baker corrector plate and a plate holder is placed near the prime focus of the telescope. The Baker corrector is an aspheric lens of 106.68 cm aperture, which corrects the off-axis spherical aberration of the parabolic primary, while the Ross lens of diameter 40.64 cm is a zero power combination of two lenses, which removes the curvature of field. The effective focal length of the f/3.5 Baker system is 4.29 m and a single exposure can cover a wide field of $3°\times3°$, at a plate scale of 48″/mm. Two plate holders for 10×10-inch and 5×7-inch plates have been provided.

(b) **In the Newtonian system,** a diagonal flat folds the converging beam from the primary mirror to any one of the four positions, ninety degrees apart, on the periphery of the telescope tube. The plate scale of the f/4 Newtonian system is 42″/mm. The plate holder for this focus takes 4×5-inch plates but a circular diaphragm restricts the field actually photographed to about 9 cm in diameter. This system may, however, be of limited use, because coma and astigmatism are expected to affect the image quality even at a few millimetres distance from the centre of the plate.

(c) **The Cassegrain system** is of Nesmyth type in which a diagonal flat turns the converging beam from the hyperbolic secondary by ninety degrees, towards the hollow centre-piece of the polar axis to which the following auxiliary equipments may be attached :

(*i*) For visual observations, a wide field eyepiece and a filar micrometer are provided.

(*ii*) For photographic observations, a plate adapter taking 4×5-inch plates is provided. As the effective focal length of f/13.7 Cassegrain system is 16.69 m, a $15'\times20'$ field would be photographed on these plates at a plate scale of 12″.4/mm.

(*iii*) Photoelectric observations are made with a dual channel photometer. This instrument enables simultaneous observations in two colours with two end-on type (EMI 6256 B and EMI 9558 B) photomultipliers, but it can also be used as a single channel photometer with either of the two photomultipliers. For observations of faint objects an off-axis guider is provided, and the dark current of the photomultipliers may be reduced by cooling them with dry ice or by the use of a thermoelectric cold box. The photocurrent, after amplification with direct current amplifiers, are recorded with Honeywell Brown recorders.

(*iv*) Spectroscopic observations at the Cassegrain focus can be made with a Meinel Spectrograph, which is a compact assembly of an inverted Cassegrain system as collimator, a plane diffraction grating as dispersing element, and a folded f/2 Schmidt with a field flattener lens as camera. The plate holder takes 1×3-inch plates, and two gratings blazed at 7500 Å provide reciprocal linear dispersions of 135 Å/mm and 67 Å/mm, respectively, in the first order. As a comparison source, either an Argon or a Neon discharge tube may be used. A Spectral Line Scanner type spectrophotometer and three Gaertner measuring engines are available for measurements of spectral plates.

(d) **In the Coudé system,** the converging beam from the secondary is turned southwards along the hollow polar axis by means of two diagonal flats, and is brought to focus in a double walled 9.6-m long coudé room, which will house any future coudé equipment. The effective focal length of the f/30 coude system is 36.7 m corresponding to a plate scale of 5″.6/mm.

The 1.2-m telescope has so far been used mainly for the photoelectric observations of the light curves of eclipsing binaries to study their orbital and light elements. Future programmes contemplated with this telescope include :

(*i*) Spectral classification and radial velocity investigations using Meinel Spectrograph. (*ii*) Optical identification, photometry and spectroscopy of quasars, pulsars, X-ray sources, etc. (*iii*) Study of emissions from the Earth's outer atmosphere and the dark side of Venus using a Fabry Perot interferometer. (*iv*) Spectroscopic studies of planetary atmospheres and infrared sources, using an infrared spectrometer at the coudé focus.

ASTRONOMY DEPARTMENT :

With the financial assistance from the University Grants Commission, a department of Astronomy was started by Osmania University in 1959, and at present this is the only department in India which offers courses leading to an M.Sc. degree in Astronomy and Astrophysics. Since 1964, this Department, along with the Nizamiah and Rangapur Observatories, has been recognized by the University Grants Commission as a 'Centre of Advanced Study in Astronomy'. The main teaching and research activities of this Centre are as follows :

Astronomy is offered as one of the subject in the 3-year B.Sc. course in combination with Physics and Mathematics. The M.Sc. course is of 3-year duration and graduates who have passed B.Sc. with Physics and Mathematics are eligible for admission, but candidates who have studied Astronomy in B.Sc. may be admitted directly to the second year of the 3-year course.

At this Centre, facilities are available for Ph.D. and post-doctoral research work in several theoretical and observational branches of astronomy and astrophysics. Research workers, taking up observational problems, make use of the facilities of Nizamiah and Rangapur Observatories. An IBM 1620 computer at the Regional Research Laboratory, Hyderabad is being used on rental basis for the computational work. The library contains a good collection of publications of different observatories besides the books and journals in astronomy and related fields. A number of scholarships and fellowships awarded by the University Grants Commission are available for the M.Sc. and Ph.D. students, and for post-doctoral work at this Centre.

We have already discussed the observational research programmes of this Centre while describing the work of Nizamiah and Rangapur Observatories. Theoretical research is at present being conducted in the fields of Dynamics of Galaxies and Radiative Transfer.

Besides holding seminars and symposia on special topics from time to time, the Centre invites individual astronomers and scientists from other institutions to give lectures on topics of their specialization.

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