IUCAA:
A NEW EXPERIMENT FOR INDIAN UNIVERSITIES

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Abstract. After India became independent in 1947, there was a great thrust for science and technology and a large number of R&D laboratories and research institutes came up. However, this movement was mostly outside the traditional university sector, which as a result suffered in its own development. To redress the balance, the University Grants Commission began creating, in the 1980s, centres of excellence in specific areas which had so far been neglected in the universities. Of these centres, the Inter-University Centre for Astronomy and Astrophysics (IUCAA) is described in this chapter. Founded in Pune in 1988, the IUCAA has centralized research aids and facilities for use by the visiting university academics. To facilitate these visits IUCAA runs an associateship programme and also conducts schools and workshops round the year. It also assists the university academics in formulating guest observing proposals for major observing facilities. The success achieved by IUCAA in the relatively short lifespan of a decade is highlighted as an example of optimization of limited resources in a developing nation.

1. Historical background

In 1947, when India became an independent nation, it already had a reasonable base for higher education, in the form of about 22 universities all over the country. A typical university had departments covering a range of subjects from the liberal arts to sciences. A few universities had faculties of engineering. However, the fraction of the population enjoying the privilege

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of higher education was very low and there was a great need for expanding the university system.

Subsequent decades therefore saw not only a rise in the number of universities, but also a growth in the size and membership of a typical university. To give one example, in the pre-independence era, there was only one university catering to the region now identified with the Western state of Maharahtra. Today, the region has ten universities at Bombay (now called Mumbai), Pune, Kolhapur, Nagpur, Aurangabad, Nanded, Jalgaon, Amravati and Wardha, not counting several agricultural universities, specialist universities and other institutions deemed to be universities.

The first Prime Minister of India, Jawaharlal Nehru was a visionary who appreciated the importance of science and technology not only for the development of the new nation but also, through basic research, for developing a measure of self-reliance in the persuit of science. It was with his active support and patronage that scientists like Homi Bhabha and Shanti Swarup Bhatnagar were able to set up a scientific research infrastructure all over the country.

In 1946, a year before independence, Bhabha had started the Tata Institute of Fundamental Research (TIFR), to encourage research in selected fields like pure mathematics, cosmic-ray physics and the theory of atomic nuclei and elementary particles. In the initial few years it was mainly supported by the Dorab Tata Trust, one of the philanthropic trusts set up by the industrial house of Tatas. After independence, within a few years it began to receive major support from the Government of India and as seen by Bhabha it became the precursor of India's Atomic Energy Programme, many of its scientists having earlier worked in the TIFR. Indeed today the Department of Atomic Energy not only manages this programme but also funds, apart from TIFR, several other autonomous institutions carrying out research in basic sciences.

The trend started by Bhatnagar was to evolve into a network of laboratories which would interact with industries and carry out R&D in numerous fields of interest to industry. The Council of Scientific and Industrial Research is the outcome of those pioneering efforts and it now controls the biggest network of scientific laboratories in the world. There are other scientific departments of the Government of India today, like the Departments of Science and Technology, Biotechnology, Space, Defence, etc. which have their own scientific laboratories.

Significantly, all these developments in the post-independence era took place *outside* the university sector. The model of an autonomous research institute (ARI) gradually took shape out of the pattern set by the TIFR. As mentioned above it is funded by a scientific department, and within the guidelines set by the department, it operates with a certain measure

of autonomy. It has an apex body (or bodies) like a Governing Board or Management Council to decide the major policies of the institute, to make the main appointments and generally monitor its academic and financial progress. The scientists, who are the prime movers of an ARI, are dedicated to their research projects and *unlike their university counterparts*, can devote all their time to research. This last difference is important. A university academic is expected to carry out teaching as well as research. The typical ARI scientist has practically no teaching commitment except for sharing any teaching in the (usually small) graduate school of the ARI. On the other hand he has access to research facilities set up at ARI.

It is debatable if it was a right decision to so bifurcate the university system from the ARIs. In retrospect the answer seems in the negative. For, by concentrating the limited resources available for research outside the university sector, it deprived the universities of opportunities for high-quality research. Although limited funds were available to the universities for experimental work, their generally low level of infrastructure made it difficult for them to maintain costly equipment, and in general increased their isolation from the mainstream research by making it hard for the university academics to participate in important and topical meetings or to invite experts from other places for discussions and reviews.

