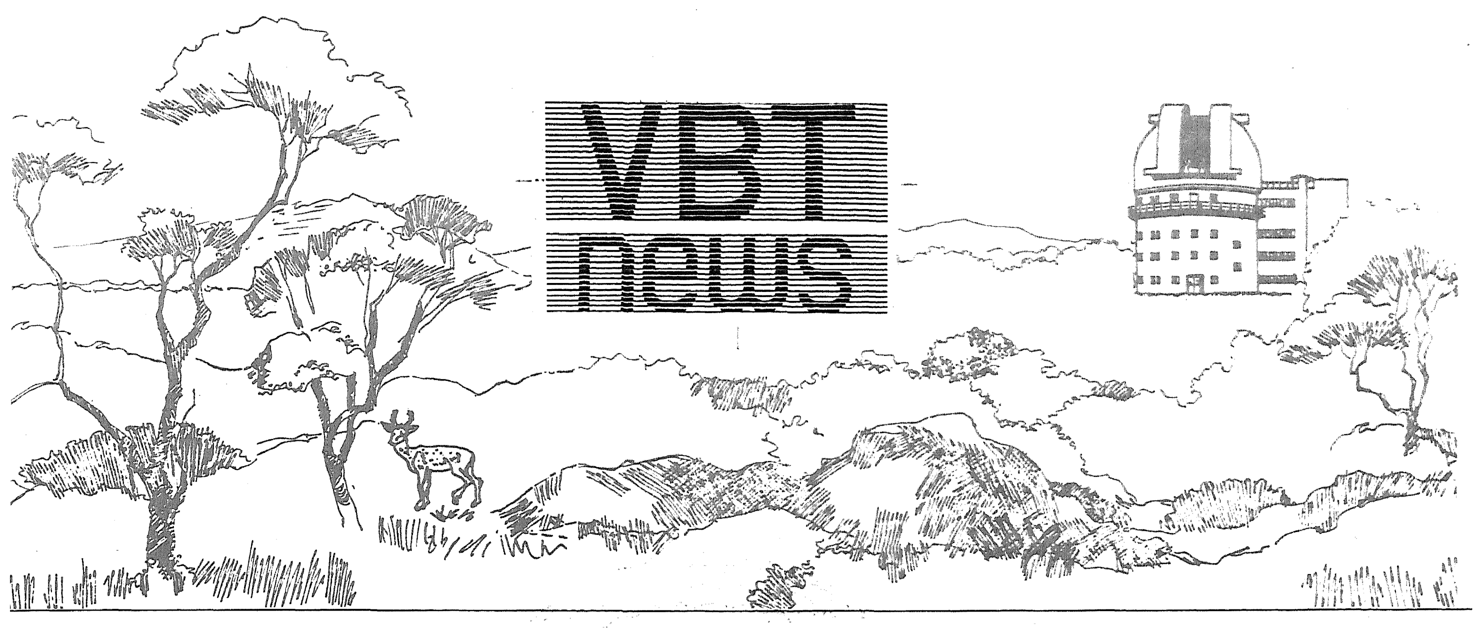
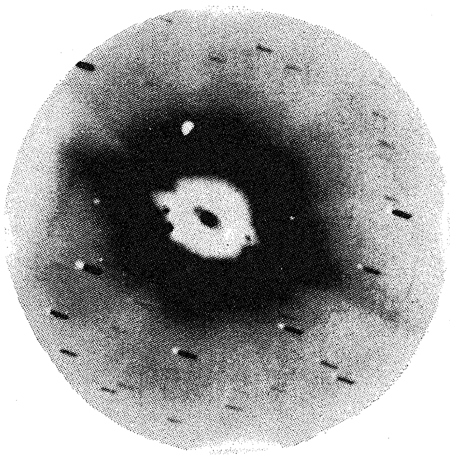
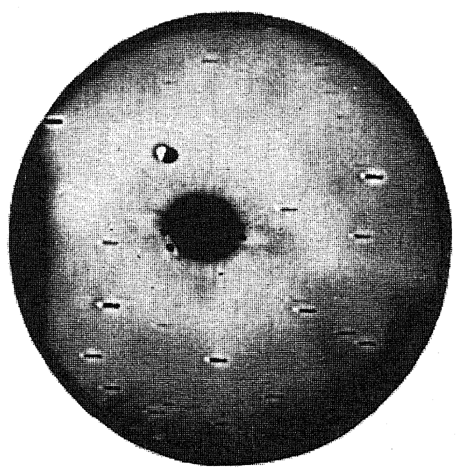


Number 4 June 1990

IMAGING THE OUTER RINGS OF SATURN





Occultation by Saturn of the star SAO 158913 on March 24, 1984 (immersion) and March 25, 1984 (emersion) by Vasundhara et.al (Nature **312**, 521, 1984) showed evidence of a ring system at a distance of 12.5 saturn radii. We tried to image this outer ring with VBT at the Cassegrain focus. Picture at left shows a two hour long exposure using Kodak 098-02 plate on the night of May 31, 1990. The central region was masked by a slightly out of focus image of Saturn.The mask was prepared by exposing a plate for seven minutes immediately preceding the experiment. Guiding was done using an intensified CCD camera (see VBT News No.2, April 1990). The guide star was drifted by the required amount to compensate for Saturn's motion. Corrections for differential flexture of the mount was also taken into account while guiding. Picture on right shows the faint features that could be brought out using unsharp masking. The apparent ring like structure at about 11 Saturn radii that is seen is probably an artifact of the subtraction procedure as it exactly lies across the east west spider arm and away from the equatorial plane of the planet. Search for still faint features are being continued.

J.C.Bhattacharyya and R.Rajamohan

THE SECOND VBT WORKSHOP

The Second VBT Workshop on Low Light Level Astronomy was held at Kavalur on April 19 and 20, 1990. In all about thirty participants from various astronomical Institutes in the country including a few from the universities, attended the meeting. Following the brief words of welcome by R.Rajamohan, the Convener of these workshops, the Director Prof.J.C.Bhattacharyya explained the purpose of these workshops to the audience. The Vainu Bappu Telescope, being a National Facility, is for the use of the entire Indian astronomical community and a periodic meeting of its users is, therefore, deemed essential for its coordinated development as a whole. It is also envisaged that these workshops will be the main forum where the projects using the VBT may be discussed, where the observers express their views on the performance of the telescope and its back-end instrumentation and where the scientists have an opportunity to meet and discuss problems with the technical personnel, responsible for the maintenance and continued upgrading of the facility.

