No. 29 – September 1982

The Users Committee – Where the Grassroots Talk

G. Lyngå, Lund Observatory, Chairman of the UC

Once a year, a sunny day in May, the Users Committee meets. Each national representative has from his colleagues at home brought a long list of complaints, suggestions and expressions of gratitude to ESO.

A number of ESO staff members devote the day listening and supplying information to them. The Director General, the Director in Chile, sometimes the head of the TRS, the head of the visiting astronomers office and several of the leading astronomers and engineers are present.

The agenda starts with a report by the Director General: Status of major telescope projects, future instrumentation and such matters. Then the Director in Chile and the head of the TRS describe the present condition of the instruments, the problems that have already appeared and those to be expected. These items are then open for discussion by the UC.

After this, the representatives of the various member countries present their points on different details of the La Silla activities, and also on the visitors facilities at Garching. Subjects debated concern calibration of equipment, information or lack of information about observing routines, logistics, etc. It is gratifying to note the good spirit in which reasonable criticism is accepted by the ESO staff. Often ESO can meet the demands, and at other times a compromise can be reached. If a certain point cannot be resolved, it is the task of the national representative to return that information to the colleague who raised the point. In all cases the airing of opinions is felt to be useful.

Sometimes the agenda contains special points which are of immediate concern. Last May we discussed the importance of astronomical staff on La Silla. Users and ESO representatives agreed about the essential function that is filled by staff astronomers who, for the benefit of their own research, take part in the development of state-of-the-art equipment. It was also pointed out that the staff astronomer is in a much better position than the visitor to detect the malfunctioning of instruments or telescopes.

The Users Committee is not only a safety valve for disgruntled visiting astronomers. It is also a fruitful collaborative effort where the ESO staff and the observers' representatives meet, talk and listen to one another.

Professor M. K. V. Bappu, 1927–1982

It is in the deepest sorrow that we have to announce the untimely death of Prof. M. K. V. Bappu, Director of the Indian Institute of Astrophysics, Bangalore, and President of the International Astronomical Union. He passed away in Munich, on August 19, 1982, during a visit to ESO, following complications after major heart surgery. An obituary will follow in the next issue of the *Messenger*.

The Metal Content of Magellanic Cloud Cepheids

J. W. Pel, Kapteyn Astronomical Institute, Groningen, the Netherlands

Introduction

Ever since 1912, when Miss Leavitt discovered the famous period-luminosity law for Cepheids in the Magellanic Clouds, the Clouds have played a central role in the study of these important and fascinating pulsating stars.

The reason for this is simple: the Magellanic Clouds are relatively small in comparison to their distances from us. When looking at one of the Clouds, we observe therefore stars which are all at approximately the same distance. A second advantage is that the extinction by interstellar dust in the Clouds is much less of a problem than in our own Galaxy, where it is a major obstacle for determinations of absolute magnitudes, distances, and intrinsic colours. Fortunately Cepheids occur frequently, both in the Large Cloud (LMC) and in the Small Cloud (SMC), and since they are supergiants they are still reasonably bright, even at a distance of 50 or 60 kiloparsecs. For an analysis of the relative differences between Cepheids of various periods the Clouds are therefore uniquely suited.

The relation between the most important observable properties of Cepheids is usually expressed by a refined version of Miss Leavitt's law, the period-luminosity-colour (P-L-C) relation. On the one hand, this relation describes the Cepheid region in the Hertzsprung-Russell (HR) diagram: it gives the period for a Cepheid of given luminosity and temperature (colour). On the other hand, it is fundamental for the use of Cepheids as distance indicators: for a Cepheid of a given period, colour, and apparent magnitude, it gives the absolute magnitude and the distance. Since long-period Cepheids are sufficiently bright to be seen in galaxies considerably more distant than the Magellanic Clouds, the P-L-C relation is an important tool in the calibration of extragalactic distances, and it is particularly this application that accounts for the fame of the relation.

Before we can apply it to derive distances, or to study the physical properties of Cepheids, the P-L-C relation has to be established accurately in the first place. This turns out to be a difficult problem, and even 70 years after Miss Leavitt's discovery, the work on improvements of the P-L-C relation is still continuing. From our earlier remarks it is clear that the slopes of the relations between P, L and C are most directly obtained by observing Cepheids in the LMC and SMC. Without independent information on the distance to the Clouds, we cannot determine absolute magnitudes, however, and the "zeropoint" of the P-L-C relation has to be found by other means. Usually this zeropoint is derived from a number of Cepheids which are members of galactic clusters, where distances can be determined from the cluster main-sequence stars. In principle it should be possible to calibrate the P-L-C relation entirely by means of these clusters, and to establish a relation that is based purely on galactic Cepheids, but unfortunately too few Cepheids in clusters are known, and they cover a too limited part of the whole range of periods.

There would be nothing against the combination of galactic and LMC/SMC Cepheid data, or against the determination of extragalactic distances from a P-L-C relation with a "galactic" zeropoint, if only we could trust that Cepheids are indeed the same in all galaxies. Especially for the Magellanic Cloud Cepheids the situation appears to be more complicated, however. There is convincing evidence for differences in average chemical composition between the Magellanic Clouds and the Galaxy, both for the interstellar medium and for the stars in these systems. These differences can be characterized as a decreasing abundance of the heavier elements along the sequence Galaxy-LMC-SMC. It turns out that composition differences can have noticeable effects on the P-L-C relation and on several other properties of Cepheids. Only very recently the first direct information on the chemical composition of Magellanic Cloud Cepheids has become available, also indicating a deficiency in heavy elements as compared to Cepheids in the solar neighbourhood. In this paper I will discuss some of these new results, which have been obtained with the Dutch telescope on La Silla.

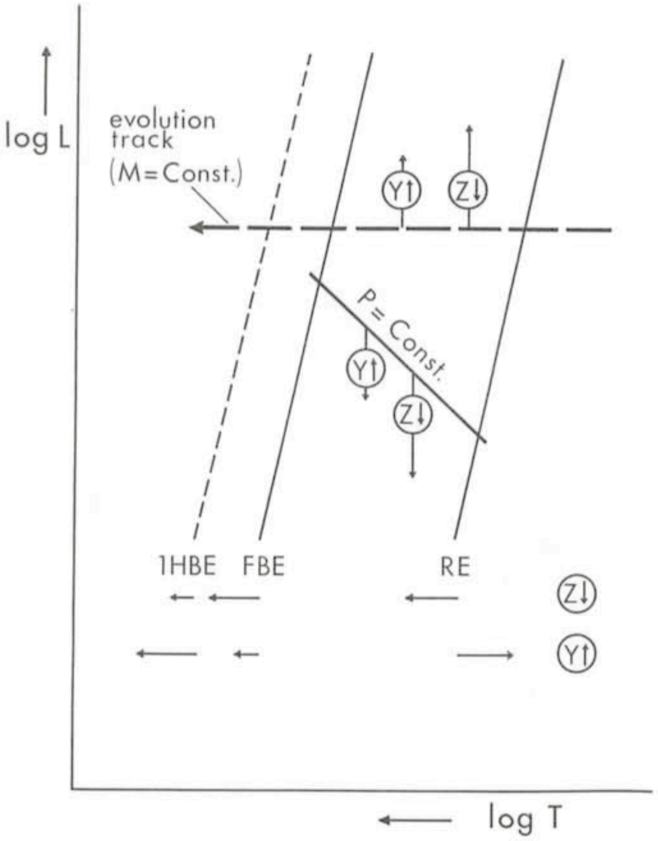

Fig. 1: *Sensitivity to helium (Y) and heavy-element (Z) abundances of the Cepheid strip in the theoretical HR-diagram. Arrows indicate schematically the effects of changes in Y and Z on the boundaries of the strip, and on the position of evolutionary tracks and constant-period lines. The blue edges for pulsation in the fundamental and first harmonic modes are indicated by FBE and 1HBE, the red edge by RE.*

Composition Effects in Cepheids

At first sight it seems surprising that one should worry about chemical composition when dealing with Cepheids. Cepheids, at least the "classical" ones that we are discussing here, are young and massive population-I stars (10^7– 10^8 years, 4-12 $M_\odot$), all passing through the same evolutionary phase, and one expects that their composition is never very different from that of the Sun. Moreover, they all obey the same pulsation relation, which is very insensitive to composition. This relation is not the only law that governs Cepheids, however, and the composition effects enter otherwise.