The ARIs also suffered, since their scientists had very little contact with the undergraduate population, with the result that they began to find it increasingly more difficult to attract students for their inhouse PhD and postdoctoral programmes. This shortage of motivated young scientists has today become a cause of serious concern for most ARIs.

A solution to this double difficulty lies in increasing collaborations between the ARIs and universities, whereby the staff from the former can lecture to the students of the latter, and the staff from the latter get opportunities to use the experimental equipment of the former. The concept of Inter-University Centres was born out of a desire to forge such symbiotic relationships.

2. The Inter-University Centres

The trend towards sharing and cooperation between universities, institutions, even nations became well established the world over, in the last quarter of the twentieth century. CERN laboratories for particle physics or the European Southern Observatory for astronomy are examples of international cooperation. In the United States, the Association of Universities for Research in Astronomy is a cooperative organization which runs major telescopes, including the Hubble Space Telescope (which it does under contract for NASA).

The reasons for such cooperative enterprises are twofold. Firstly, no single member of the organization can afford to put up the facility on its own. And secondly, even if it did so, it may not be able to generate sufficient usership, to make the facility worthwhile. For this purpose, the shared mode is the best solution.

In the 1980s, the University Grants Commission (UGC), which is the major funding agency for the university sector in India, felt the need to have autonomous centres of excellence of its own to provide access to advance research and developmental facilities to the universities on a shared basis. By a new act of parliament, the UGC acquired powers to create such centres. A typical centre came to be called an 'Inter-University Centre' or briefly, an IUC.

The IUC-experiment started in the mid-1980s and the first IUC to come up was the Nuclear Science Centre (NSC), in 1988, centred around the 15 MV Tandem Van-de-Graaf nuclear accelerator. The machine was unique to the Indian university sector and was set up (along with other follow up facilities) to help research in certain aspects of nuclear physics. The NSC is located in the campus of the Jawaharlal Nehru University in New Delhi.

The second IUC was set up in the campus of Pune University, and was the Inter-University Centre for Astronomy and Astrophysics (IUCAA), which we will highlight in this chapter.

The third IUC was the Inter-University Consortium for the Department of Atomic Energy Facilities (IUCDAEF), set up in the campus of Ahilyabai University, Indore, in central India. Through this centre universities have access to the reactors and accelerators of the Department of Atomic Energy.

Three other IUCs, created in the 1990s, are more in the nature of service providers. The Centre for Educational Communication (CEC) generates educational programmes on TV and also helps run the educational channel. The National Assessment and Accreditation Council (NAAC) provides mechanism for evaluating and grading the performance of universities and other educational institutions. The Information and Library Network (INFLIBNET) is networking library and information databases so as to facilitate access to these by universities. The CEC is in Delhi, the NAAC in Bangalore and INFLIBNET in Ahmedabad.

Having described the IUC-setup in general we now turn to IUCAA, which has brought about a see-change in research, development and teaching in astronomy and astrophysics in the Indian university sector.

3. The setting up of IUCAA

The Project Report (PR) of IUCAA prepared in 1988 gives the initial steps that led to the setting up of the centre, its rationale, modus-operandi, en-

visaged infrastructure, etc. In the PR Foreword, the then UGC Chairman Yash Pal expressed the following desirable characteristics of a typical IUC:
a) The Centre must develop into a world class centre of excellence.
b) Its management, both at the top and at a working level must involve a number of universities.
c) When stable, its core staff should be a minor fraction of the total academic population of the centre at any one time.
d) The Centre should provide a quality of academic and experimental environment which is not easily available to the university community in their own place.
e) The coming and going of university participants should be painless, even pleasurable, with least administrative bottlenecks.
f) The university community should begin to see it as a place to learn, get new ideas, set up collaborations and to develop and use facilities that they and others can benefit from.

These expectations admirably summarize the rationale of setting up IUCAA and also provide benchmarks for judging its performance to date. This account will have occasion to refer to these benchmarks from time to time. But, how did we go about setting up something, the likes of which never existed either in India or abroad? The following calendar records steps which were significant in the historical development of IUCAA, leading to its founding on December 29, 1988.