The workshop was divided into four sessions of roughly two to two and a half hours duration. Session I dealt with some of the observational results that have been already obtained using the VBT. N.Kameswara Rao (IIA) presented the results on the Time Variability of the Polarization of the BL Lac object Mrk 421 which was observed by him in collaboration with M.R.Deshpande (PRL) in January 1990. A.V.Raveendran (IIA) spoke on the polarization studies carried out by him of RV Tauri stars using the PRL Polarimeter. K.P.Singh (TIFR) gave a comprehensive talk on Broad-band and Narrow-band Imaging of Galaxies with a CCD imaging system, a program where T.P.Prabhu (IIA), A.K.Kembhavi (IUCAA) and P.N.Bhat (TIFR) are the other collaborators. This talk was illustrated with some spectacular pictures of processed CCD images of a few galaxies and globular clusters that have already been observed. In session II some of the current projects were discussed. S.Seetha (ISRO) described the Whole Earth Telescope (WET) project for studying white dwarf pulsations and emphasised how VBT provides a vital link in this network. Some of the results obtained with the 1-m telescope as part of this project were also shown. T.P.Prabhu (IIA) spoke on the work done on the star forming regions in external Galaxies using the CCD imaging system with appropriate filters. The aim is to study the chemical evolutionary aspects of these galaxies, in particular to determine if the high mass end of the initial mass function showed spatial and temporal variations. D.C.V.Mallik (IIA) presented the case of Planetary Nebulae and suggested some of the key projects that might be undertaken with the VBT. Measurement of integrated H β fluxes of these objects and determination of magnitudes of their faint central stars, using in both cases the CCD as a detector, are two of these that could provide improved and much needed data for stellar evolutionary studies.

Future plans were projected in Session III where R.Nityananda (RRI) made a case for the observation of Gravitational Lenses particularly for monitoring sources over extended periods to detect microlensing. B.Datta (IIA) spoke on the importance of estimating the abundance of lithium in Pop II stars and how this may be used as a probe for the conditions existing in the Early Universe. P.Venkatakrishnan (IIA) gave a talk on Imaging at High Angular Resolution and listed several important projects that should be attempted with the VBT using a speckle camera.

The last session (Session IV) of the workshop was devoted to Instrumentation and Image Processing. A.R.Prasanna (PRL) read a paper on behalf of J.N.Desai (also of PRL) which describe the importance of having an Imaging/Scanning Fabry-Perot Spectrometer for the VBT. This could be used to great advantage in the studies of extended galactic objects. eg. HII regions, planetary nebulae. R.Srinivasan (IIA) spoke on Fast data acquisition with CCD systems to be developed in IIA and made available to the National Facility. A.V.Ananth (IIA) summarised the existing computational facilities at VBO and discussed the immediate future plans for further augmentation of the same. An hour long open discussion on Optimum Utilisation of Telescope Time then followed after which the meeting was formally declared closed.

D.C.V.Mallik

Optimum utilization of VBT Time

The last session of the VBT Workshop was devoted to a general discussion on how to increase the efficiency of the VBT in order to use it optimally during the next observing season. V.Chinnappan (IIA) and F.Gabriel (IIA) outlined the ongoing and planned developmental activities that included (a) automation of dome rotation in synchronism with telescope movement, (b) increasing the accuracy of RA display by another digit (to the tenth of a second of time), (c) digital display of focusing movement in millimetre scale, (d) digital display of TV guide position in millimetre scale, (e) remote operation of filter change at the prime focus CCD imager.

The past and prospective users of VBT expressed their satisfaction in obtaining some useful data from VBT during the last observing season, and in the efforts already underway to improve the efficiency. They reiterated the need of (b) to (e) above in order to obtain useful data on any reasonable project in a single observing season. Such an increase in efficiency would become an absolute necessity as the competition for observing time increases in future.

At the end of the last observing season both the CCD dewars available had developed vacuum leaks. This fact was detected only after discovering moisture condensation on the windows of the dewars, resulting in a loss of considerable observing time. In addition to maintaining the existing evacuation systems well, suggestions were made on the following improvements:

(1) acquiring a turbomolecular pump,

(2) acquiring a leak detector system,

(3) installing remotely-readable hygrometers at strategic places such as the prime-focus cage, observing floor, etc.

The discussion concluded with a suggestion from Prof.J.C.Bhattacharyya that the observers should spend some additional time at VBO for familiarization with the telescopes and instruments, participation in testing and preparation of the equipment prior to the observing run; and familiarization with site-dependant data handling subsequent to observations.

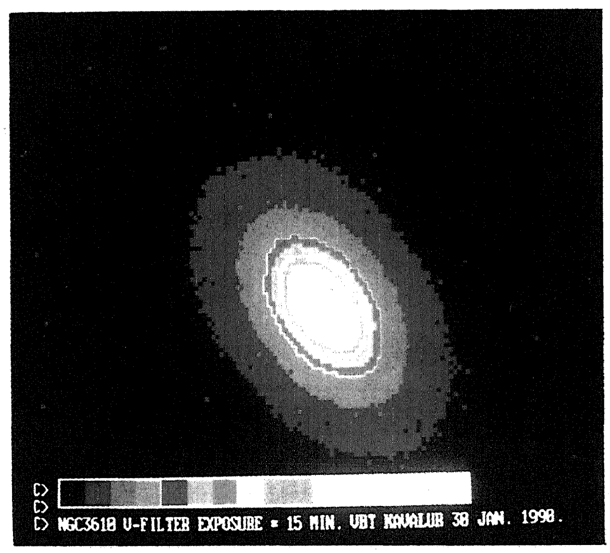
T.P.Prabhu

BROAD-BAND AND NARROW-BAND IMAGING OF GALAXIES WITH CCD : OBSERVATIONS AND CURRENT PLANS

K.P.Singh , Tata Institute of Fundamental Research Bombay

A Charge Coupled Device (CCD) is an ideal detector for imaging distant galaxies. It has virtually replaced the use of photographic plates because of its higher quantum conversion efficiency,low noise, large dynamic range, wide bandpass, photometric accuracy, geometric stability and ease of handling digitised images. In a collaborative effort between TIFR, IUCAA and IIA, a CCD chip (Type: P-8603/B GEC) with its controller and data acquisition system (details in Bhat et al. 1990) has been made operational at the prime focus of the Vainu Bappu Telescope (VBT). The large collecting power of the 2.34m VBT and a CCD at its prime focus make for an ideal combination for imaging the galaxies.