The basic pulsation law gives the period of a Cepheid as a function of its mass and radius. It can also be written as a function of mass, luminosity, and temperature. This relation is nearly independent of composition, but it contains the mass, which usually cannot be determined directly. To arrive at the more "observable" P-L-C relation, we have to do two things: firstly to eliminate the mass by

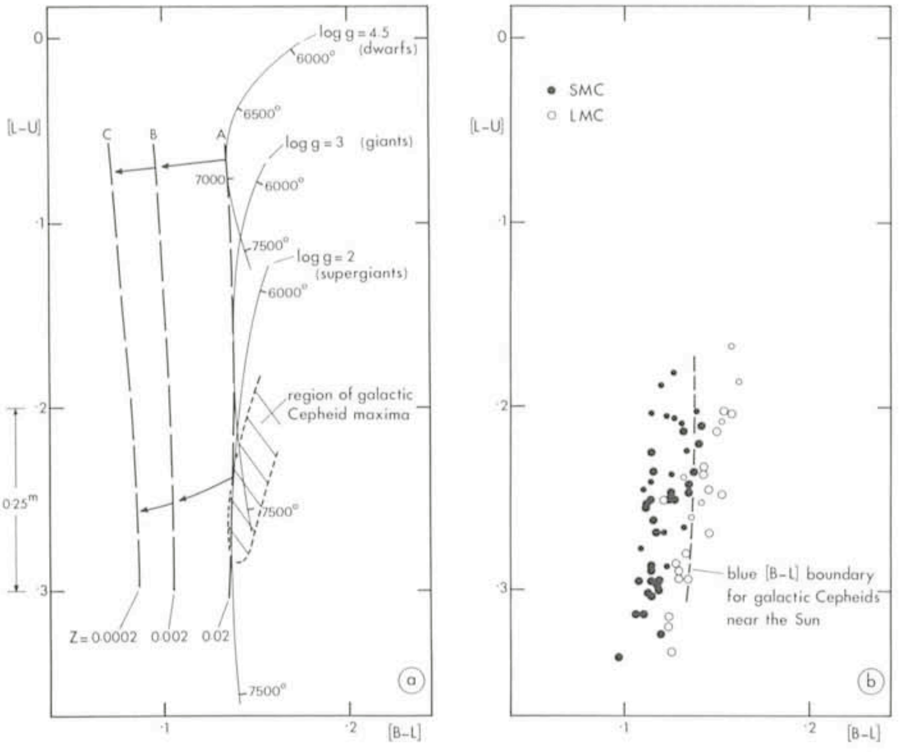

Fig. 2a and 2b: *Abundance effects in the [B-L] – [L-U] two-colour diagram. The scale is in log (intensity), so 0.1 scale unit is 0.25 mag. Fig. 2a gives the effects of temperature, pressure (log g) and heavy-element content Z, in the temperature range 6000–7500° (schematically). These theoretical colours are derived from the model atmospheres by R. L. Kurucz. For a given Z, the constant-temperature and constant-pressure lines form a sharp boundary at nearly constant [B-L]. Along this boundary [B-L] depends almost purely on Z. Line A gives this boundary for the solar value of Z (Z = 0.02). For lower Z the [B-L] boundary moves towards the left (lines B and C).*

Measurements near maximum light for 11 LMC and 14 SMC Cepheids are given in Fig. 2b. Smaller symbols denote observations further away from the maximum phase. The dashed line indicates the blue [B-L] boundary defined by maxima of Cepheids in the solar neighbourhood.

means of the mass-luminosity law for Cepheids, and secondly to relate the temperature to some observable colour via a colour-temperature relation. The problem is that both the M-L and the C-T relation are composition-sensitive, the first one because stars of the same mass but with different compositions evolve differently, the second one because, at the same temperature, stars with different chemical abundances have different spectra.

The pulsation law and the P-L-C relation predict the period of a Cepheid, but they do not tell us why it pulsates. In order to know which supergiants become Cepheids, and how the boundaries of the Cepheid instability-strip in the HR-diagram are determined, we need detailed knowledge about the physics of Cepheids. After thirty years of extensive theoretical work on the evolution and pulsation of Cepheids, the main features of Cepheid behaviour are now reasonably well understood. As a result of this theoretical effort a few more composition-sensitive factors have been discovered. Not only will a change in composition result in a different M-L law for Cepheids, which causes a shift of the lines of constant period in the HR-diagram, but it turns out that also the blue and red boundaries of the Cepheid strip in the HR-diagram are composition-sensitive, as well as the way in which the evolutionary tracks populate the strip. These composition effects on the width and position of the Cepheid strip are illustrated schematically in Fig. 1; the effects in the P-L-C relation are shown in Fig. 3, but I will return to this later.

New Results on the Composition of Magellanic Cloud Cepheids

Up to recently the evidence for chemical differences between the Galaxy and the Magellanic Clouds came almost exclusively from studies of the interstellar medium. Various differences between galactic and LMC/SMC Cepheids had been observed, and many authors had interpreted them as composition effects, but direct information on abundances in Magellanic Cloud stars was hardly available. This situation has now been improved by the work of H. C. Harris (*Astron. J.* **86,** 1192, 1981), and by the results obtained at La Silla by A. M. van Genderen, J. Lub, and the author (first results in *Astron. Astrophys.* **99,** L1, 1981). Both studies use a photometric technique to determine the metal content of Cepheids.

Harris observed a large number of galactic and SMC Cepheids in the Washington photometric system. This is a broadband system specifically designed to measure the strength of metal lines in the blue and near-ultraviolet part of the spectrum, and it provides two metal-sensitive indices which are independent of interstellar extinction. For the 45 SMC Cepheids in his programme Harris finds a mean metal abundance which is about a factor 3.5 lower than for galactic Cepheids near the Sun. An important aspect in the study by Harris is the possibility to detect gradients in metal content across the Galaxy and the SMC. Cepheids are particularly suited for this since they are visible over large and well-known distances, and since their spectra contain many metal lines. For this purpose Harris observed 102 galactic Cepheids, over a large range in galactocentric distances. The metal content of these stars shows an outward gradient of $-15\,\%\ \mathrm{kpc}^{-1}$. No similar gradient is found in the SMC.

