Bull. Astr. Soc.India (1997) **25**, 7-17

Silver Jubilee Article

Growth of the Centre of Advanced Study in Astronomy at the Osmania University

K. D. Abhyankar

Astronomy Department, Osmania University, Hyderabad 500 007, India

Abstract. After giving a brief historical introduction, the 48-inch telescope project is traced through its different phases of site survey, construction of the dome and installation of the telescope. Then follows a review of the academic programmes of teaching and research at CASA. The narration ends with the description of some special events at the centre during the last 40 years.

1. Introduction

The development of Astronomy and Astrophysics in Andhra Pradesh in the second half of the twentieth century is synonymous with the growth of Astronomy at the Osmania University. During this period, the Nizamiah Observatory, which celebrated its Platinum Jubilee in 1983, grew into Japal-Rangapur Observatory, and the Astronomy Department of the Osmania University, which celebrated its Silver Jubilee also in 1983, was recognized as the Centre of Advanced Study in Astronomy by the University Grants Commission. We shall, therefore, review the activities at the Osmania University.

Foundations for the renovation of the astronomical facilities at Osmania University were laid in the late 1950's by the then Vice Chancellor, Professor S. Bhagawantham, and Dr. Akbar Ali, the then Director of Nizamiah Observatory, The University Grants Commission, under the Charimanship of Dr. C. D. Deshmukh, was contemplating to give support to Astronomical teaching and research in Indian universities by establishing Astronomy Deparmtents at two universities, one for theoretical studies and the other for observational research. While the Delhi University, where the well-known Astrophysicist Prof. D. S. Kothari was the Head of the Physcis Department, was selected for theoretical astrophysics, the claim for an observational centre was put forward by the Osmania University which was running the Nizamiah Observatory from its inception. Although the observatory was estabished, by a

* Based on a talk given at the Seminar on 'Twenty-five years of Progress of Science in Andhra Pradesh' held by the Andhra Pradesh Academy of Science in December 1988.

'Firman' of the Nizam in 1908, with two telescopes - fifteen inch Grubb refractor and an eight inch astrograph - donated by an enthusiastic amateur astronomer Nawab Jafar Jung Bahadur, it was transferred to the control of the Osmania University since its establishment in 1918. The Nizamiah observatory had done yeoman's service in executing the international programme of carte-di-ciel and publishing thirteen volumes of the Astrographic Catalogue covering 800,000 stars in the Hyderabad zones of the sky under the guidance of its Director, late Shri. T. P. Bhaskaran. The UGC, therefore, agreed to upgrade the observational facilities of Nizamiah Observatory and start an M.Sc course in Astronomy at the Osmania University. Both of these activities centred around the acquistion of a modern telescope for research and training purposes.

2. The 48-inch telescope project

(a) *The beginning:* In 1956 the University Grants Commission sanctioned a sum of Rs. 12.5 lakhs, including a grant of US $ 1.5 lakhs made available by the US Government under the wheat Loan Educational Programme (PL 480), for acquiring a modern telescope. Order for a 48-inch reflector telescope was placed with Messr. J. W. Feckers Inc. of Pittsburgh, USA, in October 1957. Dr. J. J. Nassau, Director of Warner Swasey Observatory of Cleveland, Ohio, kindly agreed to act as the consulting astronomer to supervise the optical performance of the telescope. Preparations for creating the infrastructure at Hyderabad began soon thereafter, however several obstacles delayed the completion of the project, the principal among them was the crisis of personnel.

Dr. Akbar Ali, who had initiated the project, died on Feb. 7, 1960. His place was taken over, on April 12, 1960, by Dr. A.K. Das who had retired shortly before as the Director of Kodaikanal Observatory. Unfortunately Dr. Das also died on Feb. 18. 1961 before completing even one year of his three year contract. Consequently, the Osmania University appointed Dr. R. V. Karandikar, who was working at the Air Force Research Station in Cambridge, Massachusetts, as Director of the observatory and Head of the Department of Astronomy, in April 1961. But he did not join until June, 1963, causing a lot of confusion and difficulties for the University for a long and crucial period of about two-and-half years. There was a third death viz. that of Dr. Nassau, in May, 1965, just before his planned visit to India to assist in the installation of the telescope. Dr. A.B. Meinel, Director of the Optical Sciences Centre of the University of Arizona was then approached and he agreed to work as a consulting astronomer for the 48 inch telescope project.