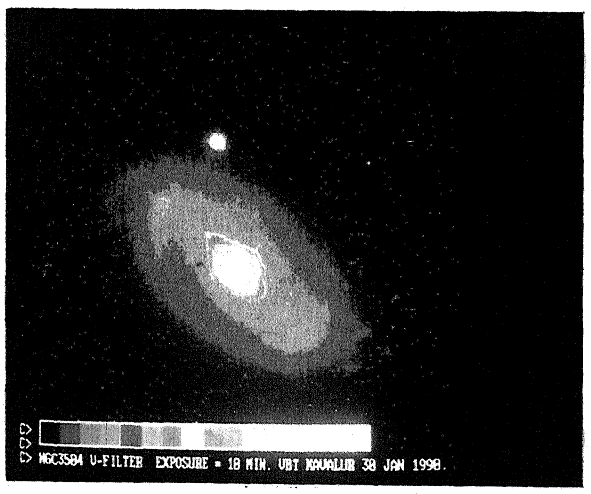
An observational programme for imaging field galaxies, and galaxies in an X-ray discovered cluster has been initiated. In the last week of January 1990, under fairly good sky conditions, we obtained pictures of a few targeted objects with the CCD at the prime focus of VBT. We used standard broad-band V, R and I filters, and typical exposure times ranged from 5 to 15 minutes. We obtained good flat-fields (for quantifying the sensitivity variations across the CCD) by taking exposures of the early morning sky. The images were transported on a magnetic tape in FITS format and a preliminary processing has been carried out in TIFR, Bombay. The processing i.e. bias subtraction, flat fielding etc., was performed on a PC-386 system equipped with a VGA monitor and using the PCVISTA (Treffers and Richmond 1989) software package.

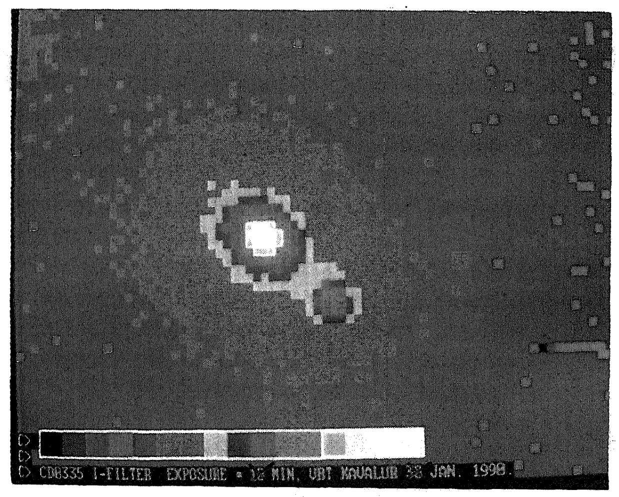


In the first photograph we show a processed image of a bright field elliptical galaxy NGC 3610(Type E5, B_T = 11.6 mag). The picture was taken with 15 minutes exposure time and using V- filter. The second photograph shows a cleaned image of a spiral field galaxy NGC 3504 (Type Sb(s), B_T=11.8 mag). The photograph has been obtained with 10 minutes exposure and using the V-filter. The image quality was estimated by studying the profiles of stellar images in the field of view. These stellar profiles were best fitted with a gaussian having a FWHM of ~3.5 arcsecs. The images of galaxies would be further processed and analysed (like deconvolving the image with the seeing profile, fitting ellipses to the isophotes etc.) to study the profiles and colour gradients of these and other targeted galaxies. Further analysis would help us to characterize the bulge and disk components of these galaxies and to investigate their mass-to-light ratios etc. Observations of a large sample of galaxies will be used to study correlations between various derived parameters, constrain models of galaxy formation and evolution, study the effect of galaxy-galaxy interaction etc. In the third photograph we show an image of the central D type galaxy (a large elliptical with an extended envelope) at a redshift of 0.035, in an X-ray discovered cluster 2A 0335+096. The apparent magnitude of the galaxy is approximately 16.0. This image is through the I-filter and was taken in a 5 minute exposure. A double nuclei can be seen very clearly in the image. The surface brightness in the outermost contours is estimated to be ~ 24 magnitudes per pixel. The X-ray emitting gas which extends to a radius of nearly 12

The above observational programme is expected to be continued in the following observing seasons. We also plan to extend this programme to carry out the imaging of the same objects using narrow band filters with their bandpasses centered on the strong emission lines present in many of these objects. For example, filters centered on H α,[O III], [S II] emission lines would help us study the regions of star formation in galaxies (both inside and outside the clusters) and map the emission line gas in the galaxies with strong nuclear activity.

The other collaborators in this programme are : P.N.Bhat (TIFR), A.K.Kembhavi (IUCAA) and T.P.Prabhu (IIA).





arcmin is centered on this galaxy and is accreting on to this galaxy in a cooling flow (Singh et al 1988). Cooling flows have been found to exist in many X-ray emitting clusters and are believed to be driving star formation and/or nuclear activity in the accreting galaxies. Analysis of the colour profiles of these galaxies is a very useful tool for studying the star formation and the nuclear activity in them. We have obtained broad-band images of a few selected regions of the cluster 2A 0335+096 which also include a powerful narrow angle tailed radio galaxy (Patnaik and Singh 1988). The colour profiles of this galaxy are being analysed. The complete cluster is expected to be covered in a few observing seasons. The distribution of galaxies, their colours and the colour gradients in the prominent members would be analysed to study the effect of the hot intracluster gas on the galaxies in the cluster.

The assistance of the telescope operators, engineers and the other staff at Kavalur is gratefully acknowledged.