Let me try to describe in some more detail the programme of VBLUW photometry for Magellanic Cloud Cepheids by A. M. van Genderen, J. Lub, and myself. This started as one of the first programmes with the Dutch 90 cm telescope and the Walraven VBLUW photometer after the move to La Silla, as a follow-up of the large VBLUW project on galactic Cepheids and RR Lyrae stars carried out previously in South Africa. In fact Van Genderen had observed some SMC Cepheids with the Walraven photometer already, and he had found indications of a low metal content in these stars, but the South African summer was "bad season", and the poor seeing at Hartebeespoortdam made photometry in dense fields very difficult. It was decided to tackle the problem again from La Silla, making use of the excellent conditions there, of the improvements that the photometer had undergone in the meantime, and of a new promising method discovered during the analysis of the large VBLUW material on galactic pulsating stars.

The Walraven photometer measures simultaneously in five passbands of intermediate width (cf. J. Lub. *The Messenger* No. 19, 1979). This gives four independent colours, but since the W signals for Magellanic Cloud Cepheids are too faint (W lies at 3230 Å!), we are left here with only three. The composition effects that we want to determine have to be separated from at least three other factors: temperature and pressure in the stellar atmosphere, and interstellar reddening. This makes 3 observed quantities with 4 unknowns, but fortunately there occur "degeneracies" in certain colour combinations, where some of the unknowns cancel out. It is such a situation that we apply in our metal index [B-L].

The method is illustrated in Fig. 2. Since [B-L] and [L-U] are defined to be independent of interstellar reddening, this diagram is reddening-free, but [B-L] is very sensitive to the abundance of heavy elements (mainly Fe and other metals). Fig. 2a shows schematically the effects of temperature, pressure, and metal content around temperatures of 6500 K. In this temperature range the intrinsic lines for a fixed composition form a sharp vertical boundary. [B-L] at this boundary is almost purely sensitive to metal content. This range around 6500 K is reached by the maxima of large-amplitude Cepheids, and this allows us to determine the metal abundance in these stars in a temperature-, pressure- and reddening-insensitive way. The results obtained at La Silla for 14 SMC Cepheids and 11 LMC Cepheids are shown in Fig. 2b. After calibrating the diagram by means of the theoretical spectra by Kurucz, and by stars with spectroscopic abundance analyses, we find a mean metal deficiency of a factor 5 for the SMC Cepheids, and a factor 2 for the LMC Cepheids (compared to their galactic counterparts). Observations of non-variable F-type supergiants in the Clouds by Van Genderen confirm these numbers. These results agree within the uncertainties with the data of Harris for the SMC, and they are also consistent with spectroscopic calcium abundances for Magellanic Cloud supergiants by Smith (H. Smith, *Astron. J.* **85**, 848, 1980), who finds that calcium is low by a factor 4 in the SMC and a factor 1.6 in the LMC.

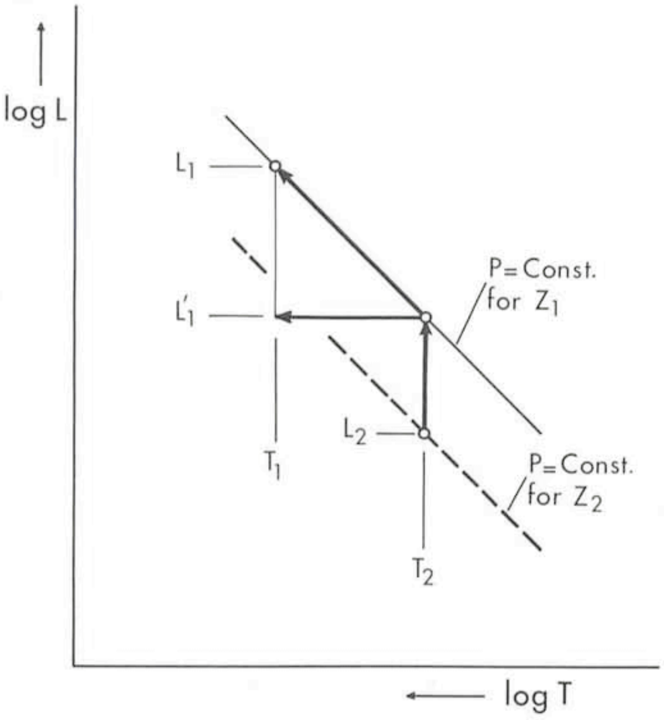

Fig. 3: *The sensitivity to Z of the P-L-C relation. T_2 and L_2 are the real temperature and luminosity of a Cepheid with period P, colour C, and $Z = Z_2$. When applying a P-L-C relation for $Z = Z_1$ ($Z_1 > Z_2$) to this star, we assign a higher temperature, T_1, to the same colour C, and also use a too luminous line of constant P. The result is that we put the star at (L_1, T_1), and overestimate the luminosity. For Z_1 = 0.02 and Z_2 = 0.005 the error is L_1–$L_2 \simeq$ 0.5 magnitude.*

This new information on abundances in Magellanic Cloud stars is still very limited, but it fits well with the existing data on emission nebulae in the Clouds (cf. Pagel and Edmunds, *Ann. Rev. Astron. Astrophys.* **19**, 1981), and it is clear that we can no longer ignore composition differences between the Cepheids in SMC, LMC, and Galaxy, or between those in inner and outer regions of the Galaxy. One of the most far-reaching consequences of these differences is the effect that they have on the P-L-C relation, which is particularly sensitive to Z. We saw already in Fig. 1 that a decrease in Z shifts the constant-period lines towards lower L. At the same time the C-T relation changes, making the colour of a Cepheid at a given temperature bluer for lower Z. The result of both effects is (Fig. 3), that by applying a "solar" P-L-C relation to Cepheids with low Z, we overestimate their luminosities. If we assume that metals are representative for the overall heavy-element content, the SMC Cepheids have probably $Z \simeq 0.005$. In this case a P-L-C relation for $Z = 0.02$ would give 50 % too high luminosities, or distances that are 25 % too large.

This example, although schematic and incomplete (e.g. we did not yet discuss the effects of Y), demonstrates that abundance determinations are not only necessary for a better physical understanding of Cepheids, but also for improved accuracy of the Cepheid distance scale, which still remains one of the "steps towards the Hubble constant".

List of Preprints Published at ESO Scientific Group

June – August 1982

201. H. PEDERSEN, J. VAN PARADIJS, C. MOTCH, L.COMINSKY, A. LAWRENCE, W. H. G. LEWIN, M. ODA, T. OHASHI and M. MATSUOKA: Optical Bursts from 4U/MXB 1636–53. *Astrophysical Journal.* June 1982.
202. H. PEDERSEN et al.: Simultaneous Optical and X-ray Bursts from 4U/MXB 1636-53. *Astrophysical Journal.* June 1982.
203. P. A. SHAVER, A. BOKSENBERG and J. G. ROBERTSON: Spectroscopy of the QSO Pair Q0028+003/Q0029+003. *Astrophysical Journal,* Letters. June 1982.
204. J. ROLAND, P. VÉRON, D. STANNARD and T. MUXLOW: MERLIN Observations of Compact Sources with Very Steep Radio Spectra. *Astronomy and Astrophysics.* June 1982.
205. A. F. M. MOORWOOD and I. S. GLASS: Infrared Emission and Star Formation in NGC 5253. *Astronomy and Astrophysics.* August 1982.
206. A. C. DANKS, M. DENNEFELD, W. WAMSTEKER and P. A. SHAVER: Near Infrared Spectroscopy and Infrared Photometry of a New WC9 Star. *Astronomy and Astrophysics.* August 1982.

