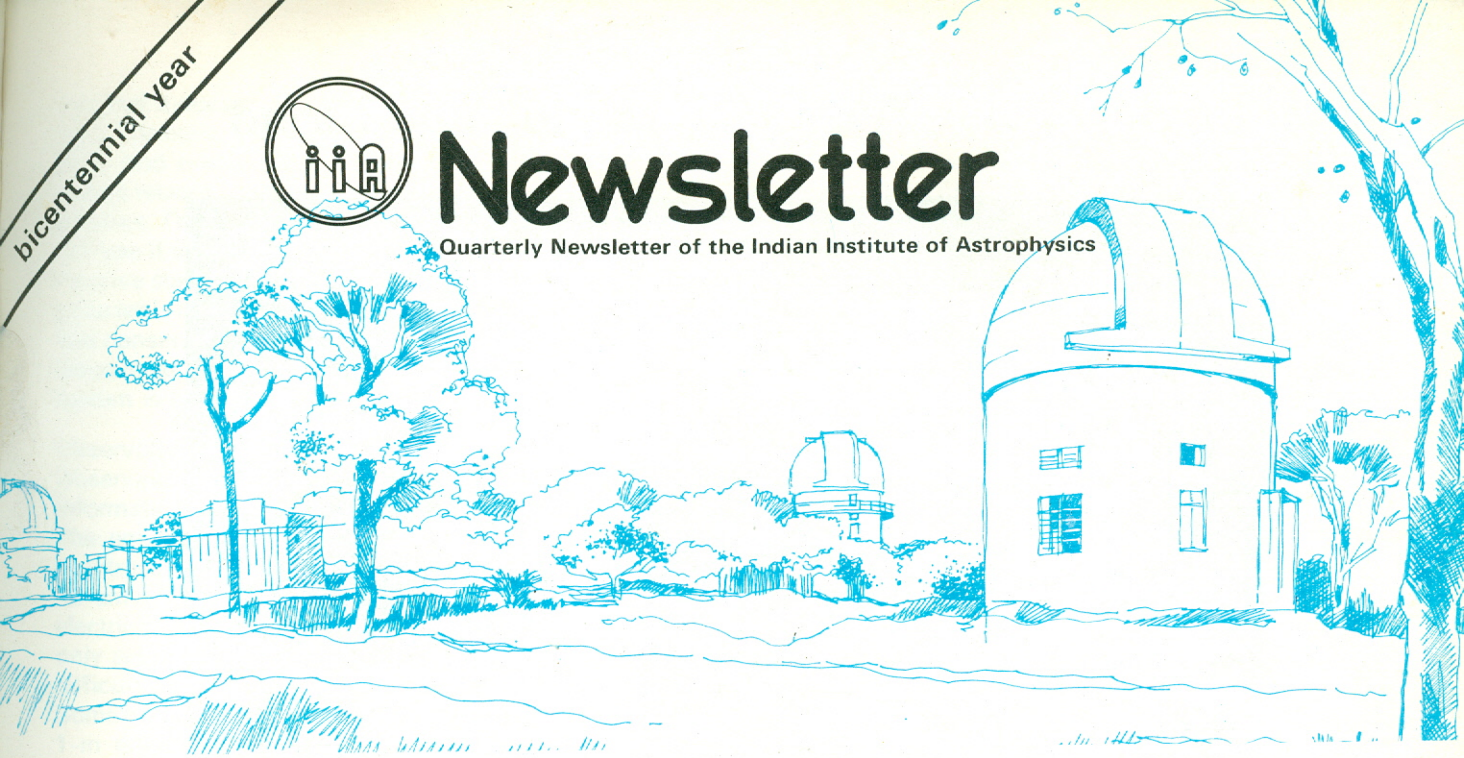
bicentennial year

Newsletter

Quarterly Newsletter of the Indian Institute of Astrophysics



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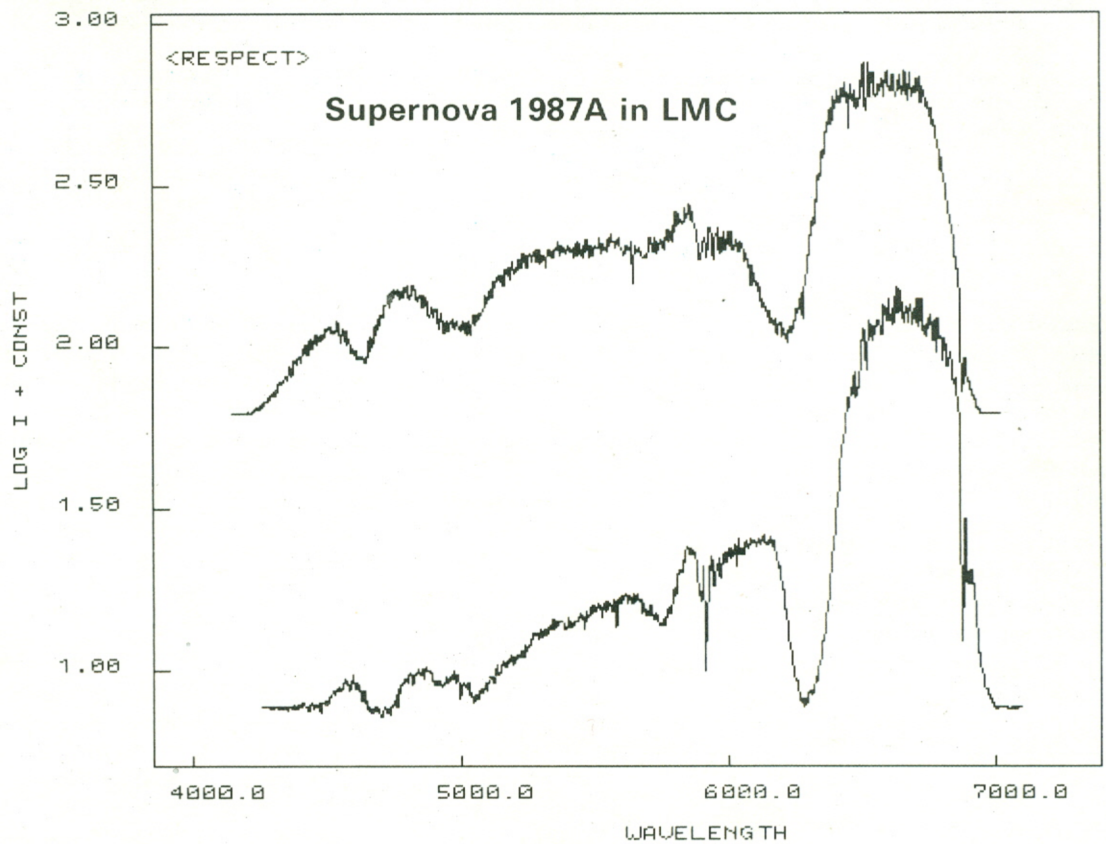
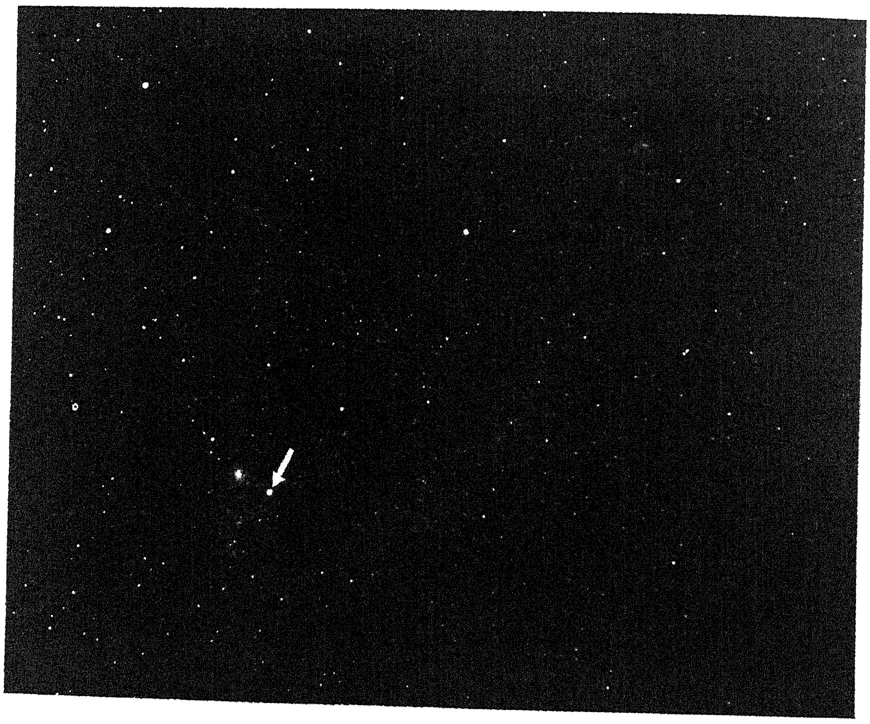


Photographic spectra of the supernova 1987A in the Large Magellanic Cloud. The spectrograms were obtained with the 1-m reflector at the Vainu Bappu Observatory, Kavalur, at a reciprocal dispersion of 130 Å mm^{-1}. Kodak 098-02 plates were used. The top spectrum was recorded on 1987 February 26.6 UT and the bottom on 1987 March 4.6 UT.

Supernova in the Large Magellanic Cloud



The region around the Large Magellanic Cloud obtained with a Zeiss astrograph of 10 cm aperture by M. J. Rosario on 1987 March 4. The supernova is seen close to the Tarantula Nebula, the brightest nebulosity in the photograph. Emulsion: Kodak 098-02; filter: Wratten 25; Exposure: 15 min.