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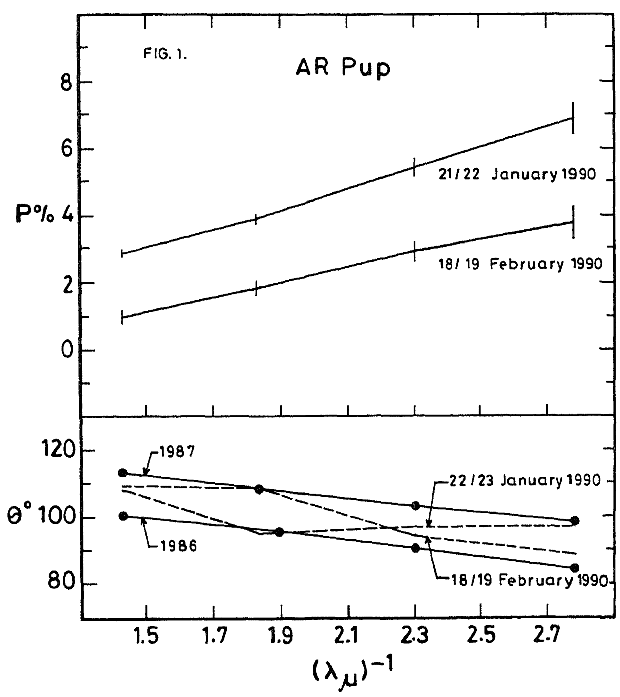
MULTIBAND POLARIMETRY OF RV TAURI STARS

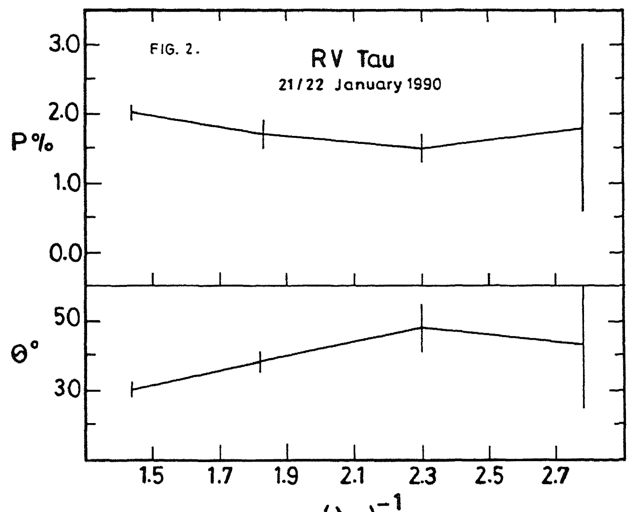
A.V.Raveendran, Indian Institute of Astrophysics, Bangalore.

RV Tauri are variable yellow supergiants and constitute an interesting and rather poorly understood class of pulsating variables. They display anomalous excesses in infrared radiation indicating the presence of cool and extended dust envelopes, presumably formed out of matter ejected from them. There are indications from both theoretical and observational studies that RV Tauri stars are Population II low mass objects undergoing post-asymptotic giant branch evolution, representing a crucial phase in the evolution towards white dwarfs.

In general, RV Tauri stars have received less attention polarimetrically. As part of an ongoing polarimetric programme, AR Puppis and the prototype RV Tauri were observed during Jan-Feb 1990 with the VBT and the results are plotted in Figure 1 and 2. Polarimetric observations of AR Pup have been reported earlier by Raveendran and Kameswara Rao (1987, Astron. Astrophys. **192**, 259) and Raveendran, Kameswara Rao and Anandaram (1989, Mon.Not.R.Astr. Soc. **240**, 823). Figure 1 also shows the mean values of the position angles in UBVR



bands obtained during 1986 and 1987 observing seasons. Even though the linear polarization observed in AR Pup shows a large variation (amplitude in U band ~15%), the position angles of polarization observed so far show only a range of ~20° implying the presence of a preferred plane about the star.



No polarimetric observations have been reported in the literature for the prototype RV Tau. Since the shape of the polarization curve (Figure 2) is different from that expected due to the interstellar medium alone, it is certain that the object is intrinsically polarized. The small dip in the polarization and the corresponding rotation of the position angle in the yellow-blue region suggests that the observed quantities are contaminated by the interstellar components.

The other collaborators in this programme are: N.Kameswara Rao(IIA), M.R.Deshpande (PRL) and U.C.Joshi (PRL).

VBT - ONE VITAL LINK IN WHOLE EARTH TELESCOPE NETWORK

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This report describes briefly the role, the Vainu Bappu Observatory, and in particular the VBT will play in the Whole Earth Telescope (WET) network, an international collaborative network for obtaining continuous photometric data. It is aimed mainly at studying pulsations in white dwarfs. The study of these pulsations is important because they can be used to probe stellar interiors as opposed to our current capability of observing merely surface phenomena. Moreover, pulsations being self excited, enable us to study syngle objects also, which are ob servationally less accessible.

The white dwarf pulsators are similar in every other way to the field white dwarfs. Therefore, whatever properties the pulsators reveal, can be extended to non-pulsating white dwarfs leading to the study of the properties of white dwarfs as a class. White dwarfs during the course of their evolution pulsate predominantly in three temperature ranges

DAVs	11,000 - 13,000K
DBVs	25,000 - 30,000K
DOVs	Above 80,000K

Since white dwarfs are remnants of stars less than 7Mo,their study gives important information about the progenitors and might provide an insight into the immediately preceding masslosing stages of stellar evolution which are difficult to observe.

The presence and the observations of oldest white dwarfs and the modelling of white dwarf evolution lead to an estimate of the age of the Galaxy and hence the age of Universe. The study of pulsating white 1|dwarfs may give important parameters like temperature, layer thicknesses etc. which will give improved limits for the white dwarf structure. Identification of a stable period P and the study of its variation with time P will help in observationally tuning current cooling theories and the constitutive physics and hence improve estimates of the age of the Galaxy.

The salient features of these pulsations are i) The periods typically range from 100 sec to 2000 sec. and ii) The amplitudes range from 0.005 mag to 0.34 mag for different objects. Since the apparent magnitudes of white dwarfs are typically fainter than 13,

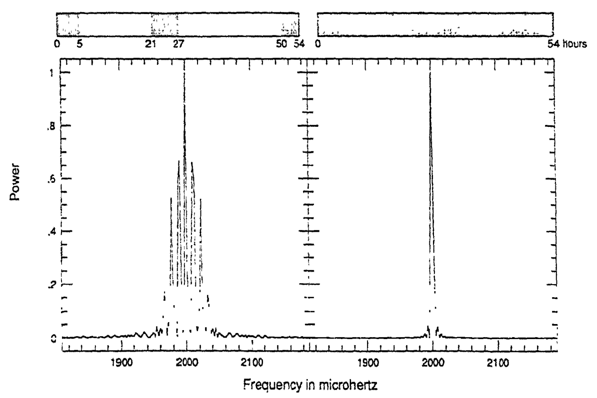

Fig 1. Fourier transforms of a single, noise-free, untapered sine wave sampled as indicated at the top of each panel. Fig 1a (left panel) shows the "alias" pattern typical of time series data from a single site with daytime gaps. Fig 1b (right panel) shows the pattern obtained if the gaps are not present.