• In 1984 through efforts of mathematics faculty member Naresh Dadhich, the University of Poona (PU, now University of 'Pune') made a proposal to the UGC to set up an advanced centre for astrophysics.

• In 1986 a decision was made by PU and the Tata Institute of Fundamental Research (TIFR), Bombay to site the centre for the Giant Metrewave Radio Telescope (GMRT) in the PU campus, the GMRT itself being located at Khodad, about 85km from there.

• The UGC Chairman Yash Pal felt that an IUC in astronomy and astrophysics could be located in the PU campus, in lieu of the more limited PU proposal to have an astrophysics centre of its own. Such an IUC would serve to facilitate participation of university academics in the GMRT facility. To this end on September 23, 1987 a brainstorming session was convened at TIFR in which Vice-Chancellor of PU V.G. Bhide, the Director-designate of the GMRT centre Govind Swarup, Naresh Dadhich and a few other scientists from PU and TIFR, including myself, participated. These discussions served to crystallize the basic structure of IUCAA.

• On October 16, 1987, in an informal meeting convened in his chambers and attended by Dadhich and myself, Yash Pal, provided important inputs from the UGC side promising a financial commitment if such a centre came about.

• At its meeting on December 19, 1987, the Executive Council of the PU accorded its approval to setting up such a centre on its campus and to provide administrative support till it became an autonomous registered society under the Societies' act of 1860, under the UGC. Thus, path was cleared for bringing the idea of a centre into reality.

• At the annual meeting of the Indian Science Congress held on the campus of PU, on January 6, 1988, Prime Minister Rajiv Gandhi announced the Government's intention of setting up the centre on the PU campus.

• On January 21, 1988, the UGC agreed to set up the centre and initiated the procedure by appointing a Steering Committee (SC) of scientists to guide the new institution till it became autonomous. A subset of the SC was empowered to act as the Executive Committee (EC), with the Chairman, UGC chairing both committees.

• At the recommendation of the UGC, PU appointed Naresh Dadhich as Project Coordinator and he took charge of this assignment on February 10, 1988. He set up a temporary office in a room in the Golay Bungalow at PU.

• On April 6,1988, the first meetings of the SC and EC of the proposed centre took place in the UGC premises. At this meeting the centre (which was till then called the Inter-University Centre for Astrophysics – IUCA) was formally named the Inter-University Centre for Astronomy and Astrophysics (IUCAA). The draft Project Report of the centre was discussed and approved by the SC. The EC recommended that I be appointed the first Director. This recommendation was forwarded by the SC to PU.

• At its meeting on April 29, 1988, the UGC approved the project report (PR) of the new centre and made a formal budgetary allocation of Rs 1 Crore for the financial year 1988-89. It was decided to approach Charles Correa, distinguished architect and planner, for designing the campus of the centre.

• On July 19,1988, I took charge as Honorary Director of IUCAA. Coincidentally, on the same day the Government of Maharashtra (the State of which the city of Pune is a part) made an allocation of approximately 8 hectares of land adjoining PU and the GMRT Centre, on a lease of 99 years for IUCAA. The PR approved by the UGC was printed for circulation and general information.

• The centre was formally approved by the Government of India on November 18, 1988 and became an autonomous registered society on November 22, 1988.

• The first meetings of the apex bodies of the newly registered centre were held on December 29, 1988, the same day on which Professor Yash Pal, Chairman, UGC, laid the foundation stone of IUCAA.

The march of events mentioned above indicates the rapid progress made by IUCAA during its primordial phase. This was possible because of the

help received from UGC, the HRD Ministry, the Prime Minister's Office, the Government of Maharashtra, the local authorities in Pune, the Vice-Chancellor of PU and my own lone colleague at the time Project Coordinator Naresh Dadhich. The next challenge lay in planning an academic strategy that could translate into reality all the brainstorming expectations from the new centre.

4. The Eightfold Way

To meet its various objectives, an 'Eightfold Way' was identified, along which the new centre was expected to function:

1. *Basic Research*: IUCAA was expected to have a small core staff of scientists engaged in frontline research in astronomy and astrophysics (A&A). They were expected to guide research scholars towards their PhD degree, conduct an inhouse postdoctoral programme, and to carry out several other duties not normally assigned to academic staff in a typical research institute. The rest of the items below highlight this unique feature of IUCAA.