A SIT Vidicon for Surface Photometry

E. H. Geyer and A. Hänel, Observatorium Hoher List, Daun

Introduction

The study of surface brightness distributions of extended cosmic light sources is an essential observational approach to understand their spatial structure. In general, however, surface photometry is difficult to interpret without other supporting observations like spectroscopy, which yields the velocity field or other physical parameters. The reason is that the surface illumination is the total number of light sources within a conical column along the line of sight. This cone is the solid angle of an individual picture element ("pixel") projected onto the sky by the telescope optics. Therefore, astronomical surface photometry yields the surface density of cosmical light sources, which is badly contaminated by light sources in the fore- or background or even in the surrounding field.

Under certain assumptions (spheroidal system, no internal absorption), which seem to be fulfilled in globular clusters, the spatial star and luminosity distribution can be derived using star counts, which give the surface star density, and surface photometry, respectively. Thus the relative mass-luminosity ratio and its variation within these systems can be unambiguously studied.

For some years we have used star counts to investigate the age dependency of physical and structural parameters of open and globular clusters in the Large Magellanic Cloud (LMC). These counts have been made using photographic plates taken with the ESO Schmidt and 3.6 m telescopes. However, this plate collection is not suitable for surface photometry due to different problems inherent to the photographic material. Therefore, we designed at our observatory an efficient area photometer which is based on a digital detector system with a SIT vidicon.

Methods of Surface Photometry and its Difficulties

Until the advent of modern two-dimensional digital detectors like vidicons or charge-coupled devices (CCDs), astronomers had to rely on the photographic plate and the photomultiplier for surface photometry. Though the photographic plate is still unrivalled as an imaging detector as far as its resolution and geometrical size are concerned, it shows a number of drawbacks: photographic material has no linear response with a very limited dynamic range, it shows the reciprocity failure and has a threshold. As the photographic plate can only be used once, point by point photometric calibrations of the whole plate are impossible and restrict its photometric accuracy.

On the other hand the photomultiplier, which has not the drawbacks of the photographic plate, is a none-imaging detector. It detects all the radiation, to which it is sensitive, from the solid angle which the photocathode sees through the telescope optics. Therefore it is not placed into the focal plane of the optics but into their exit pupil. This solid angle is proportional to the ratio of the square of the diameter of the diaphragm in the focal plane to the telescope's focal length. Due to scintillation and diffraction effects encountered in ground-based observations the angular size of the focal plane diaphragm can't be made smaller than typically 10 arcsec. Thus, doing surface photometry with a conventional single-beam photometer, the extended object must be scanned either by moving the telescope relative to the object or by moving the diaphragm in the focal plane. This observing mode is very time-consuming and all information from points outside the diaphragm, but within the telescope's field, is wasted. For example, during an observing run of 5 nights in November 1979 at the ESO 50 cm telescope we could obtain brightness profiles in B and V of only two globular clusters in the LMC. Furthermore, surface photometry with a single-beam photometer suffers from background variations due to atmospheric transmission and/or airglow. A double-beam photometer, as has been designed for ESO in 1976 by one of us (E. H. G.) can overcome these last difficulties.

The SIT Vidicon and the Area Photometer

The situation for astronomical surface photometry has recently changed with the introduction of modern two-dimensional multi-element detector devices like vidicons and CCDs. These detectors not only allow digital image processing but also have a large dynamic range ($> 10^3$) and show linear response within this wide range. This offers the possibility to correct for sensitivity variations of individual pixels.

In considering to purchase a panoramic detector for our project we had to take the limited manpower and budget at our observatory into account. Therefore we decided for a commercial digital two-dimensional detector based on a **s**ilicon **i**ntensified **t**arget (SIT) vidicon. Such vidicons have successfully been used at different observatories for several years, mainly for spectroscopy (e.g. at Cerro Tololo Interamerican Observatory: Atwood et al., 1979, *Publ. A.S.P.*, **91**, 120, Hesser and Harris, 1981, *Publ. A.S.P.*, **93**, 139). Our detector system is called

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ANNOUNCEMENT OF AN ESO WORKSHOP ON

PRIMORDIAL HELIUM

ESO Munich, 3–4 February 1983

This workshop is intended primarily to survey the existing observational evidence regarding the primordial abundance of helium and related light elements, and to explore new avenues for improved abundance determinations.

There will be both review papers and short contributions, and a panel discussion on future prospects. The proceedings will be published by ESO.

Further information can be obtained from:

P. A. Shaver	D. Kunth
ESO	Institut d'Astrophysique
Karl-Schwarzschild-Str. 2	98 bis, Blvd Arago
D-8046 Garching bei München	F-75014 Paris
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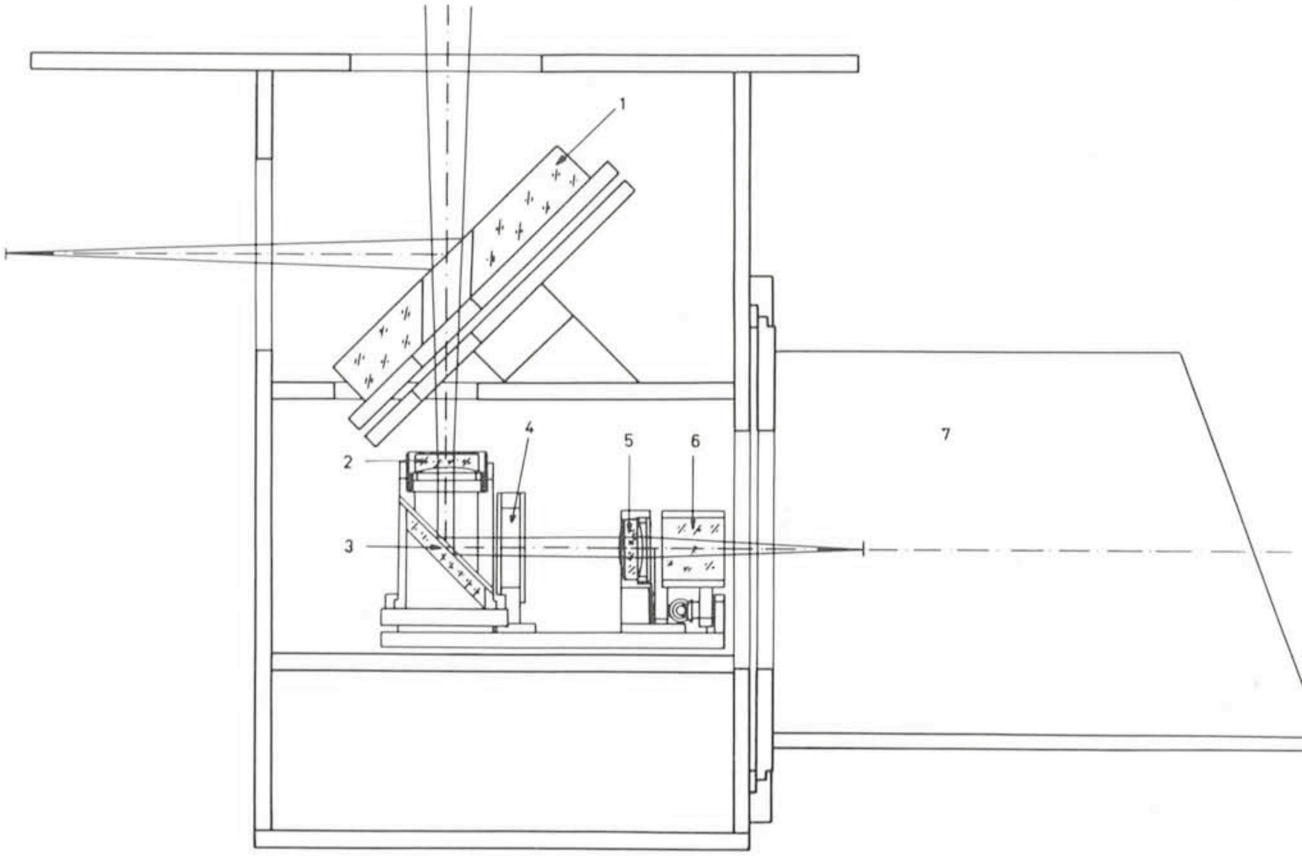
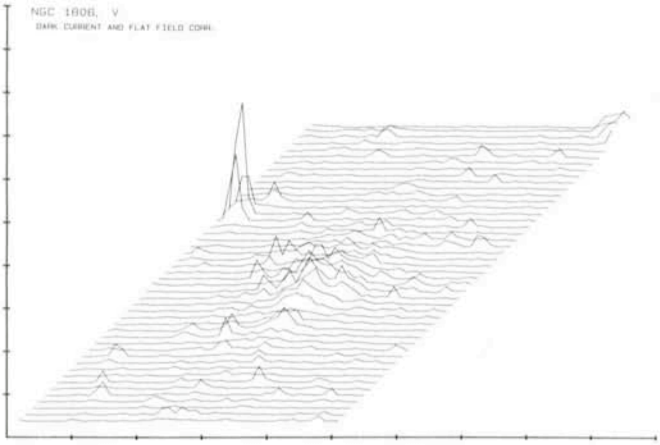