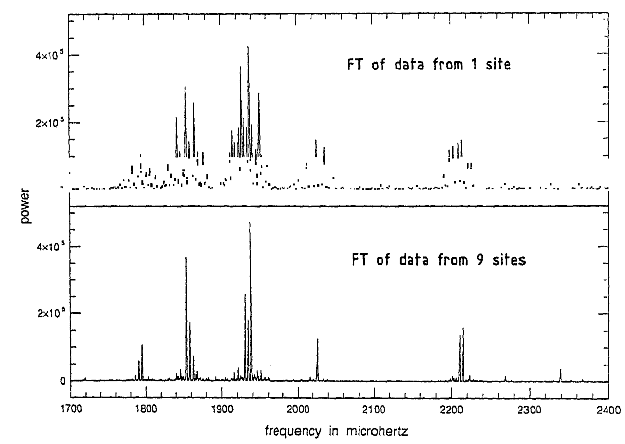

Fig 2. A portion of the power spectrum of data collected on PG1159 in March 1989. The top panel gives the FT of data collected from a single site and the bottom panel gives the resolved FT using data collected from all sites.

these pulsations are observable with telescopes of diameter 1 metre or greater.

The main aim in the study of white dwarf pulsations is to resolve the various pulsation periods present in the system and to establish they are stable. In order to do this we have to collect long stretches of continuous photometric data which are then subjected to Fourier analysis. The technique of Fourier transform will give accurate estimate of the period present and its amplitude, provided we have an infinite length of noiseless data. In reality we have gaps in our optical photometric data at least due to weather conditions and daybreak. Any data gap leads to 'aliases' in the output Fourier transform (FT). These are beats caused by the actual frequencies present and the data gap lengths, giving rise to the appearance of various close frequencies in the FT. For example in Fig 1, a simulated data using a single sine frequency (at 2000 micro Hz = 500 sec period) subjected to an FT analysis is shown. The left hand side portion (fig 1a) shows the FT of a sine wave sampled as shown in the top panel (which is very similar to data collected for a single site for three days). The right hand side portion (fig 1b) shows the FT of the same sine wave when sampled continuously for 54 hours. The presence of aliases in the FT is obvious for the data with gaps (fig 1a) thus highlighting the problems of determing the exact frequency present in the data.

In actual photometric data, in addition to data gaps, we also have i) noise superposed on the signal ii) multiple closely spaced frequencies excited from the stellar object Thus in order to resolve these frequencies it is necessary to obtain as long a data stretch as possible with high signal to noise ratio. This is the foremost aim of the WET with which coordinated observations are conducted from observatories at different longitudes distributed over the globe. The main difference between other networks and WET is that as much as possible, this network is operated in real-time. The PI who is present at the control centre at the University of Texas at Austin contacts observers at various sites on a day-to- day basis (wherever possible) both to review weather conditions and observations conducted and also to change priorities or maximise data length. Thus the WET can be effectively called "A multi-mirror telescope with its elements distributed around the earth at various longitudes and operated nearly in real time". (See Nather et al 1990).

The real time operation of this network helps in

i) optimising data collected such that we get overlapping data; but in case the weather is good at two nearby sites, data can also be obtained on a second priority object.

ii) minimising weather effects by communicating between closely spaced sites, thus helping in obtaining as long a stretch of data as possible.

iii)overlapping data increases the confidence in the data quality and can be very useful for studying aperiodic phenomena like transients, flares etc.

The network was started in March 1988. India joined the network from November 1988. For the March 1989 run the observatories which comprised the network were

Observatory	Location
McDonald	Mount Locke, Texas, USA
Univ.of Hawaii	Mauna Kea Hawaii, USA
AAO	Siding Spring Mt., Australia
VBO	Kavalur, India
SAAO	Sutherland, South Africa
Haute-Provence	St.Michel, France
Roque de los Muchachos	La Palma Canary Islands
LNA	Itajuba, Brazil
CTIO	Cerro Tololo, Chile

All sites have at least a two star photometer and are equipped with identical data collection and recording facilities. Fig.2 shows a portion of the power spectrum of the data collected on PG1159 using WET in March 1989. The top panel gives the FT of data collected from a single site and the bottom panel gives the resolved FT using data collected from all sites. The effectiveness of multiple sites in contributing to the significant reduction of alias power is obvious even though the multisite data still has some gaps.

An Indian site is crucial for obtaining data in the interval 16- 22 hr UT. No other co-ordinating observatory exists on this longitude and the Indian site has to bridge the data gap between South Africa and Australia. In case of a northern object which cannot be accessed by southern observatories, India will be the only site between France and Hawaii. This gap will reduce with the inclusion of Israel as a site from March 1990. Kavalur in India has the added advantage of being at $12^{\circ}.5$ latitude. Thus it can access objects of both the hemispheres, which is often not possible for many of the other sites. An ideal situation would be to have more than one observing site in India to reduce the effects of weather patterns. So far we have contributed data using the 40-inch telescope at Kavalur. A two star photometer which has been operational for some time at ISRO has been used for data collection in this project since November 1988. There exist however only a handful of white dwarf pulsators which are brighter than 14.5 magnitude. Therefore within a year or two of operation of WET, the brighter objects which are accessible will be studied and it will be necessary to go in for bigger telescopes in order to observe the fainter objects. In addition, the amplitude of the pulsations are typically less than 0.01 magnitude. Thus from the point of view of improving the signal to noise ratio also, data collection using bigger telescopes will be essential. In this respect the VBT will form the vital link in the network to obtain data from 16-22 hour UT which should be predominantly contributed from an Indian site. With better weather patterns and better communication links it is certain that the VBT will significantly contribute to the quality of the data collected and to a better understanding of the Universe.

The authors wish to thank B.N.Ashoka, K.Kasturirangan, T.M.K. Marar, V.N. Padmini, and C. Padma for their whole hearted contribution towards the success of the Indian participation in the WET network.