(b) *The site survey*: Originally the 48-inch telescope was proposed to be installed in the Osmania University campus. However, on a visit to the United States by Dr. Laroia, the then Secretary of the UGC, he was advised by the astronomers there, particularly by Prof. F. Zwicky that the telescope should be located at a site far away from the city to avoid the glow of city lights which interfere in astronomical observations. Consequently Dr. A.G. Wilson, a former staff member of Mt. Wilson Observatory and the Director of Lowell Observatory arrived in India in December, 1959 for a six week visit to assist in the selection of a suitable site. The author of this article joined him in the effort in January, 1960 and took over the full responsibility of this task after Dr. Wilson's departure in February, 1960, continuing the site survey for a full one year.

A large number of sites within about 50 km of Hyderabad (see Fig. 1) were tested for clear skies as well as transparent and turbulent free atmosphere. In this effort I had the opportunity to get acquainted with the surroundings of Hyderabad in all directions: upto Bhongir in the east, Malkapur in east-south-east, Rangapur in south-south-east, Shad nagar in south-south-west, Narsapur/Basreddipalli in north-north-west, Pargi and Anantagiri in the west and Mulug in the north. It was found that the climatic conditions like cloud cover and wind speed were more or less similar over the wide area. But seeing and transparency were generally somewhat better in the east and south and somewhat worse in the north and west. On the basis of a preliminary survey it was decided to concentrate on the sites short listed in Table 1.

Observations of the pole star were taken simultaneously with two 4-inch telescopes, one placed at the site and the other at the Nizamiah observatory. Three parameters were noted on an hourly basis, viz. (1) Seeing based on the visibility and structure of the diffraction rings around the pole star with a scale from 0 (worst) to 5 (best); (ii) Transparency based on the visibility of the faintest stars with the naked eye on the scale of 0 (worst) to 3 (best), and (iii) Scintillation estimated by looking at the stars near the horizon again on the scale of 0 (worst) to 3 (best). They are given in Table 1.