The entire astrophysical community is excited over the recent supernova in the Large Magellanic Cloud (LMC). The supernova was discovered independently by several observers in the southern hemisphere on 1987 February 24. It brightened from a magnitude of 5 to 4.5 in mere 8 hours. However, it did not continue to brighten at this rate, and levelled off at a magnitude of about 4.

The cause for the excitement is obvious. This is the first supernova to explode in LMC, or in any of the satellite systems of our Galaxy, in recorded history. Optically, it is the brightest supernova observed since the invention of the telescope and of the spectrograph. It has appeared at the right moment when observational and theoretical astrophysics have developed sufficiently, and one would naturally expect that this event would shape the future course of our understanding in this field.

Fritz Zwicky fought hard in the 1930s to convince astronomers that there exist stellar explosions that are several orders of magnitude larger than those of galactic novae. He pioneered in the field of detecting and observing supernovae in external galaxies. Since then several hundreds of supernovae have been discovered in other galaxies, and a fraction of them studied in some detail. About 5 such events in the nearby region of our Galaxy have been identified from historical records, whereas two more events have been observed in modern times before the invention of the telescope: one was observed by Tycho Brahe in 1572 and another by Johannes Kepler in 1604. Statistical arguments were already mounting the expectations of astronomers during the last several years of finding a similar event in our Galaxy shortly. In this context the supernova in LMC is not only a pleasant surprise, but will also serve as a dress rehearsal for a brighter event that may take place in near future.

The supernova '1987A' in LMC appears to be fainter even on absolute terms. If it were a typical supernova, one would have expected it to brighten to at least magnitude 1. On the contrary, it appears to have reached its maximum at about magnitude 4. Thus it is underluminous by a very large factor. Spectroscopic observations also corroborate the fact that it is atypical. It remains to be seen whether these impressions would last: It is possible that its uniqueness lies in the fact that it is so nearby, and we have caught it in an early phase of development.

Another impact of the supernova 1987A is due to the fact that it occurred in an irregular galaxy of Magellanic type. The current rate of star formation in such galaxies is high, and one expects a fairly high rate of supernova events related to the last stages of massive stars in such galaxies. The spectrum of this supernova resembles that of Type II supernovae, believed to be the end results of massive stars. On the other hand, total mass of irregular galaxies is low, and the supernova rate per galaxy is also low consequently. SN 1987A is the first supernova to be discovered in LMC in over a century when this stellar system is being observed continuously.

Observations of this supernova at the Vainu Bappu Observatory (VBO), Kavalur began as soon as the information of its discovery reached there (February 26). The emphasis was placed on intermediate resolution spectroscopy with the 1-m and the 75-cm reflectors. A 40-cm reflector soon joined these in conducting photoelectric photometry though at a maximum elevation of only about 8 degrees above horizon the supernova is a difficult object to conduct photometry from Kavalur. Some polarimetric observations were obtained using the 1-m reflector in collaboration with the Physical Research Laboratory, Ahmedabad. Photographs of LMC were obtained with an F/2.5 astrograph of 10 cm aperture. Observations are continuously being made.

The early photographic spectra obtained from VBO showed puzzling features. The deep absorption feature at 6200 Å appeared similar to the spectra of Type I supernovae whereas the emission at about 6600 Å was clearly much above the continuum and could be attributed to Hα line at 6563 Å, typical of Type II supernovae. If the dip near 6200 Å is attributed to the P-Cygni-like absorption feature due to Hα, one obtained a value nearly 16000 km s^{-1} for the expansion velocity of the shell, a value much higher than observed in Type II supernovae. On the other hand, the line due to neutral helium was clearly seen at 5876 Å, and indicated an expansion velocity of only 9000 km s^{-1}.

Spectra obtained from VBO show also that the absorption velocity of Hα continuously decreased in magnitude, reaching a value of 9000 km s^{-1} on March 15. The helium line, and the infrared triplet of calcium consistently showed a smaller value of expansion.

The Hα emission is prominently seen in the figure on page 9. The P-cygni absorption core due to Hα has shifted from 6212 Å (−16000 km s^{-1}) on February 26 to 6292 Å (−12400 km s^{-1}) on March 4. The P Cygni feature of He I 5876 Å is also seen clearly. The sharp absorption on the red side of this profile is due to interstellar sodium D. Many other sharp absorption features are due to earth's atmosphere.

Observations of the supernova in LMC are continuing at VBO. A large number of astronomers of the Institute are actively engaged in the study of this phenomenon.