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SEARCH FOR PRIMORDIAL LITHIUM

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Homogeneity of the primordial universe is one basic assumption in the standard hot big bang model in cosmology[1]. This model gives correct abundances for light element nuclei (H, D, ^{3}He, ^{4}He, ^{7}Li) provided the density of the universe making up the baryonic matter is no more than about a tenth of the density that is required for a flat universe. It is generally accepted that the universe be flat, in preference to other modes of expansion, for only then certain basic puzzles concerning the large scale structure of the universe can be resolved[2]. Therefore, in recent times, the question has been raised : can there be a modification of the standard model which (a) gives a flat universe having only baryons (that is, nuclear matter) and no exotic dark matter and (b) preserves the primordial light element abundances? Since there now exists cumulative evidence to suggest that neutrons, protons and all other subnuclear particles are composites of more elementary units called quarks, it has been suggested[3] that the early universe underwent a phase transition from quarks to nucleons accompanied by a supercooling. In such a scenario, there would arise density inhomogeneities, and the possibility that quark nuggets could survive up to the present era, making up the nine-tenths of the universe's density that we believe is non-luminous. This way, there would be no need to invoke exotic particles to explain the dark matter in the universe. However, a theoretical problem in most such calculations is an undesirable 'overproduction' of the isotope ^{7}Li, although this point remains debatable as the nature of the cosmic phase separation is something that is not well understood[4]. Observationally, there exists a very large scatter in the estimates of ^{7}Li at a variety of stellar sites. Therefore, an important research theme in cosmology today is : what the primordial ^{7}Li abundance should be.

For relatively low values ($< 3 \times 10^{-10}$) of the nucleon density characterized by η, (η = total nucleon density divided by the total photon density), ^{7}Li is produced mainly by the reaction

$$^4He + ^3H \text{--------}> \gamma + ^7Li$$

and destroyed by the reaction

$$^7Ly + p \text{-----------}> \alpha + ^4He.$$

At higher values of η ($> 3 \times 10^{-10}$), there is an alternate way of producing lithium by electron capture on beryllium :

$$^7Be + e^- \text{--------}> \nu_e + ^7Li$$

The beryllium comes from the reaction

$$^4He + ^3He \text{------}> \gamma + ^7Be$$

in the early universe. Thus the abundance ratio (^{7}Li/H) acquires a non-monotonic behaviour with respect to η, and this is referred to as the lithium valley. For a quantitative description of the lithium valley, see reference 1. The lithium valley is not accurately determined because there exist major uncertainties in the rates of the reactions mentioned above for the relevant temparature range (which is upwards of MeV). Therefore, the abundance of ^{7}Li is considered to be no more accurate than a factor of two to three, and it is certainly not ruled out at the present time that the uncertainty in the observational estimate is comparable, or even less than, the theoretical uncertainty.

Abundances of ^{7}Li have been estimated in hundreds of stars in various stages of stellar evolution. These are based on measurements of the equivalent widths of the Li I resonance doublet at 6707.761 Å and 6707.912 Å. Among the sources identified for this purpose are supernovae, supermassive objects, novae, red giant interiors. Production of lithium in solar-like flares and due to cosmic ray spallation are also possible. As a star evolves, the lithium near the surface can be diluted and destroyed by various transport mechanisms. Stars hotter than about 8000 K are not good sites for lithium observations as in such stars the Li I resonance line will be too weak to observe. Estimates based on Population I stars, meteorites and interstellar gas give[1]:

$$^7\text{Li/H} = 10^{-9} \qquad (1)$$

whereas studies of Population II stars give [5]:

$$^7\text{Li/H} = (0.7 - 1.8) \times 10^{-10} \qquad (2)$$

If the value (2) is primordial, the galactic disk must have enriched itself in lithium uniformly by a factor of ten. On the other hand, if the value (1) is primordial, the Population II stars must somehow have uniformly destroyed lithium by a factor of ten. A resolution between these possibilities constitutes a central issue in cosmology today. A plausible scenario is that measured lithium abundances in Population I stars is a combination of primordial lithium plus lithium produced by Galactic cosmic rays. In that case, the lithium abundance seen in Population II stars would set a lower limit for primordial ^{7}Li. This, therefore, suggests that it will be worthwhile to go for an extensive observation of ^{7}Li in as many halo dwarfs as possible. The requirements for this are high resolution spectroscopy and sensitive detectors. With the VBT, such an aim is perhaps at its limiting edge. With a slightly bigger class of telescopes, this is an achievable goal. At the same time, a more accurate determination of the cross-sections of the following reactions

$$^4\text{He} + {}^3\text{He} \dashrightarrow \gamma + {}^7\text{Be}$$

$$^7\text{Li} + p \dashrightarrow \alpha + {}^4\text{He}$$

$$^7\text{Be} + n \dashrightarrow p + {}^7\text{Li}$$

$$^3\text{He} + \alpha \dashrightarrow \gamma + {}^7\text{Li}$$

at temperatures > MeV will provide a valuable guide in estimating primordial lithium.

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PHOTOPOLARIMETRIC OBSERVATIONS OF COMET AUSTIN WITH VBT DURING PRE-PERIHELION PHASE ON FEBRUARY 20, 1990.

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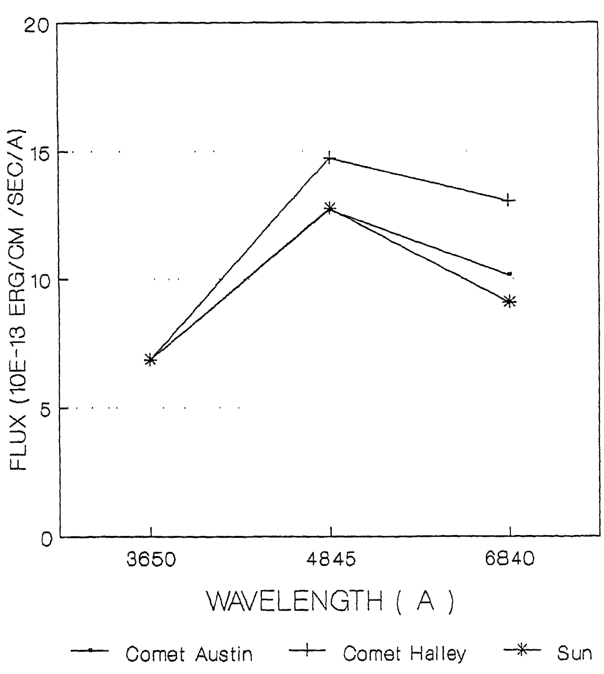
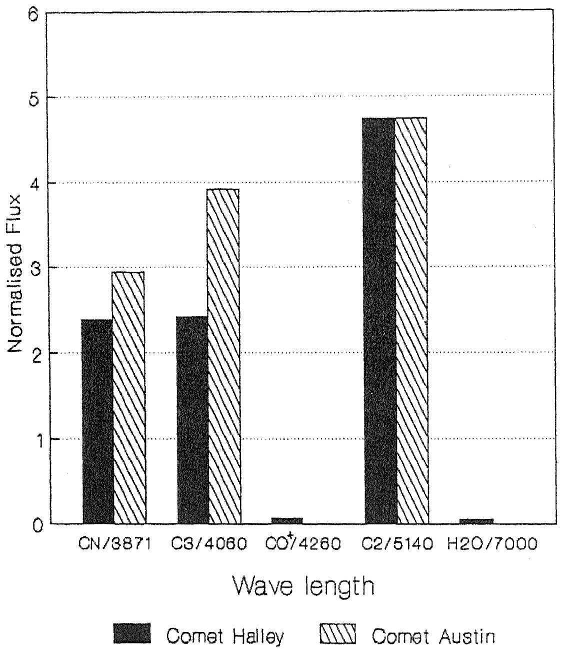
One of the spectacular events in the solar system is the appearance of comets from time to time. These objects give an opportunity to study various physical processes as they pass around the Sun. One such important study relates to the nature and dynamics of dust particles, behaviour of gas in the cometary environment and the time evolution of different interesting features in the tail like knots, helices, disconnection events etc. With some of these objectives in mind several experiments were planned and carried out successfully for the recent comet "Austin". As a part of this programme, the first observations were carried out with VBT on February 20, 1990 to study the nature of the dust particles, neutral (C_2, C_3 and CN) and