Fig. 1: *Schematic layout of the area photometer. 1 – field observing mirror, 2 – negative achromat lens, 3 – flat mirror, 4 – filter holder, 5 – positive achromat lens, 6 – control ocular, 7 – cooled housing with SIT vidicon.*

"**O**ptical **M**ultichannel **A**nalyzer", OMA 2 (improved version, manufactured by EG & G Princeton Applied Research Co.) and consists of three units: the SIT vidicon, its control unit and a computer console with peripheral plotter and printer. This system has been purchased by a generous grant of the German Science Foundation (Deutsche Forschungsgemeinschaft, DFG, grant Ge 209/8, 11–2).

The physical principles underlying the SIT vidicon have been described elsewhere (e.g. Ford, 1979, *Ann.Rev. A&A,* **17,** 189), so that we summarize them only very briefly. Our SIT or EBS (**e**lectron **b**ombarded **s**ilicon) vidicon consists of an electrostatically focused image intensifier with a S20 photocathode. The photoelectrons are accelerated and focused onto the storing target, which consists of a thin disk of monocrystal silicon with a microscopic array of several million diodes on it. The usable target area is 12.5 x 12.5 mm^2. Without image intensifier these silicon diodes behave like photodiodes with a high quantum efficiency (**s**ilicon **t**arget [ST] vidicon). With the image intensifier tube, the target is bombarded by electrons with energies of some keV and an amplification of 1,500 is achieved. The diodes behave like capacitors and can store a charge image corresponding to the optical image for about 0.5 sec at room temperature before it leaks away due to thermal recombination. If the target is cooled to about $-50°$ C with dry ice, thermal recombination as well as dark events are significantly reduced and the charge picture can be stored up to 1 hour. The charge image is then read by an electron beam with a diameter of 25 μm; this can be done using certain scan patterns programmed by the controller and the computer console. The recharging current flowing through the electron beam is a measure for the charge of the target. All scan operations and signal digitization is performed by the multichannel detector controller. This is connected to the computer console, based on a LSI-11 microcomputer, which provides control functions for the controller and for acquisition, manipulation and storage of up to 18,000 16 bit words. The computer operating system and the data are stored on 8 inch flexible disks. Due to its operating system the computer can't be programmed to the user's demand. Nevertheless some routines for reduction using simple arithmetic techniques

Fig. 2: *The area photometer at the 1 m telescope; detector controller, monitor and computer console can be seen in the foreground.*



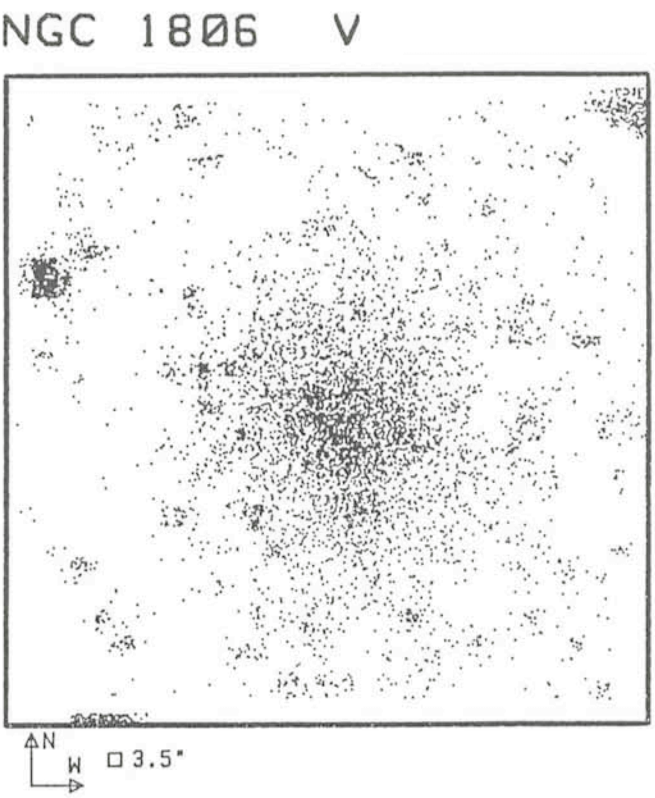
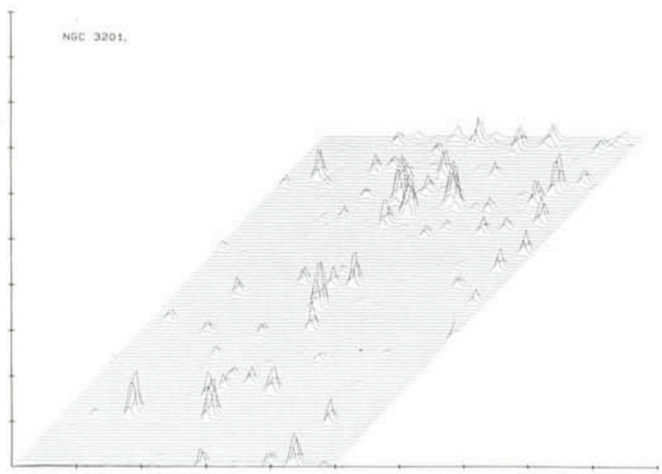


Fig. 3a: *NGC 1806 in V, a red globular cluster in the LMC. This "3D-plot" has been generated by the OMA 2 software and shows 50 tracks shifted by a small amount in the channel direction (x-axis) and intensity (y-axis). Pixel size is 250 × 250 μm² corresponding to 3.45 × 3.45 arcsec² and integration time was 3.5 min, dark current has been subtracted and the image has been corrected for pixel to pixel variations using a flat field.*
Fig. 3b: *Same object. This "grey scale plot" simulates a photographic picture: in each pixel square a number of points proportional to the count rate (intensity) of this pixel has been randomly distributed. Directions on the sky, pixel size and the grey scale with the appropriate count rates are plotted below the picture. Some defects at the edges of the picture—especially in the lower left and upper right corner—are due to some imperfections in the detector system.*

(e.g. background and flat field corrections) and for plots and data transfer are incorporated into the operating system.