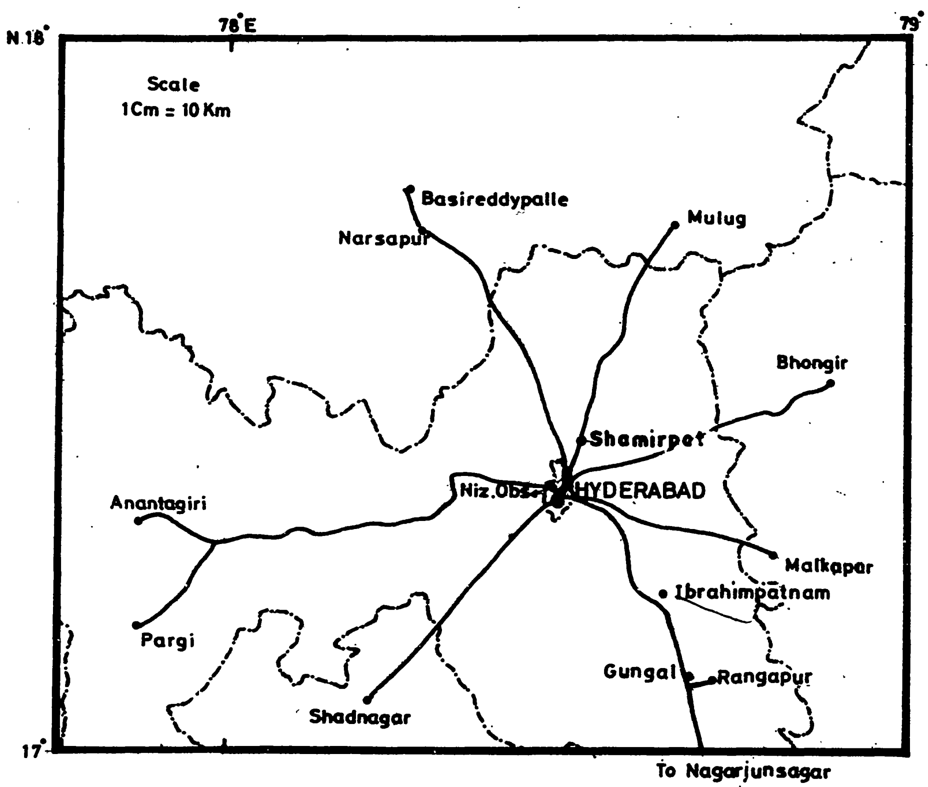

Figure 1. Site survey around Hyderabad.

On the basis of these data Malkapur, Narsapur and Basreddipalli were rejected outright. Of the remaining two sites Shamirpet was not considered suitable on account of its closeness to the city and consequent large city glow in the southern direction which is towards the center of the Milky Way. On the other hand the site near Rangapur village in the Ibrahimpatan

Table 1. Relative indices for selected sites.

Site	Distance from city limit in km	Elevation (ft).	No. of visits (Jan-Oct 1960)	Total Wt of observations (6, 4, 2 for good fair & poor)	Comparision (site vs N.O.) Transparency scale 0 to 3 (3-best)	Seeing scale 0 to 5 (5-best)	Scintillation scale 0 to 3 (3-best)
Narsapur	40	1900	9	22	+0.20	-0.40	–0.25
Basreddipalli	65	2360	9	27	–0.15	–0.15	–0.20
Rangapur	45	2300	14	40	+0.30	+0.40	+0.40
Malkapur	38	1800	14	50	+0.10	–0.30	–0.20
Shamirpet	10	2000	20	43	+0.20	+0.45	+0.55

taluq which is 45 km SSE of Hyderabad, had a nice plateau on the hilltop - a rare landscape in Telangana. The city glow was confined to the north, away from the center of the Milky Way. Being in the interior, the region around Rangapur was less likely to develope industrially and otherwise in the near future. (This turned out to be incorrect after 35 years). However, since there was no power line running to Rangapur, a site called Mulug in the direction of Shamirpet but farther from the city was chosen in the state forest on the range north of Narasampalli for intensive observations in December, 1960. It had observing conditions similar to those at Shamirpet. The city glow was somewhat, less than at Shamirpet, but more than that at Rangapur which was shielded due to the location of Hyderabad in the valley of the Musi river. Further, there was no approach road to Mulug inspite of it being close to the power line running towards Siddipet.

It was, therefore, decided to give Rangapur the top priority. The site was later approved by Professor S. Chandrasekhar, who visited Osmania University in 1961, with the comment that it was as good a site as he had seen elsewhere. So, about 200 acres of forest land was acquired from the Andhra Pradesh Government at a nominal price of Rs. 2,000/- only. The Andhra Pradesh Government also provided an approach road and an electrical power line up to the observatory site. A small area at the top of the hill was cleared and the North-South line was established in 1963.

There was a small drama about naming the new observatory. The local name for the hill is Venkalgutta which has a bad connotation in the telugu language. Hence it was decided to call it the Rangapur Observatory, However, it happens that although the hill is close to Rangapur village it falls within the jurisdiction of Japal village which is farther away. So the Japalians protested and demanded that the observatory be called the Japal observatory. They even approached the Chief Minister for this purpose. Finally a compromise was reached and the name Japal-Rangapur Observatory was ultimately accepted. Even after this the villagers would wipe out from the road signs one of the two names which they did not like. Hence now all road signs mention plain Observatory although officially it is called the Japal-Rangapur Observatory.

(c) *Construction of the dome* : The 48-inch telescope requires a dome of 36 to 40 feet diameter. A large dome of this size was not previously constructed in India. Hence this part of the project passed through several vicissitudes which caused delays and shortcomings, but the experience proved to be of great educational value in the construction of similar large domes, later, at other observatories in India.