SN 1987A on the International Scene

SN 1987A in LMC is being observed continuously by all the observatories from which it is visible (about the latitude of VBO, or to the south of it). The neutrino detectors are not hampered by the occultation by earth as the neutrinos pass right through it; thus the above limitation on the observations of the electromagnetic spectrum is not applicable to them. Summary of all observations are being communicated to the International Astronomical Union which maintains an efficient intercommunication between scientists through the *IAU Circulars.*

First, there is a distinct possibility that the progenitor of the supernova has been recorded in the earlier photographs of the region. The most probable candidate is a B3 supergiant of magnitude V=12.24, designated CPD −69°402 or Sanduleak −69°202. However, the observations with the International Ultraviolet Explorer (IUE) indicate the possibility that this star is still intact, and thus it is not excluded that one of the nearby, fainter stars has exploded. Two such stars of respective magnitudes 16 and 17.5 have been identified. If the progenitor is one of these, or fainter, it will have serious implications in terms of theoretical models of the supernova.

Wide-band photometric and polarimetric observations are being recorded in *UBVRIJHKL* bands and in other photometric systems. The supernova is becoming continuously redder, and increasing in brightness at longer wavelengths.

Optical spectra are being monitored by several observatories and indicate that there is a significant amount of hydrogen in the envelope. The matter is continuously streaming through the photosphere and the optical depth in hydrogen lines is decreasing with time. The results are in general conformity with hydrodynamical models where the velocity of matter increases outward, whereas the density decreases radially.

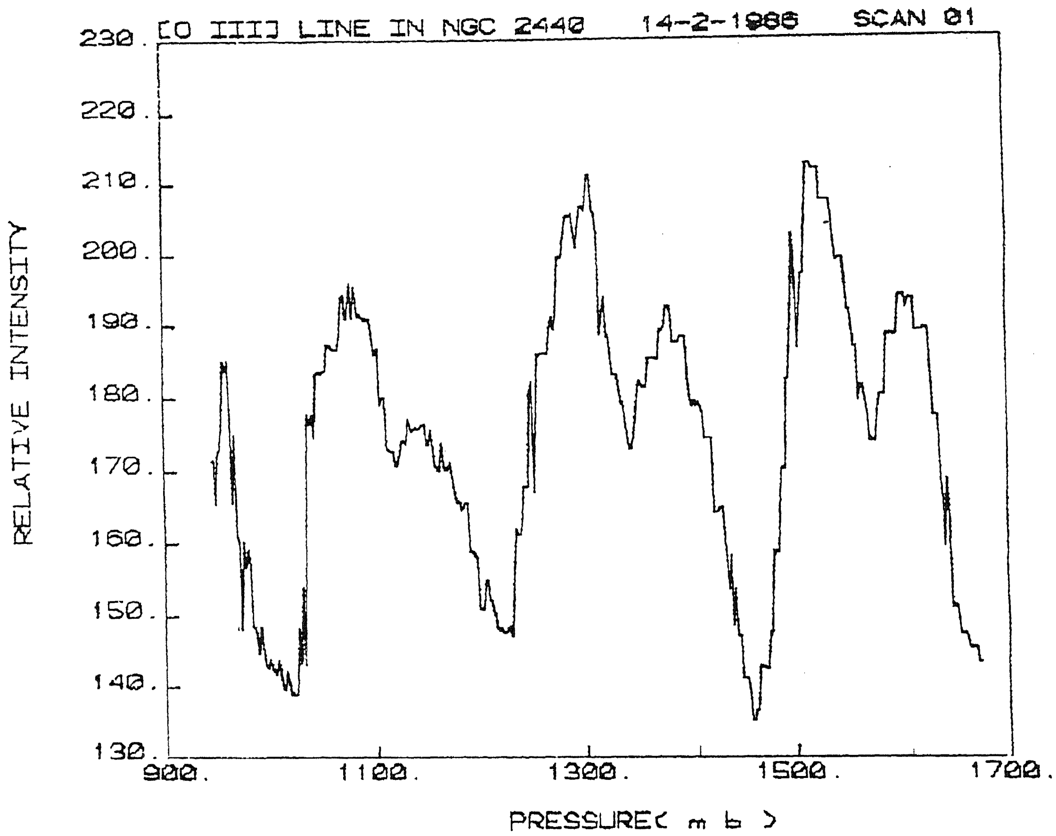
Ultraviolet observations with the IUE indicate a steep light curve, and a behaviour different from post-maximum observations of typical type II spectrum.

There was a radio detection soon after the explosion, but the supernova has subsequently faded in the radio region. It is possible that the radio emission would increase again at a later phase in the evolution of the ejecta.

There is more than one record of detection of neutrino emission from the supernova. Some of them would certainly be associated with the supernova, but some would require alternative explanations. The detection of neutrinos signals the birth of a neutron star.

Such a plethora of information has already provided a boost to an activity of choosing between available theoretical models, or of making fresh scenarios.

High resolution observation of [O III] emission line in some planetary nebulae.