2. *Advanced Research Workshops and Schools*: IUCAA decided to hold a number of pedagogical meetings ranging from introductory schools to advanced research workshops so as to bring the latest developments in A&A to the faculty members and students in the university sector.

3. *Visitors and Associates Programme*: Faculty members from universities and colleges who were interested in pursuing teaching, research and developmental activities in A&A were made associates of IUCAA with well laid arrangements to visit the centre a number of times for extended durations during a three year period. In addition IUCAA welcomed visitors from outsde the university sector as resource persons for its pedagogical activities.

4. *Refresher Courses*: IUCAA proposed to arrange refresher courses periodically for A&A teachers in universities and colleges to bring them up-to-date with the developments in the field.

5. *Nucleation of A&A in Universities*: IUCAA proposed to provide a model syllabus for teaching A&A at the MSc level in physics/mathematics departments in the universities, with guidance on books, experimental programmes and lecture notes where necessary. The aim was to introduce A&A as a viable option at the masters level in many universities.

6. *Masters and Doctoral Programmes*: As part of its close interaction with PU, the IUCAA academics offered to teach A&A courses in the MSc Physics of PU. IUCAA's inhouse programme of guiding research scholars to PhD degrees at PU was considered an integral part of its academic activities, and its graduate school was open to research scholars from universities.

7. *Interaction with the GMRT*: One strong reason for bringing IUCAA to the PU campus was to have a close interaction between the university sector and the GMRT facility. To this end the IUCAA hoped to set up a working relationship with the GMRT centre.

8. *Guest Observer Programmes*: Apart from the GMRT usage, the general culture of observational astronomy needed to be introduced to the university sector and to this end IUCAA hoped to involve the faculty and students from the university sector as guest observers in national and international observing facilities.

In addition the PR laid special emphasis on two other aspects: (I) *Astronomical Instrumentation* and (II) *Science Popularization*. This account will outline IUCAA's performance in these areas along the above eightfold way. But before coming to these aspects it is necessary to look at how the facilities and infrastructure of the budding centre were set up at Pune.

5. Buildings and facilities

The following calendar sets out the chronology of how IUCAA's buildings and infrastructure grew up. Considering the many bureaucratic and financial hurdles that exist in a developing country this progress has been considered exemplary.

- To start its activities IUCAA decided to construct a shed of approximately 200 square metres area. Named *Aditi*, it was completed on August 24, 1989. The GMRT Centre made available five office rooms for IUCAA in its newly constructed building. The library of IUCAA initially shared space with the GMRT library. On the above date IUCAA shifted from the Golay Bungalow to these new premises. The old timers recall the relief of a 30-fold increase in working area brought about by this transition.
- Construction of IUCAA's Phase I of the Campus, consisting of staff quarters began with ground breaking on September 4,1989 and was over in 1991. Since the number of houses exceeded the number of staff entitled to occupy them, a decision was taken to move the institutional offices of IUCAA into some of the houses till such time as Phase II was over.
- The construction of Phase II, the main institutional complex began on August 24, 1990 and was completed in December 1992.
- Shifting of academic and administrative offices and the library to the main institutional premises began on June 30, 1992. The library was still in a temporary abode. The computer centre, the library and the instrumentation laboratory moved to their final locations during December 16-25, 1992.
- The IUCAA buildings were dedicated on December 28, 1992 by UGC Chairman G. Ram Reddy with Nobel Laureate S. Chandrasekhar delivering

the Dedication Lecture. The act of 'starting IUCAA' was symbolized by setting its centrally located Foucault Pendulum in motion.

• Work on Phase III (Auditorium) began on January 29, 1992. The Auditorium was completed on August 14, 1993, the occasion being marked with a lecture by the Director to schoolchildren on that day. The auditorium was formally used for the first time with the Sixth Asian Pacific Meeting of the IAU starting on August 16, 1993.

I now return to the academic programmes of IUCAA.

6. Academic programmes

It will be seen from the above time table, that after several shifts and dislocations, IUCAA stabilized its infrastructure late in 1992, and has since consolidated its facilities *in situ*. Its academic programmes however continued right from Day 1, the day it was formally founded.