The original plans of the dome were prepared by Ashok and Vanguard Company of Hyderabad in consultation with Dr. A.K. Das. After the death of Dr. A. K. Das the Osmania University appointed a committee consisting of late Dr. K. R. Ramanathan and Dr. M.K. Vainu Bappu to took into the matter. They suggested several alterations and the construction was finally started in 1962. After about one year it was found that Ashok and Vanguard Co. could not make much progress due to lack of experience. Hence the work was handed over to Shri Engineering Company of Bombay with Mr. K. V. Kini serving as consulting engineer. Even this firm did not complete the job and some modifications were later executed by Gupta and Company of Hyderabad. But the dome drive was not ready even in 1966 for which another firm, Rotodyne of Hyderabad owned by Mr. K. Bernikar, was employed and they completed the job in 1968.

(d) *Installation of the telescope :* The construction of the telescope house and other buildings at the new site near Rangapur started in 1963 and was completed in the following two years The telescope parts were received in India in December, 1964. The mechanical parts were assembled in the telescope house in November, 1966 during the first visit of Dr. A.B. Meinel. But the assembly of the optical and electronic components had to be postponed as the dome drive was still not ready. The installation of the telescope was finally completed by the Fecker engineers two years later in December 1968 when the first star images were also obtained. The optical alignment of the telescope was checked by Dr. Meinel during his second visit in November, 1969. The polar axis alignment was checked and corrected later by the observatory staff by inserting a half inch plate at the south end during late 1970. Finally the regular observations were started from January, 1971.

The whole project, thus, took a long period of 15 years for its completion.

3. The Centre of Advanced Study in Astronomy

(a) *The academic programme:* Although the Director of the Nizamiah Observatory used to teach Spherical Astronomy to B.A. and B.Sc. students of mathematics since 1935, there was no separate Astronomy Department at the Osmania University. With the financial support from the U.G.C. a separate Astronomy Department was started in 1958, and for more than twenty years it remained the only Astronomy Department in a university setup in the country. First, a 3-year B.Sc., course with Mathematics-Physics-Astronomy (MPA) combination was started in the academic year 1959-60, and a 1-year Pre-M.Sc. course was introduced in 1960-61. The regular M.Sc. course in Astronomy was started from the academic year 1961-62. The author was deeply involved in forming these courses. While the other two courses were discontinued, the M.Sc. course is being offered continuously since then except for a gap of two years during 1980-82. Recently, two more courses, namely M.Sc. in Astrophysics and M.Sc. (Physics) with Astrophysics specialization have been introduced and are being received well. About 100 students have obtained their M.Sc. degree while about 30 candidates have received Ph.D. degree in Astronomy and Astrophyscis during the last 35 years. In the Fifth Five-year plan, the U.G.C. had sanctioned ten fellowships under the Faculty Improvement Programme to the Department. Under this scheme 15 teachers obtained the M.Phil. degree in the subject and half of them continued to complete their Ph.D.

In 1964, the U.G.C. recognized the Astronomy Department and the Nizamiah and the Japal-Rangapur Observatories together as the centre of Advanced Study in Astronomy (CASA). The CASA received several posts as well as recurring and non-recurring grants for 15 years, upto 1980. In addition to providing funds for equipment and contingencies the U.G.C. granted four National scholarships for M.Sc. students, four Junior Research Fellowships and two Senior Research Fellowships every year during this period. It was this kind of assistance which sustained the centre till that time.

(b) *Research activity:* It is not possible to cover the whole gamut of research work done at CASA during the last 3 decades in a short space. Hence, I shall concentrate only on a few salient features.

(i) *Observational research:* The 48-inch telescope has been provided with three accessories viz. a 42-inch Baker corrector system for wide field photography, a duel-channel photometer for measuring the brightnesses of stars, and a Meinel spectrograph for obtaining stellar spectra. The Baker corrector system could not be used effectively because the Fecker company, which had no experience of building a large telescope of this size, did not provide a good drive and a guiding telescope, which are essential for photographic work. The photometer and the spectrograph have been and are being used for observations of eclipsing and variable stars by the group consisting of K.D. Abhyankar, M.B.K. Sarma, N.B. Sanwal, G.C. Kilambi, P. Vivenkanandarao, their students and other research staff.