Planetary nebulae represent an important transitory phase near the end-point of evolution of the vast majority of stars in a galaxy. The stars in the mass interval $1.2 \lesssim M/M_{\odot} \lesssim 8$ eject shells of material when they evolve to the highly distended configuration of a red supergiant. Following the ejection event these stars evolve to the hot condensed configuration of pre-white-dwarfs. The ejected shell thins out as it expands and the ultraviolet radiation from the parent star ionizes the gases in the shell.

A programme of studying the internal kinematics of the ejected shells—planetary nebulae—was initiated some time ago jointly by the scientists of the Institute, and of Physical Research Laboratory (PRL), Ahmedabad. The programme is based on the measurement of the velocity of expansion of the ejected shells. A pressure-scanned Fabry-Perot photoelectric spectrometer developed by the PRL group, has been used for this purpose. Salient features of the spectrometer are given below:

	[O III] λ5007 Å	Hα λ6563 Å
Free spectral range	1.25 Å	2.25 Å
Resolution	0.08 Å	0.11 Å

In terms of velocity the resolution is 1 km s^{-1}.

We obtain monochromatic scans of the nebulae in the [O III] λ5007 Å and Hα λ6563 Å lines. The splitting observed in the lines due to the approaching and the receding parts of the expanding shells gives a direct measure of twice the expansion velocity on the assumption that the expansion is symmetric. Morphological mapping of the velocity field on the surface of the nebula is done by recording the line profiles at different locations on the nebulae.

We have recently obtained [O III] scans of the planetary nebula NGC 2440 over three different locations using the 102-cm telescope at Kavalur. A representative profile of the line in the central region of the nebula is shown in the figure. From this profile we derive an expansion velocity of 15 km s^{-1}. This is substantially lower than the only previous measurement available (Robinson et al. 1982: *Mon. Not. R. astr. Soc.*, **199**, 549) which yielded a value of 22 km s^{-1}. Our measurement is more in conformity with what is expected from theory.

D. C. V. Mallik & S. K. Jain (IIA)
B. G. Anandarao, D. Banerjee, N. S. Jog & F. M. Pathan (PRL)

from the director

A second instrument has now become operational at the prime focus of the Vainu Bappu Telescope, Kavalur. This is a photometer of special design that suits a fast (*F*/3.25) beam and the restricted space in the prime focus cage. The instrument has been designed and fabricated in the laboratories of the Institute.

In the first series of experiments with this instrument, photometric observations of a faint, rapid variable star AM Canum Venaticorum have been obtained. The detector employed was a dry-ice-cooled photomultiplier RCA C31304 with gallium arsenide photocathode. The photometer operated in pulse-counting mode. The experiment formed a part of an on-going collaborative programme between the scientists of IIA and ISRO, and thus the stand-alone counting and recording system of ISAC-ISRO is employed. The counts recorded were six times larger than what were previously recorded with the 1-m reflector. This is as expected from the ratio of the apertures. Steps are already underway to obtain the data under the control of the on-line computer.

Another interesting programme initiated recently at the Vainu Bappu Observatory aims to discover new objects in the solar system, and also variable stars. The project has been nick-named *Kalki* by the project leader Dr. R. Rajamohan, perhaps with a fond hope of stumbling upon the still elusive planet X. The survey telescope used in the programme is the 45/60 cm Schmidt which was installed a year ago for the observations of comet Halley. Already several moving and variable objects have been detected in the first few plates obtained under the programme. The identification of these objects is in progress. We are confident of reporting discoveries of new solar system objects in due course.