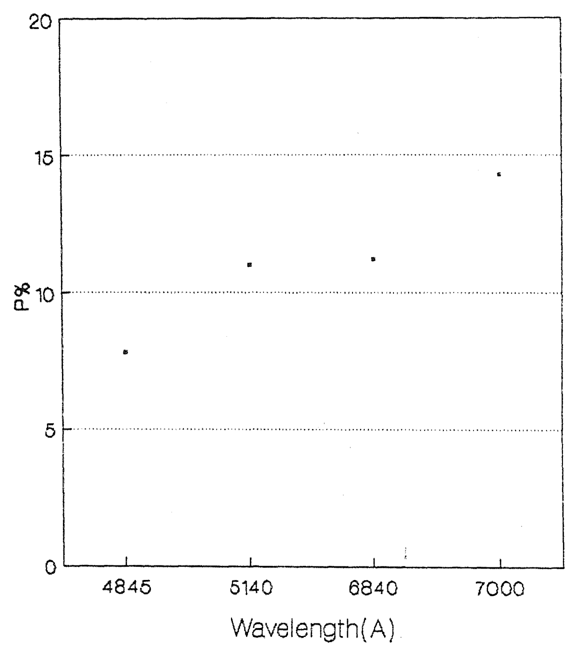


Observed Continuum fluxes in Comet Austin on Feb 20,1990. Fluxes were normalised w.r.t. Comet Halley flux of March 19, 1986 at 3650Å

ionized (CO^+ and H_2O^+) gases using a set of IHW filters (UC:3650, CN:3871, C_3:4060, CO^+ :4260, BC:4845, C_2:5140, RC:6840, H_2O^+:7000) (Note:UC,BC,RC: Ultraviolet, Blue Red Continuum respectively). These observations are quite important and significant as they give the opportunity to make a comparative study between the Comet Halley and Comet Austin as Comet Halley is a periodic Comet and Comet Austin is a new Comet.



Fluxes in different emission bands as observed on Feb 20,1990. For comparison Comet Halley data on Mar 19,1986 is also shown.



Wavelength dependence of polarization in Comet Austin observed on Feb 20, 1990.

The flux distribution of Comet Austin, observed through these continuum filters, when compared with that of Comet Halley and the Sun, show that Comet Austin seems to contain less number of particles and Fluxes indifferent emission exhibit less reddening. The distributiuon of fluxes in various molecules in both the comets show that CN and C_2 are relatively strong in Austin compared to Halley.CO^+ and H_2O^+ are almost non-existent in Comet Austin. To study the nature of dust particles, polarization in different wavebands were made. In Comet Austin, polarization was found to be increasing with wavelength.

We have made post-perihelion observations on 1.2m Gurushikhar telescope and imaging polarimetry on two 14" telescopes. We hope that after a careful analysis of various types of data (on photometry and polarimetry in various filters, imaging polarimeter) in different wavebands and also some interesting tail features recorded by Schmidt camera we will be able to identify difference between these two Comets, which we hope will give a good handle to understand the properties of different types of comets.

NARROW- AND BROADBAND IMAGING OF EXTRAGALACTIC GIANT H II REGIONS

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A study of the stellar content and chemical evolution of galaxies requires a knowledge of the history of star formation. Canonically, the history of star formation is split into two components, the time-dependent star formation rate (SFR) expressed as the mass of gas converted to stars per unit time at a given instant, and the shape of the mass spectrum of stars formed (IMF: the initial mass function) assumed to be constant, at least in the first approximation. There are no compelling reasons to believe that the IMF is universal in time and space (see Tinsley, 1980). On the other hand, evidence has been accumulating that the IMF is bimodal, being a superposition of two different spectra one relating to stars more massive than about $1 M_{\odot}$, and the other relating to lower mass stars. It would appear that the individual modes are themselves variable in time and space, depending on the characteristics of the protostellar cloud such as the metallicity and internal dynamics (see Scalo, 1986).

Individual star-forming complexes (SFCs) in galaxies offer a fertile ground for the study of variation of high-mass end of the IMF. First, the SFCs in a broad-based sample of galaxies offer a diversity of physical conditions. Secondly, the duration of star-formation burst in

SFCs is short enough to render the evolutionary effects tractable (see Lequeux et al., 1981). Finally, one can make in an individual SFC the assumption on the uniformity of physical conditions, and consequently on the constancy of the IMF. The ionizing radiation inferred from the observed properties of H II regions around SFCs provide information on the massive O stars ($M > 15\ M_\odot$), whereas the continuum luminosities of SFCs provide information on the intermediate-mass B stars ($15M_\odot > M > 10\ M_\odot$). Many investigations have hence used giant HII complexes to probe the properties of star formation. (see e.g., Lequeux et al., 1981; Vilchez and Pagel, 1988).