Photometric and spectroscopic study of eclipsing binaries is important because it provides the masses and radii of stars, which are vital inputs for the theories of the structure and evolution of stars. The astronomers at CASA have concentrated on two types of binaries: the algols and RS CVn's. About two dozen stars have been extensively studied as detailed in the article by M.B.K. Sarma in one of the Silver Jubilee issues of BASI.

The first group of binaries i.e. the algols tell us about the effect of mass transfer between components or mass loss from the system on the evolution of the two components of the binary. Study of typical stars like TT Hydrae, R CMa etc. at CASA has shown that they consist of a small but massive and hot bright component and a less massive and cooler star of large radius. Since this is contrary to what one expects from the theory of evolution of single stars, one has to conclude that the present less massive star was originally the more massive component and it has arrived at its present giant configuration by loss of mass either to its companion or into the interstellar space. This phenomenon is accompanied by changes in the periods of the binaries, so studies of period changes have also been carried out by T. Panchatsaram and K.D. Abhyankar. In a few cases, they have revealed the presence of a third body in the system. As the binary revolves around the center of mass of the triple system the eclipses come earlier or later as happens in the case of the eclipses of the satellites of Jupiter.

The second group of binaries contain sun-like stars which have large dark spots on them. In the case of the sun the spots are small and they do not reduce the light of the sun significantly. However, in RS CVn type stars the spots are large enough to make the star appreciably dim when the spot passes over the center of its disc. As the star rotates the spot is carried along causing a wave like variation in the brightness of the star. By studying the waves it is found that the spots migrates over the stellar surface in forward or retrograde direction.

While observing eclipsing binaries, which show periodic changes in brightness due to eclipses, one needs to observe some comparison stars which remain constant in brightness. Twice during our observations it was found that the comparision star itself was changing in brightness. In this way CASA astronomers have been able to discover two new eclipsing binaries (SX CrV and HD 8357) and one Cepheid (BV 690).

Some stars vary in brightness because they are undergoing pulsations, and some show flaring activity in the visible as well as X-ray wavelengths. In collaboration with TIFR scientists CASA astronomers have also observed such stars in the visible and infrared wavelengths. Observations of a few Be stars indicated some of them to be variable.

In the recent years, the 48-inch telecope has also been used by S. Sreedhar Rao for the spectrophotometric and MK Morphological studies of peculiar and metallic line stars which has led to the discovery of an intermediate class of objects with 41 Sex A as its prototype. Observations of a few binaries with the Meinel spectrograph by Sreedhar Rao and Raghavender Rao have provided new radial velocity curves and elements for their orbits.

(ii) *Theoretical research:* The CASA also has groups working on two theoretical topics viz. collisions of galaxies and transfer of radiation in stellar and planetary atmospheres.

When two galaxies come close to one another the tidal forces acting between them produce a host of phenomena. For example, one of the galaxies may be completely disrupted. Alternatively, they may merge together, a ring structure may be formed around one galaxy, or the stars leaving a galaxy may form either a tail or a bridge between the two galaxies. Various cases of this type have been studied by the group consisting of S.M. Alladin, K. Shankara Sastry, G.M. Ballabh, P.V. Subrahmanyam and the ex-teacher Fellow, K.S.V. S. Narasimham. For more details see article by S.M. Alladin in one of the Silver Jubilee issues of BASI.

K.D. Abhyankar has extended Chandrasekhar's work on the formation of absorption lines in moving atmospheres and has shown how the bewildering variety of lines Epsilon Aur can be obtained in this way.

Effect of Rayleigh scattering on the profiles of molecular lines of the planets have been studied by K.D. Abhyankar and R.K. Bhatia. They found that in the case of Venus, Rayleigh scattering is important in the top layers of the venusian atmosphere where lines are formed while aerosol or Mie scattering predominates in the deeper layers where the continuum orginates. This work has been extended to the lines of the telluric bands by K.D. Abhyankar in collaboration with K.E. Rangarajan and D. Mohan Rao of the Indian Institute of Astrophysics.