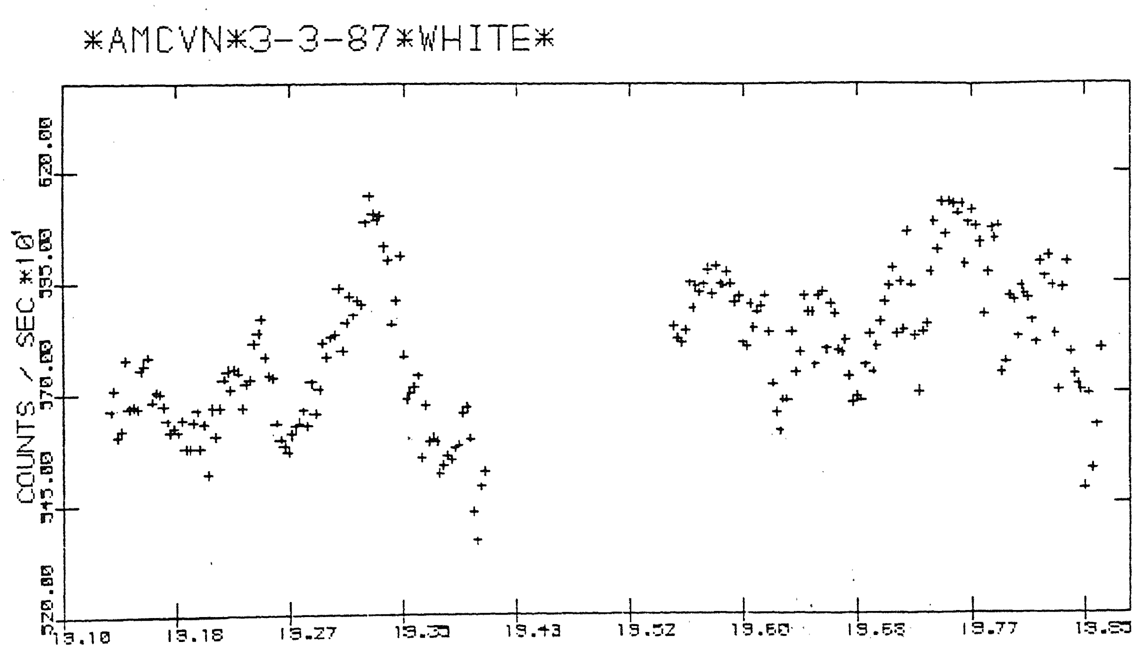
J. C. Bhattacharyya

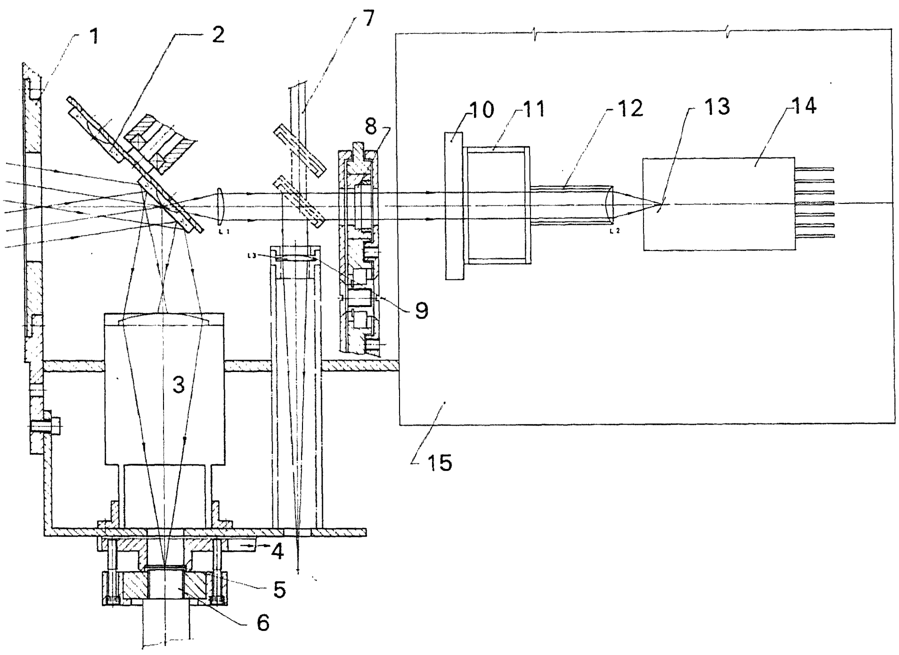
Prime Focus Photometer

Design, fabrication, installation and testing of prime-focus photometer for the 2.34 m Vainu Bappu Telescope has been completed recently. First observations with this instrument were made between 1987 February 21 and 1987 March 4, as a part of the international watch programme of AM CVn (Hz 29). The present observations were undertaken as a collaborative venture between Indian Space Research Organization, and this Institute. The performance of the system has been satisfactory. Typical photon counts s^{-1} are given below, and a portion of the light curve obtained without filter is also reproduced.

AM CVn: Typical photon count rates measured at 20^h33^m UT on 1987 March 3 with a diaphragm of 800 μm.

Filter	Counts s^{-1} (Star – Sky)
Clear (no filter)	5957
U	47
B	215
V	846
R	1810
I	753





1 Connecting flange
2 Reflecting diaphragm-slide
3 Televue wide-angle eyepiece
4 Slide
5 Graticule (1mm grid)
6 Fibrescope
7 Retractable mirror
8 Filter
9 Diphragm reimaging unit
10 No-dew ring
11 Window optics
12 Glass spacer
13 Photocathode
14 Photomultiplier tube
15 Cooling chamber

The design of this photometer differs from that of the Cassegrain photometers because of the F ratio of the prime-focus beam being shorter. The field lens L1 collimates the beam coming from the telescope focus, and the primary mirror is imaged on to the photocathode by the lens L2. An optically flat, nickel mirror with a series of diaphragm holes (350, 500, 800, 1000 μm), placed at 45° at the focal plane is used for field viewing and guiding during observations. A retractable flat mirror is brought in the path of the collimated beam and directs the light to the lens L3. The image so formed is used for centring the star in the diaphragm.