In the initial stages IUCAA arranged a number of regional meetings in different parts of the country to inform the university faculty of the setting up of IUCAA and its aspirations of generating a strong interaction with those interested in the pursuit of A&A. On January 1, 1990, it launched its quarterly newsletter *Khagol* which has steadily improved in its quality and coverage. The main aim of Khagol has been to give information on IUCAA's activities and also generate interest in A&A through regular columns on A&A topics.

IUCAA's make up and its activities reflect the aims and objectives outlined earlier. It has modelled itself as a composite of several different types of scientific institutions: for example, as a research institute, like the Institute of Astronomy, Cambridge, UK or the Canadian Institute of Theoretical Astrophysics, Toronto, Canada, as a resource centre for schools and workshops and the associateship programme, like the International Centre for Theoretical Physics, Trieste, Italy, as a centre for observational astronomy and instrumentation, like the Kitt Peak National Observatory, as a centre for science popularisation, like the Royal Institution of Great Britain, etc. Thus no single institution has served as a role model for IUCAA. In reviewing IUCAA's work, this important aspect has to be noted.

Keeping the Eightfold Way in view we consider the academic activities in some detail.

(a) *In-house academic activities*

In the early days Yash Pal had set up a Working Group headed by the former UGC Vice-Chairman Rais Ahmed and including physicist N. Mukunda and myself to think of strategies for IUCAA's various academic programmes. In the brainstorming carried out on August 14, 1989, by the

Rais Ahmed Working Group, it was emphasized that IUCAA would command credibility as a resource centre in the university sector only if its core membership were manifestly seen to be highly qualified in research. This perception has played a lead role in the recruitment to IUCAA's core membership.

Although the PR envisaged the ultimate strength of core members to be 20, the march towards this number has been slower than anticipated. IUCAA has consciously been cautious in recruiting core members, as the emphasis is on quality which is not easy to come by. Likewise, the coverage of A&A by the core membership is not exhaustive; again a conscious decision has been taken to cover a few areas well and in depth, rather than cast the net wide and shallow.

The areas covered are Galaxies and Cosmology, Quasars, AGN and High-Energy Astrophysics, Classical and Quantum Gravity, Gravitational-Wave Data Analysis, Stellar Spectra and Astronomical Instrumentation. From pure formal theory, through modelling vis-a-vis observations, to observation-related instrumentation, all different shades may be found in the work coming out of IUCAA's academic programmes.

So far as external recognition of this work is concerned, several positive indicators like being invited to give review talks at well-recognized conferences, invitations to write review articles in good review journals, the extent of international participation in meetings organized at and by IUCAA, invitations to write books by reputed international publishers, responses to its postdoctoral programme, citations and references are heartening indicators.

The postdoctoral programme has been more successful than anticipated. IUCAA's annual advertisement attracts around 30-40 applications from which around 6-8 offers are made and around 3-4 join. Postdocs from Europe and North America as well as Japan, Iran and Korea have worked here, apart from several expatriate Indians who find the place worthwhile to join in order to continue their research interests initiated abroad. Typically postdocs work for a couple of years before finding a more permanent job elsewhere. A very small fraction has been absorbed into the core membership of IUCAA.

Not so successful have been IUCAA's efforts to attract research scholars. The PR had projected about 20 scholars doing PhD in A&A to be in residence at any given time. Given a core faculty of 10 the above number is quite manageable. In fact the number has largely remained between 10-15. This phenomenon is not, however, linked with IUCAA or A&A, but indicates an overall growing apathy towards basic sciences in India as well as abroad.

As in any research institute IUCAA organizes colloquia by distinguished scientists, seminars on A&A, a journal club activity (under the title Infor-

mal Discussion Group), after dinner PEP-talks (Perceptions in Emerging Physics), and extramural programmes.

Recently I have introduced a lunchtime forum called MAHFIL (the word means an assembly for cultural activity), an accronym for Midday Astronomy Hour For Interaction and Lunch, where academics, visitors as well as locals, talk briefly over lunch on what research they are doing.

In addition to seminars and colloquia, and the above talks, IUCAA has instituted a Foundation Day Lecture to be delivered by a distinguished personality on the Foundation Day, December 29.