In addition Praveen Nagar and K.D. Abhyankar have shown that a star spot model gives a better fit to the spectroscopic and photometric variations in the peculiar A type star α^2 CVn as compared to the oblate spherical model.

(iii) *Development* In this area R. Swaminathan has built two instruments under the guidance of R.V. Karandikar and K.D. Abhyankar. One is a Czerny-Turner type scanning spectrometer and the other is a high dispersion Echelle spectrograph with image tube detection, both for use at the Nasmyth focus of the 48-inch telescope for the study of several chemically peculiar stars. Some of these show that hot spots contain an over abundance of iron peak and rare earth elements.

(c) *Future prospects* With the stoppage of the UGC assistance to CASA in 1980, it became increasingly difficult to maintain and run the Japal-Rangapur Observatory in an efficient and professional manner. The Andhra Pradesh Government also could not come to its rescue due to its own financial constraints. A proposal to make the Japal-Rangapur Observatory, a National Centre for use by all Indian Universities was mooted by the UGC in 1982. However it did not take off the ground. On the other hand UGC has provided funds for the modernization of the 48-inch telescope under its Special Assistance Programme.

4. Special Events

The period under review contains two special events of astrophysical importance viz. the total solar eclipse of 16 February 1980 and the appearance of Halley's comet in 1985-86.

(a) *The Total Solar Eclipse of 16 February 1980:* At the time of a total solar eclipse the shadow of the moon covers the main disc of the sun and we can see its outer atmosphere which consists of a thin layer of chromosphere and the tenuous but extended corona. As these features can be observed well only during a total solar eclipse, astronomers travel to the remotest and often inaccessible corners of the globe for observing that event. The path of totality of the total solar eclipse of 16 February 1980 passed over well populated parts of Africa and India. In particular the Japal-Rangapur Observatory was located within the path of totality, and many astronomers were eager to make use of this good opportunity. So CASA was host to about 40 astronomers from USA and 25 scientists from other Indian institutes including PRL, SAC, NPL and Udaipur Solar Observatory, who had set up equipment at JRO to conduct their experiments. About 20 members of the staff and students from the Zoology Department of Osmania University also carried out experiments at JRO to observe the influence of the total solar eclipse on plants and animals. Teams of Andhra Pradesh Film Development Corporation and Doordarshan kendra of Hyderabad took movies of the solar eclipse which were later shown on T.V. Another suitable site for observing the eclipse was found to be the Palem village in Mahboobnagar district which was used by the astronomers from the Uttar Pradesh State Observatory. Some foriegn astronomers and a group from CASA also had set up their experiments at Palem.

The CASA astronomers conducted the following experiments during the total solar eclipse:

(i) Under a research project sanctioned by ISRO the 8-inch astrograph was shifted to JRO to photograph the sun during the total phase of the eclipse for testing Einstein's theory of gravitation. This experiment was not successful due to the scattered light in the telescope which fogged the plate.

(ii) Polarization studies of the solar corona in red and blue light for determining the electron densities were made by using two 4-inch telescopes with polaroids, mounted piggyback on the 48-inch telescope. This formed the subject of the Ph.D. thesis submitted by Anthony Raju, a Teacher Fellow at CASA.

(iii) Under another project sanctioned by the UGC and in collaboration with PRL, Ahmedabad, total solar eclipse measurements were made at 5, 10, 19 and 22 GHz at JRO by B. Lokanadham.

(iv) Measurements of the changes in the total electron content of the upper atmosphere were made at Nizamiah Observatory where 98 per cent of the sun was eclipsed.

(v) A Fabry-Perot etalon system to photograph the sun's disc in the green coronal line of iron was set up at Palem.

(b) *Apparition of Halley's Comet:* Halley's comet had provided a grand spectacle during its last apparition in 1910, because, then, at the time of its closest approach to the sun, it was placed favourably between the sun and the earth, and the earth actually passed through its tail. During 1985-86 the circumstances were quite unfavourable, because at the closest approach the comet was placed behind on the other side of the sun. But the popular interest in it was aroused considerably, because the Russians, the Europeans and the Japanese were sending space probes to its vicinity for its *in situ* detailed study. And they needed the back up observations from earth stations. Hence a worldwide network was established under the International Halley Watch (IHW) Programme and Indian astronomers also participated in it. At CASA they made three kinds of observations.