A fibrescope mounted on a slide in the common focal plane of the wide-angle eyepiece and lens L3 brings in view either the field, or the star image in the diaphragm, by a proper choice of retractable mirror. The eye-end of the fibrescope provides viewing at a position convenient for the observer. With the present arrangement, viewing and guiding can be done comfortably up to the 15th magnitude in moderate seeing. The filter assembly consists of the following *UBVRI* filters:

U : UG 2 (2mm) + BG 18 (2mm)
B : BG 12 (2mm) + BG 18 (2 mm) + CG 4 (1mm)
V : GG 14 (2mm) + BG 18 (2mm)
R : OG 550 (2mm) + RG 6 (1mm)
I : BG 3 (1mm) + RG 1 (2mm).

In order to have a wider, flat spectral response, RCA C31034 photomultiplier (2-inch diameter, 11-stage QUANTACON type) having a gallium arsenide photocathode has been used. The back-end electronics used consist of a fast preamplifier (ORTEC model 9301) followed by an amplifier/discriminator and a photon counter (ORTEC model 7315). The output data from the counter, alongwith time in UT can be printed on a parallel printer.

A. K. Saxena & J. C. Battacharyya

Current Facilities at the IIA Library

The Indian Institute of Astrophysics library is a complete source for astronomy and atrophysics literature available for scientists working in this field in the country. The issue system is very liberal and the scientists can use the library throughout the day and night.

The main library of the institute was shifted to Bangalore from Kodaikanal in 1976 and was moved to its present location in 1978. Though the collection of books expanded over the years, it was only in 1974 that a concerted effort to catalogue and classify all the books was made. The UDC system of classification is followed for books, whereas the bound volumes of journals are arranged alphabetically. The library has a total collection of about 10,000 books and 15,000 bound volumes of journals. It subscribes to 130 journals and receives 110 journals and observatory publications in exchange of the *Kodaikanal Observatory Bulletins*, or gratis. An inter-library exchange with other astronomical libraries in the city helps it to display an additional twenty journals. The library also has a complete collection of reprints of the publications of the staff.

Special mention must be made of the Vainu Bappu collection of books. A total number of 795 volumes of books and journals were donated by Mrs Yemuna Bappu to the library in 1983. These books have been shelved separately.

The library extends a current awareness service through *Recent Research in Astronomy and Astrophysics* which is a monthly index of papers (classified subjectwise) that appear in journals and observatory publications not included in *Current Contents*. Preprints received by the library are also included. In addition, the library brings out an IIA preprint list which is mailed to different observatories and institutes around the world. The library also looks after the publication of the *Kodaikanal Observatory Bulletins* which contain research and technical articles by the staff of the Institute.

The library has well-equipped reprographic units including a microfiche reader/printer which can make hard copies from microfiche/microfilm on plain paper. A small offset printing machine helps printing of library publications. The library has a collection of a good number of slides on astronomical objects, and it also provides the scientists with the slides and prints needed for their lectures.

The library at the Kodaikanal Observatory houses all the old volumes of books and journals, and old loose issues of observatory publications. Its valuable collection would interest the historians of astronomy. The library at VBO, Kavalur is located in the 1-m reflector building and contains only important astronomical journals since 1968, essential catalogues and some text books. A larger library is being planned and would be housed in the 2.3-m Vainu Bappu telescope building.

A. Vagiswari & Christina Louis

IIA Bicentennial Celebrations

On 6 January 1987, Professor M. G. K. Menon, Scientific Advisor to the Prime Minister, and member, Planning Commission, delivered the first IIA bicentennial commemorative lecture on *International Cooperation in Science*, at the Indian Institute of Science faculty hall.

Professor Menon felt that the topic of his talk was appropriate for the occasion on two counts. First, the last 200 years have not only witnessed the growth of this institution but also the growth of the entire field of astronomy and astrophysics through cooperation by people of various countries. Secondly, M. K. Vainu Bappu 'who gave this institute its new existence, its new sense of *elan* and vision' was the president of the International Astronomical Union at the time of his premature death in 1982.

Menon traced the history of *organized international scientific cooperation* since the pioneering efforts of Karl Gauss to the modern era that began with the international geophysical year in 1957 in which the USSR also participated.

Menon went on to describe in some detail three areas where international cooperation is already found effective, and necessary. The first of these is the study of geosphere-biosphere interconnections—how the human activities such as deforestation, desertification, and industrialization affect the global environment to a magnitude equal to natural phenomena. It is hence imperative to study the long-term effects of industrialization on the environment. 'The reason for urgency in this matter is the fact that these are the only pathways, only models of development we know today.'

Menon's second example was related to the study of comet Halley. A particular example of international cooperation was in space observations of comet Halley where the satellite Giotto was tracked to an accuracy of ±50 kilometres, thanks to the 'pathfinder project'. Under this project, the Vega satellites of the Soviet Union were tracked using very-long-baseline interferometry, and from this information Giotto could be navigated with a precision an order of magnitude better than what could have been achieved otherwise.