The stellar content of the SFCs may be probed by comparing the observed spectra of stars plus gas with the one synthesized theoretically using an assumed IMF and SFR. The synthetic spectra are generally computed using stellar evolutionary tracks and model atmospheres (see Leitherer 1990, for a recent critical application).

We propose to investigate the high mass end of the IMF of young star clusters in different extragalactic HII regions using broadband continuum fluxes and narrowband line fluxes. Since the Lyman continuum flux originates mostly in O type stars, whereas the blue band flux mostly in B type stars, the ratios of these two quantities can be used as a diagnostic of the IMF for $M > 5M_\odot$. We describe here different narrowband images needed to estimate the Lyman fluxes from the ionizing star cluster. Addition of other broad- and intermediate-band continuum filters enable subtraction of background continuum from the narrowband images and also provide further constraints on the visible continuum from the embedded cluster. The Balmer line emission is an indicator of Lyman continuum flux. One can derive the latter from the former assuming case B recombination, and an ionization-bounded nebula. The results are weakly sensitive to the assumed electron temperature (T_e). One needs to correct the observed fluxes to the interstellar extinction in order to get a realistic estimate of the Lyman flux. T_e, and abundances O/H and N/H are interrelated for observed HII regions, and to a fair degree of approximation one can estimate these quantities using empirical relations between them and a few observed emission-line ratios (see e.g. Edmunds and Pagel, 1984; McCall et al.,1985). Sahibov and Smirnov (1990) obtained the following empirical relations using published observational data:

$$12+\log(\frac{\mathrm{N}}{\mathrm{H}}) = (8.16\pm0.17) + (1.10^{+0.17}_{-0.15})\log([\mathrm{NII}]/\mathrm{H}\alpha), \qquad (1)$$

$$12+\log(\frac{\mathrm{O}}{\mathrm{H}}) = (8.82\pm0.07) - (0.80^{+0.18}_{-0.15})\log([\mathrm{OIII}]/\mathrm{H}\beta), \qquad (2)$$

$$12+\log(\frac{\mathrm{N}}{\mathrm{H}}) = -(4.7^{+0.9}_{-1.1}) + (1.4\pm0.1)(12+\log(\frac{\mathrm{O}}{\mathrm{H}})), \qquad (3)$$

$$T_e(\mathrm{K}) = -(15800^{+1800}_{-2100}) - (7200\pm500)\log(\frac{\mathrm{O}}{\mathrm{H}}). \qquad (4)$$

Here, [NII] and [OIII] represent the observed fluxes in [NII] 6548, 6583 Å, and [OIII] 4959, 5007Å, respectively. The relations (1)-(4) imply that O/H, N/H, and T_e in individual HII regions are mutually related. The effect of metallicity on T_e is well-known since higher metallicity increases the efficiency of cooling. Relation (4) also depends on the rate of heating due to the ionizing flux. It has hence already been used to infer that lower metallicity favours high-mass star formation (Campbell et al., 1986). The metallicity Z is computed by

$$\frac{Z}{Z_\odot} = \frac{1}{2}[\frac{\mathrm{N/H}}{0.912\times10^{-4}} + \frac{\mathrm{O/H}}{0.661\times10^{-3}}]. \qquad (5)$$

The method we outline here requires imaging of HII regions in Hα + [NII],[OIII] and Hβ lines, and in broad bands corresponding to nearby continua. Fluxes in these bands are integrated over the entire HII region. The background continuum is estimated from the broadband images and subtracted (e.g. from V band for OIII and Hβ and from R band for Hα). The ratio [O III]/Hβ is used to determine O/H and T_e. Then N/H is computed and the Hα flux is estimated from Hα + [NII]. The interstellar extinction is computed using Hα and Hβ fluxes. The Hβ flux and T_e are used to compute the Lyman continuum photon flux (N_L) using the relation (Lequeux, 1989),

$$\frac{N_L}{1\,\mathrm{ph\,s^{-1}}} = 2.47\times10^{62}(\frac{I_{H\beta}}{1\,\mathrm{erg\,cm^{-2}s^{-1}}})(\frac{T_e}{10^4})^{-0.09}(\frac{d}{1\mathrm{Mpc}})^2, \qquad (6)$$

or from an equivalent relation for Hα.. These parameters are then used to compute the total spectrum of the HII region. The broadband magnitude of the stellar component is then estimated as

$$I^{o}\mathrm{band} = \mathrm{I\ band} - \mathrm{I\ cont} - \mathrm{I\ lines} \qquad (7)$$

where I_{band} is the observed magnitude of gas and stars, I_{cont} and I_{lines} are the contributions to the band from the continuum and line emission from the gas, respectively. Preliminary results using published spectrophotometric data and imaging from the 1-m reflector at VBO have shown not only that the method is sound, but also brought out intrinsic differences in the IMF of metal-poor and metal-rich star-forming regions. We obtained a relation

$$\log\frac{N_L}{L_B} = 6.74^{+1.29}_{-1.08} - 1.86^{+0.48}_{-0.65}\log Z, \qquad (8)$$

L_B being the blue luminosity of the embedded star cluster. The HII regions with higher N_L/L_B have lower metallicity in comparison with those with a lower value. The conclusion is that metal-rich clusters are deficient in O-type stars. We propose to study a sample of extragalctic giant HII regions using the VBT in the following observing season.The visit of FHS to IIA was supported by the USSR Academy of Sciences, Indian National Science Academy Bilateral Exchange Programme. He thanks Director, IIA for hospitality.

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Photograph by R.C.Kapoor

Jacaranda is a very beautiful tree and is considered among the best flowering trees of sub-tropical and tropical regions. It is a native of Argentina but now very common in Indian gardens. The flowers are violet-and-blue in colour, small and bell shaped, and bloom in huge bunches covering the whole tree during the flowering season. The tree grows to a height of eight metres and the foliage resembles that of a fern being symmetrical and elegant. Any one visiting Kavalur during the months of March, April and May will not forget the beautiful sight of Jacarandas lining the 'Milky Way' (the path running east-west in front of 40-inch Dome). The above picture was taken in Bangalore campus.

A.Vagiswari

VAINU BAPPU OBSERVATORY

Sky Condition at Kavalur, March - June 1990

Month 1990	Spectroscopic hours	Photometric hours
March	177	63
April	198	78
May	55	06
June	60	00

The deadline for receiving proposals for the allotment of observing time on the 2.34m Vainu Bappu Telescope for different quarters are:

15 February	for April - June
15 May	for July - September
15 August	for Oct - December
and 15 November	for Jan-March

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