The instrumentation laboratory has a dual role to play. It develops its own research level instruments for use in astronomical observations; it also makes prototypes of instruments for duplication by scientists from the university sector. Since the culture of instrumentation and experimentation is relatively rare in India, special efforts are needed to get scientists interested and involved in R&D activities of this kind.

Against this background, the instrumentation group at IUCAA has made a research level instrument, the *imaging polarimeter* which measures and prepares maps of polarization of optical sources. The polarimeter is being used on the 1m optical/infrared telescope at Guru Shikhar. The instrumentation laboratory also devised testing instruments for testing sites for the IUCAA telescope now under construction. CCD controllers and liquid nitrogen cooled CCD cameras were also made here.

Instruments under the second programme include a 14-inch automated photoelectric telescope, small photometers for use on amateur telescopes, etc. University users are encouraged to come here and build their own instruments as per the prototypes.

In 1996 IUCAA signed a contract with the Particle Physics and Astronomy Research Council (PPARC) of the UK Government to acquire a 2m telescope. The telescope is expected to be installed in the year 2001.

It is expected that with the IUCAA Telescope in the offing the instrumentation laboratory will have more projects on its plate. Already an imager spectrograph has been made by the Copenhagen University Observatory as a first light instrument for the IUCAA telescope.

A major facility most essential for university users is a *well-equipped library*. The IUCAA library has been recognized as the best A&A library in India and has many 'firsts' to its credit, including computerization, e-mail for user service, remote login, etc. It is adapting to the CD-ROM age and is expected to remain at the forefront for use of new information technologies.

The *computer centre* also has many firsts on a national basis, being the first to have a website for IUCAA (February 1993) and a 1-MBps data link (December 1, 1997). Its networking serves academic, administrative and

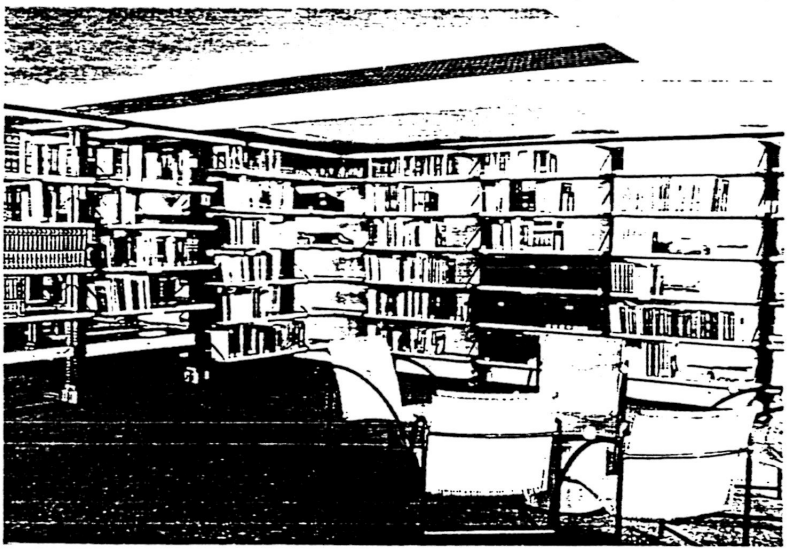

Figure 1. An inside view of the IUCAA Library. The library houses journals, books and CD-ROMs relating to astronomy, astrophysics and other topics of interest to astronomers.

library needs and is expanding with more workstations of greater power and capacity. Several research-oriented A&A software packages are available. A *data centre* was established in 1992 as a national facility and its volume and efficiency are also being expanded with mirror sites of foreign data centres.

(b) *Interaction with universities and the associateship programme*

In the PR it was anticipated that the *number of associates* in the university sector will eventually reach and stabilize at around 100, a number not too large considering that the number of active members of the Astronomical Society of India is around 300. At present the number of associates is howering around 80.

Those associates who have been actively using IUCAA's facilities have clearly demonstrated that the IUC mode works. There has been an improvement in their quality of work, publication record and range of research interests. IUCAA has encouraged the associates to bring their research students with them, if they feel it would be beneficial to them, and some indeed do with great advantage. One tangible result is the growing interaction between academics from different universities by their getting together

at IUCAA. Some associates and other faculty members from universities and colleges have been good users of the *instrumentation laboratory*. Thus scientists from Bangalore University were the first to copy the automated photoelectric telescope made by IUCAA and those from Bhavnagar University were next in line. Several observers have made photometers.