As a third example Menon described the study of the effects of a nuclear war. There is an indirect aspect which has not been studied in detail: that is the effect of suit injected into the atmosphere by the large-scale burning of forests, asphalt, oil, coal, plastics and other things that contain carbon. It would appear likely that the suit would induce a 'nuclear winter' caused by a significant decrease in daylight.

Menon appreciated the organized international cooperation that has become possible during the last four decades in a whole range of programmes which were narrow until relatively recently. He called on the scientists to 'get out of compartmentalization, of narrowness, and to reach out to see the linkages that exist between disciplines, between people, and their impact on life as it moves into the decades ahead'.

Before delivering the lecture, Professor Menon unveiled a plaque at IIA, Bangalore, commemorating the bicentennial. He also planted a sapling of *Brachychiton Acerifolia* to commemorate the occasion.

Indian Institute of Astrophysics Bicentennial Workshop on 'Astronomical Instrumentation in India: Past, present, and future' will be held at Kodaikanal 1987 August 10–12. Contact address: *R K Kochhar, Indian Institute of Astrophysics, Bangalore 560034*

Of human elements

Automated Supernova Search

The Reverend Robert O. Evans has truly amazed us all by the way he can go out to the telescope in his backyard and know, with the speed of light, that the galaxy NGC 1532, or 1316, or 5236 or 1448 or 3169 or 1559 or 991, is right now being invaded by a supernova, perhaps, one still on the rise and therefore a particularly valuable target for astrophysical observations over the whole range of the electromagnetic spectrum. Nobody else in the world can, it seems, do this: only Bob Evans, and he's already done it close to a dozen times. On a recent evening he started out his routine, just after sunset, and within a period of four hours or so he had checked out 337 galaxies against the charts carefully stored away in his head. In the 338th galaxy, NGC 7184, there was a supernova. This was of course immediately picked up by his sensors, and, as is his custom, he quickly alerted the people at the Anglo-Australian Observatory about the phenomenon.

Supernovae as Distance Indicators
Ed. Norbert Bartel
Springer-Verlag, Heidelberg 1985, p. 222.

Out of context

He considered an initial population of several thousand stars . . . and followed the fate of each star with a computer . . . .

Nuclei of Galaxies (1971) North Holland, Amsterdam, p. 464.

* *

Several hundred emission line galaxies have been found and they are accessible from the north.

A. Rev. Astr. Astrophys. (1977) **15**, 78.

* *

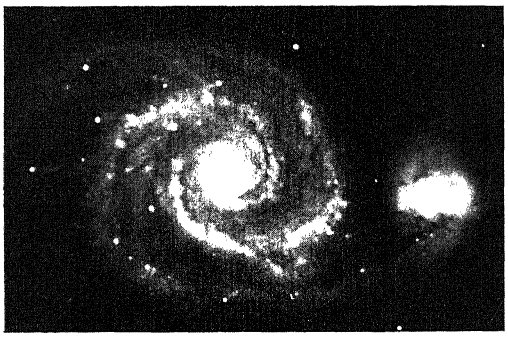
At the time of the Solvay Conference many extragalactic astronomers were all well aware of violent events in certain galaxies.

Problems of Physics and Evolution of the Universe, (1978) Armenian Academy of Sciences, p. 248.

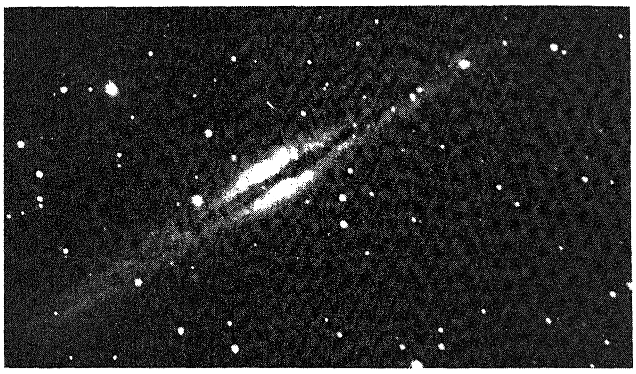
* *

. . . and disappear in at most 2–3 yr, having radiated $\gtrsim 10^{49-50}$ erg in optical phonons.

Rev. Mod. Phys. (1982) **54**, 1203



The spiral galaxy M51 photographed by K. K. Scaria and K. Kuppuswamy with the 2.3-m Vainu Bappu Telescope. Emulsion: 103a E; exposure time: 65 min.



An edge-on spiral galaxv NGC891 photographed by K. K. Scaria and M. J. Rosario with the 2.3 m Vainu Bappu Telescope. Emulsion: Kodak hypersensitized 103 aE; exposure time: 30 minutes.

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