For the use at the Cassegrain focus of the 106 cm telescope of Hoher List Observatory, which is identical to the ESO 1 m telescope, a mechanical-optical system, the area photometer (Fig. 1 and 2), has been built in our workshop. Beside different arrangements for finding, centering and guiding the objects to be observed, this photometer has an optical transfer system, consisting of a negative and positive lens, yielding a parallel beam before the image is focused onto the SIT vidicon. Colour or interference filters of different thickness can be inserted into this parallel beam, so that the time-consuming procedure of refocusing the detector is avoided. Presently we are also incorporating grating prisms (grisms) for spectrophotometry in the $\lambda/\Delta\lambda \simeq 200$ resolution range.

The smallest pixel size of the detector is 25 ×50 μm² which corresponds to 0.35 × 0.7 arcsec² at the f/15–1 m telescope. Due to the finite computer memory we use for surface photometry larger pixel sizes of 125 × 125 μm² or 250 × 250 μm² corresponding to 1.7 × 1.7 arcsec² or 3.45 × 3.45 arcsec², respectively, on the sky. This can be



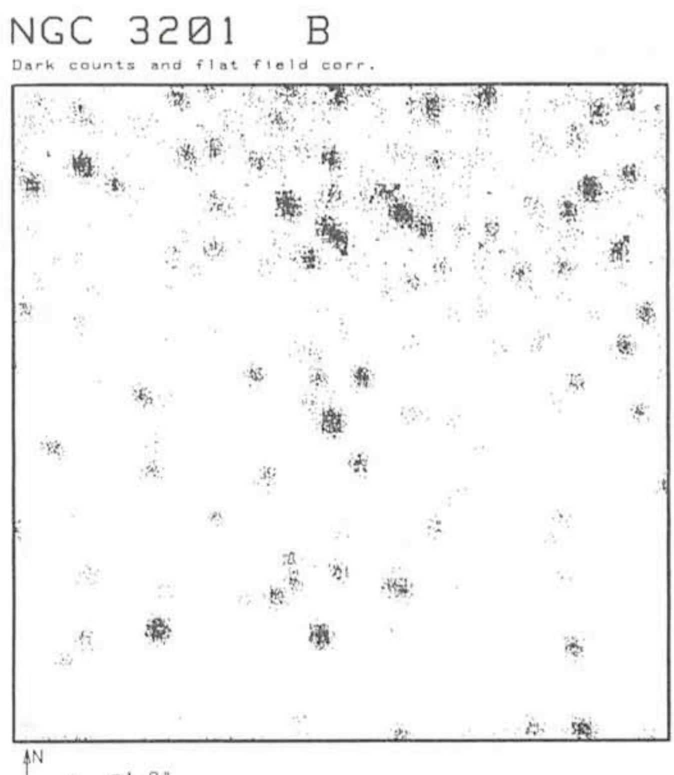


Fig. 4a: *Southern part of NGC 3201 in B. Pixel size is 125 × 125 μm². 3D-plot as in Fig. 3a.*
Fig. 4b: *Same object as in Fig. 4a, grey scale plot as in Fig. 3b.*

allowed for since in most cases the stellar images are blurred to the same size due to seeing. Increasing the pixel size has the advantage that the detector's dynamic range is improved. Therefore the square image frame consists of 100 × 100 or 50 × 50 pixels and the image size corresponds to 2.9 × 2.9 arcmin² at the 1 m telescope.

The First Observations

Due to some technical difficulties with the system's electronics and bad weather conditions in October and November 1981, the instrument could undergo only short test phases at Hoher List Observatory before it was shipped to Chile. During our observing run of 7 nights in January 1982 at the 1 m telescope on La Silla the instrument worked perfectly: for 20 young (blue) and old (red) globular clusters of the LMC surface photometry with 3.45 × 3.45 arcsec² pixel size could be carried out in the ranges U,B,V,G and R of the UBV and RGU colour systems. (An example of these observations is given in Fig. 3.) The typical integration time per image frame was 3.5 minutes. This shows clearly the enormous effectiveness of such modern panoramic detectors. During the morning hours, when the LMC was too low, we additionally obtained observations of galaxies and some galactic objects (open and globular clusters, Hα regions, planetary nebulae). On 100 × 100 pixel frames (pixel size 1.7 × 1.7 arcsec²) of the globular cluster NGC 3201 stars fainter than $17^{m}_{.}1$ and $16^{m}_{.}3$ in B and V could be detected (Fig. 4). Up to now only preliminary reductions have been done. However, the enormous amount of data we have collected requires more detailed evaluation to derive brightness and colour profiles of these globular clusters. We hope that we can report about the results in the near future.

Acknowledgement

We thank the ESO technical staff on La Silla for their assistance which contributed significantly to our successful observing run.

Dust and Young Stars in Puppis

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Introduction

Two decades ago the presence of a group of young stars in the constellation Puppis was noted and described by Westerlund (*Mon. Not. R. Astr. Soc.* **127,** 71, 1963). This group appears to form an association of hot and luminous O and B stars also containing the long-period cepheid RS Puppis. The association was named Puppis OB 3. In the region occupied by the association a number of small and peculiar bright nebulae were noted as well as several dark globules and dust lanes (Fig. 1). Also present in the region is the H II region RCW 19 which obviously is excited by the most luminous of the association members. The age of the association was estimated from the most luminous member, the O7f star HD 69464, to be no more than $4 \cdot 10^6$ years. Thus the stage seemed to be set for the scrutinizing of a relatively restricted region of recent star formation concerning the content of both stellar and interstellar material. The following is only intended to be a progress report of this project as some of the recent observational material is still being analysed.

Observations

To get as much information as possible about the different constituents in a region of star formation a number of various techniques must be applied, covering a large part of the electromagnetic spectrum reaching from the ultraviolet to radio. Most of the observational material, in the optical and infrared (IR), for this project was collected at ESO, La Silla, partly together with Westerlund, during the period January 1980 to January 1982. Spectra of the 10 brightest OB stars were taken at high dispersion (12 Å/mm and 20 Å/mm) with the coudé camera of the 1.5 m telescope. These spectra yielded spectral types as well