Usage of guest observer programmes on national facilities is now becoming more popular with new observers coming from universities like Ravishankar University, Raipur and colleges like the Sri Venkatesvara College, Delhi. One associate from Raipur has observed galaxies using a telescope at the Las Campanas Observatory in Chile, and it is expected that the trend will grow. This has become possible through the intervention of IUCAA.

The original motivation of interaction and usage of the GMRT facility by the university academics is only now becoming possible because the telescope is becoming functional. IUCAA expects that as the GMRT gets into full swing the interaction will build up.

Since the inception of IUCAA at least ten universities and colleges have *introduced A&A in their MSc curricula*, while several have modernized their existing ones. IUCAA has prepared a model syllabus for such courses, giving it a modular structure, leaving it to the user department to include modules as per their course regulations (which vary from department to department).

IUCAA has organized *introductory schools* at several universities and colleges where A&A are to be introduced or revised substantially. These schools are meant to acquaint the teachers in the region with highlights of these subjects. IUCAA staff have been *teaching A&A courses in the MSc programme* of the Physics Department of Pune University. Occasionally some have taught small capsules of courses at the MSc level at other universities. Although IUCAA would like to get more actively involved in the teaching of MSc courses in universities, the constraints of manpower and distances makes this a rather difficult proposition at present.

Even so, IUCAA faculty have travelled to remote parts of the country from the North East to the deep South in their efforts to plant A&A in universities and colleges. Thus the early credibility gap about IUCAA has been largely bridged and IUCAA activities have been welcomed and actively sought in university campuses.

Schools and workshops as well as *refresher courses* form the core of IUCAA's pedagogical activities for the university sector. Some are organized on the IUCAA campus while about equal number are distributed across the university and college campuses all over India. Certainly the growth in the users of IUCAA has more than met Yash Pal's original expectations.

7. Science popularization programmes

Amongst all scientific institutions in India, IUCAA is probably unique in having an institutional programme for science popularization. The PR stresses this and the general philosophy behind it is as follows. The overall purpose of creating human resources in A&A cannot be fulfilled by simply planting A&A at the MSc level. A coherent strategy which develops an interest for science at school level and then builds on it by introducing some aspects of A&A at the undergraduate level is required. Because astronomy is a subject that excites the human mind even at the layperson level, it provides an excellent opportunity for introducing highlights of astronomy to the general public. Hence IUCAA's science popularization programme aims at the general public as well as at schoolchildren.

Following are the different facets of this programme:

(a) Exhibits in the building

As the IUCAA campus was being constructed several scientific notions or models were built into its overall ambience. These include, for example, the Foucault pendulum, the aperiodic tiling, Sierspinski's gasket, the binary star system, the accretion disc-cum-jet model of a radio source, statues of scientists, Newton's apple tree, the dome with star distribution frozen as on IUCAA's Foundation Day and of course the excellent range of astronomical photographs presented by David Malin. There are also a couple of wall pictures such as Glashow's snake and the Lorentz Spiral, to which more may be added.

(b) Science Park

A series of open air exhibits, some of interactive type are under construction which will illustrate the way scientific laws operate. Some are already in place, like the Samrat Yanrtra model of Jai Singh's observatory and a model of the Hampton Court Maze. A sapling of Newton's Apple is planted here too. The Science Park is located next to the Chandrasekhar Auditorium and will be open to the general public, especially to schoolchildren visiting IUCAA for lectures.

(c) National Science Day

Every year the National Science Day (February 28) is celebrated with a science-oriented programme of lectures, entertainment and quiz for schoolchildren. There is also an open house for the general public with short lectures and lecture demonstrations, exhibits of IUCAA's work, astronomy films, night sky observing, etc. The event receives tremendous response from the Pune public.