(i) Direct photography with the 8-inch astrograph, which was shifted to JRO for the 1980 eclipse, and with the Baker corrector system of the 48-inch telescope, which was used then for the first time to photograph a celestial object. The positions of the comet obtained by CASA staff M. Ballabh & N.B. Sanwal) were communicated to the IHW data centre where they were incorporated in the general pool for deriving the improved orbital elements of the comet. These were used for correcting the trajectories of the space crafts on their way to Halley Comet.

(ii) Photometry was carried out by M.B.K. Sarma and P.Vivekananda Rao through the standard filters supplied by the IHW for isolating the bands of C_2, C_3, CN, and H_2O molecules. These observations gave information about the production rates of these molecules.

(iii) R. Swaminathan used spectroscopy in the visible and ultraviolet regions through the Meinel spectrograph for studying the variation of temperature and concentration of CN in the comet with the change of its distance from the sun.

(c) *Seminars and Conferences:* The following meetings have been held at CASA since it its inception:

1. A seminar on 'Optical astronomy with moderate sized telescopes', 18-19 Nov. 1969. (Proceedings edited by R.V. Karandikar, S.M. Alladin and K.S. Sastry).
2. A Symposium on the 'Spectroscopic studies of astrophysical interest', 16-18 Aug. 1972. (Proceedings edited by R.K. Asundi and K.D. Abhyankar).
3. A seminar on 'Infrared and millimeter range astronomy', 25-26 Feb. 1974. (Proceedings edited by S.M. Alladin and K.D. Abhyankar).
4. The first Annual and Scientific meeting of the Astronomical Society of India, 27-28 Feb. 1974.
5. A Workshop on 'Training requirements of astronomy in India', 27-30 Dec. 1977. (Proceedings edited by K.D. Abhyankar and N.B. Sanwal)
6. The Platinum Jubilee Symposium of Nizamiah Observatory on 'Binary and multiple systems', 22-24 Nov. 1983. (Proceedings edited by K.D. Abhyankar and G.M. Ballabh).
7. The Ninth Annual and Scientific meeting of the Astronomical Society of India, 22-24 Nov. 1983.
8. An International workshop on 'Binary stars and stellar atmospheres', 7-11 Aug. 1989. (Published in Bull. Astr. Soc. of India, Vol. 18, pp 109-376, 1990)
9. The Ninth Space Sciences Symposium, 7-10 Feb. 1996.

5. Conclusions

While concluding this review of the development of Astronomy and Astrophysics at the Osmania University it will be interesting to compare it with the progress elsewhere.

As far as India is concerned we have witnessed the installation of two 40-inch telescopes, one at Nainital and the other at Kavalur, the large radio telescope at Udhagamandalam, the 94-inch optical telescope at Vainu Bappu Observatory and the 48-inch infrared telescope at Gurushikhar on Mt.Abu. An ambitious project of building a Giant Meter Wave Radio Telescope at Narayangaon near Pune is nearing completion. But the space astronomy has been limited to a few balloon flights carrying x-ray and infrared instruments. An X-ray payload has been recently placed on board IRS-3 by ISRO and TIFR scientists.

On the international scene, the advent of satellites and space probes have completely revolutionized the exploration of the solar system and the observations of the stars and galaxies in the invisible and normally inaccessible parts of the electromagnetic spectrum like the ultraviolet. X-ray and gamma-ray domains. While the Americans have already launched the 90-inch Hubble telescope in space, the Russians and Americans are jointly preparing to send manned space missions to Mars and its satellites. We, in India, thus appear to be in the bullock cart age in comparison to the jet age. This situation can be changed only if Astronomy is given a pride of place in our science curriculum by making it an integral part of Physics. This will, most likely be accomplished by the Inter University Center for Astronomy and Astrophysics established by the UGC in the Pune University campus.