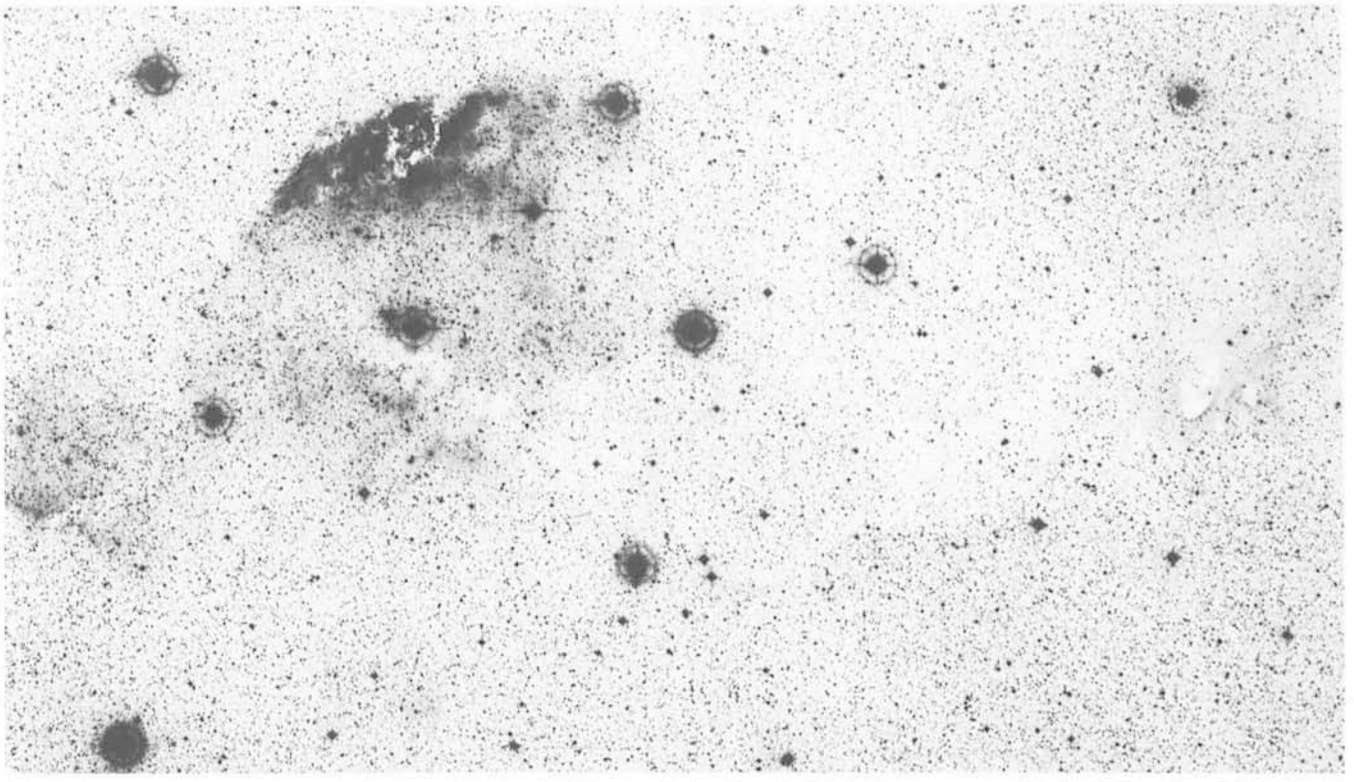


Fig. 1: *The southern part of the region occupied by the OB association Puppis OB 3. This part contains the H II regions RCW 19 (left of centre), excited by the O7f star HD 69464, and RCW 20 (extreme left). To the extreme right is a complex of cometary globules. Projected against RCW 19 and spanning the stellar background between it and the globules is an obscuring dust lane. See also Fig. 5. The bright stars in the field are foreground stars. North is up and east is to the left. (ESO Schmidt telescope red plate.)*

as radial velocities for the stars and for the interstellar K line (Ca II) that was seen towards 8 of the stars. The 1.5 m and 3.6 m telescopes equipped with the Boller & Chivens spectrograph and the Image Dissector Scanner (IDS) were used to get spectra at medium dispersion (114 Å/mm) of the fainter stars connected with the reflection nebulosities as well as most of the bright nebulae in the region.

The 3.6 m and the 1 m telescopes were used with the InSb detector for infrared JHKL(M) photometry both of visible stars and of IR sources found in scanning the areas of the globules and the reflection nebulae in the K band (2.2 microns). A search for Hα-emitting objects has been carried out with the purpose of finding Herbig Ae stars and T Tauri stars, i.e. stars commonly associated with star-forming regions. For this survey a number of objective prism plates were acquired with the ESO 1 m Schmidt telescope. Several promising candidates were found, and IDS spectra of some of them have been secured and UBVRI photometry has been performed with the 1 m telescope.

Further observations of the region have been made in Australia with the radio telescopes at Parkes (6 cm line of formaldehyde) and in Epping outside Sydney (2.6 mm line of carbon monoxide). These observations have yielded information about the molecular gas connected with the obscuring dust in the globules and in the numerous dark patches in the field. Ultraviolet observations of the brightest association members have been acquired with the International Ultraviolet Explorer (IUE) satellite at both high and low resolution. The numerous interstellar lines found in these spectra will provide valuable information on the interstellar medium along the line of sight towards the association.

Some Preliminary Results

From radial velocity data and photometric observations it soon became obvious that the dust and the OB stars were not all in the same volume of space. The large complex of cometary globules to the west of RCW 19 is in fact a foreground configuration as is shown by radio observations of the molecular lines of H_2CO and ^{12}CO. Also geometrical considerations tend to link this complex with the large Gum nebula (cf B. Reipurth, *The Messenger* No. 26, 2, 1981, and T. G. Hawarden and P. W. J. L. Brand, *Mon. Not. R. Astr. Soc.* **175,** 19 P, 1976) at a distance of 450 pc, whereas the H II region with its exciting OB stars seems to fall at a distance of roughly 2 kpc. Whether the dust streak across the field (Figs. 1 and 5) belongs to the globules or the H II region is as yet not quite clear.

Herbig-Haro Object

Let us for a while concentrate on the globules. Radio observations in the 6 cm line of formaldehyde and the 2.6 mm line of carbon monoxide yield a radial velocity of 6 km/sec relative to the Local Standard of Rest. This velocity, combined with the standard circular rotational model for the Galaxy, would place the globules at a distance of 650 pc with considerable uncertainty. In view of this value and their assumed connection with the Gum nebula at 450 pc a distance of 500 pc has been adopted for them. Now let us consider the particular globule in the complex shown in Fig. 2. Immediately apparent is the bright nebula in the middle of the completely opaque globule. An IDS spectrum of this nebula is shown in Fig. 3. It has all the features typical for a Herbig-Haro object, i.e. a nebulosity

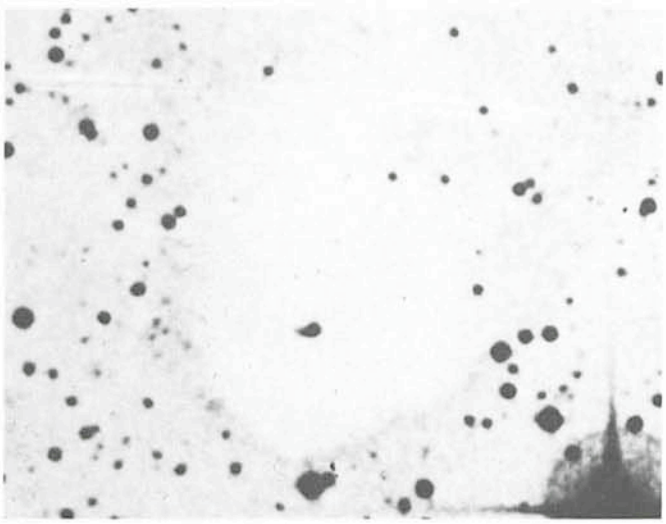


Fig. 2: *One of the globules shown in Fig. 1. The diameter on the sky is 2 arc minutes corresponding to 0.3 pc with an adopted distance of 500 pc. The bright nebula in the centre is a Herbig-Haro object (see text). The linear dimension is approximately 5,000 by 2,500 astronomical units.*

believed to be associated with a star that is still in a state of contraction towards the main-sequence, a protostar. There are several ideas how to interpret Herbig-Haro objects. One school believes that they are reflection nebulae illuminated by scattered light from the protostar, escaping through a hole in the dark cloud, others maintain that they are shock-fronts created as flow of matter from a central protostar (e.g. a strong stellar wind) becomes supersonic at some point of inhomogeneity in the outer part of the cloud. In favour of the shock theory are the spectral similarities between many Herbig-Haro objects and supernova remnants. However, it may very well be that different types of Herbig-Haro objects exist and that both interpretations may be relevant.