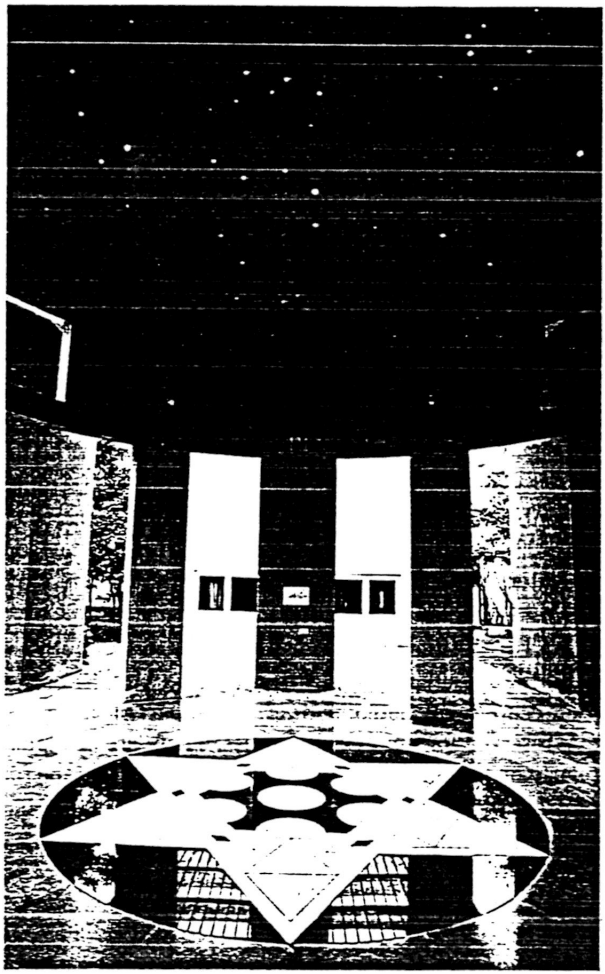

Figure 2. The dome which borders the central courtyard at IUCAA has tiny holes right through it. The holes are of varying sizes admitting day light through them so that persons standing underneath the dome see the star studded sky during the day time. The star distribution is arranged to match that prevails at 8:30 pm on IUCAA's Foundation Day, December 29, 1988.

(d) Schoolchildren's Programmes

In 1993, IUCAA began a series of lectures and lecture demonstrations for schoolchildren of classes 8-10 every second Saturday. They are extremely

popular with schools in Pune and the Chandrasekhar Auditorium gets filled to capacity at every lecture. Now lectures are also arranged for students of classes 11-12, so that one lot comes on the 2nd Saturday while the other on the 4th.

In the summer vacation schoolchildren from the classes 8-10 do a week-long project with an academic or scientific member of IUCAA and write a report on what they have done. Like day scholars at schools they come in the morning and leave in the afternoon, spending some 5-6 hours working on their project. Nearly 150 students take advantage of this scheme every year.

Additionally IUCAA enthusiastically contributes to the national effort for training gifted children for the international Astronomy Olympiad. I strongly feel that such efforts are worthwhile as they help induce some enthusiastic and motivated children to take up a career in A&A later.

(e) Interface with amateur astronomers

IUCAA has a continuing dialogue with the amateur community and was in fact responsible for convening the first national meeting of amateur astronomers in 1991. The meeting led to the formation of the Confederation of Indian Amateur Astronomers which convenes a national meeting every year in some part of India.

In addition IUCAA has held workshops in areas of interest to amateur astronomers such as telescope making, celestial-globe making, on viewing the total solar eclipse or a meteor shower, etc. A part of the instrumentation laboratory is reserved for amateur activities. There are also public viewing nights regularly on the fourth Friday of the month outside the rainy season.

8. Concluding Remarks

It should be recognized that IUCAA's multi-dimensional programmes could not have functioned at the level of efficiency that they are generally perceived from outside, had it not enjoyed an excellent administrative infrastructure.

In dealing with the core staff requirements, the maintenance of facilities, attention to the visitors' needs, organization of the many workshops on and off campus, and in keeping the campus in a good clean condition, the administrative and support staff have acquitted themselves very well.

It is also to be noted that in comparison to the typical university or a national research institute, the number of such staff is small. This has been achieved by assigning many activities to one staff member and setting premium on quality.

This account is being written as IUCAA just completes twelve years of its existence. It has come a long way from the times of the late 1980s when it was just a concept. The spectrum of its achievements from a public outreach programme to international research reflects the universal appeal that A&A enjoy.

The key to its success lies in making the maximum use of this appeal. For, in the last analysis, a scientific institution should reflect human endeavour and aspirations at all levels.