The spectrum shown here is typical for what is expected from a shock of a very low degree of excitation. Furthermore, the measured radial velocity relative to the surrounding cloud material indicates an expansion away from the centre of the cloud of 65 km/sec, a velocity that is consistent with theoretical models for shocks in a dark cloud. Thus the conclusion must be that the emission nebula in question is a bona fide Herbig-Haro object consistent with a shock interpretation, and that most likely at least one protostar is hidden in the globule. Scans with the 3.6 m telescope at 2.2 microns have actually revealed three infrared sources in the globule, two coinciding with the Herbig-Haro object and the third situated two thirds of the distance from the centre to the south-eastern rim. The latter is probably a background star shining through. Its infrared colours enable us to make an estimate of the amount of obscuring matter in the globule. If the extinction in the globule follows the normal interstellar extinction law, the total visual absorption at the centre of the globule is at least 35 magnitudes and the corresponding mass 17 solar masses, assuming a gas to dust ratio of 100. This value agrees well with the mass range for Bok globules: 0.1 – 70 solar masses.

Fig. 4 displays two images of the Herbig-Haro object obtained through the courtesy of Dr. H. Pedersen with the Danish 1.5 m and a CCD array. The top image is in the Johnson V-band and the bottom one in the near IR at appr. 9500 Å (Gunn z-band). Note the additional bright spot that appears in the IR image. This spot and the bright knot also visible in the visual image are probably identical to the IR sources found in the K-band. An IDS spectrum

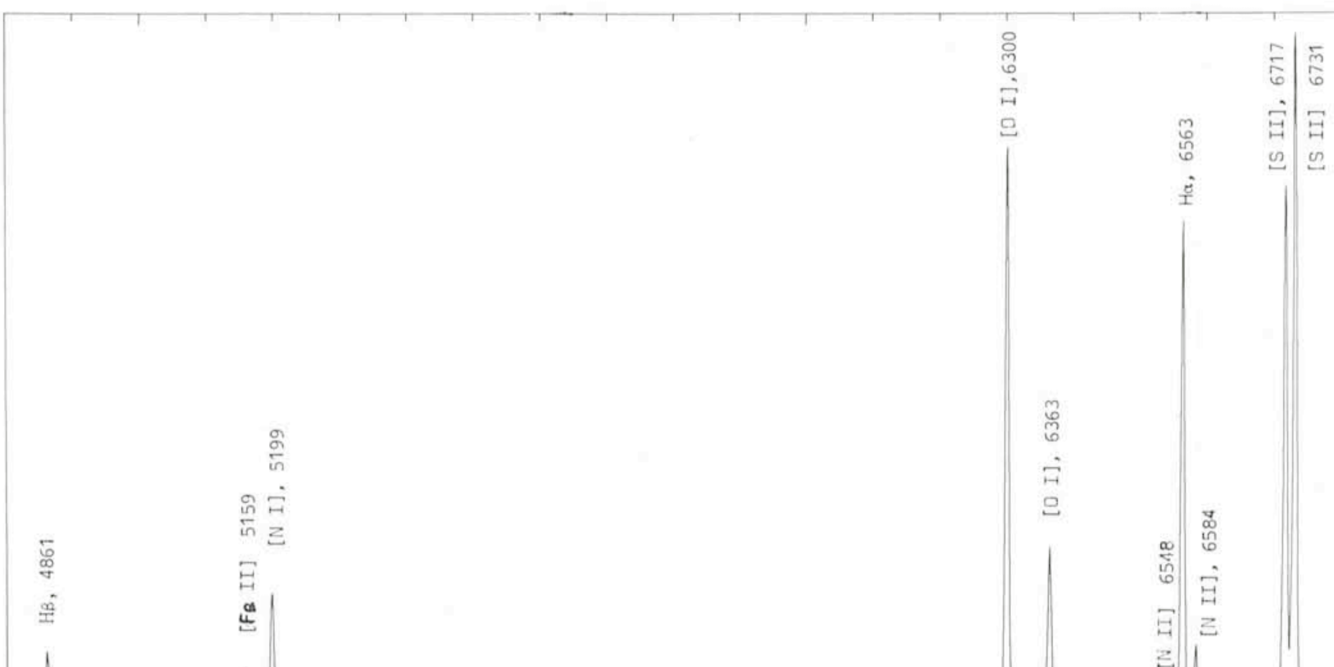


Fig. 3: *An IDS spectrum of the bright condensation in the Herbig-Haro object. The wavelength range is 4800 Å to 6800 Å and the intensity is given in arbitrary units. Note the very strong lines from [O I] and [S II] and the complete absence of [O III] at 4959 Å and 5007 Å. This is indicative of a shocked gas of a very low degree of excitation.*

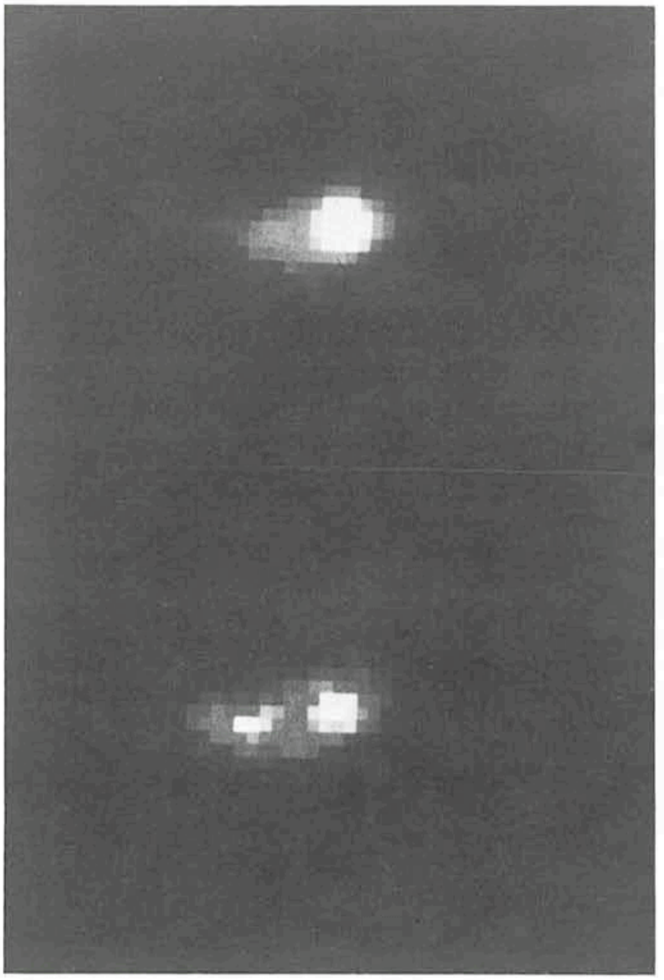


Fig. 4: *Top. A CCD image in the Johnson V-band of the Herbig-Haro object from Fig. 2. It has the typical appearance of a Herbig-Haro object with a bright condensation in an extended nebulosity. Bottom. Same as top but in the near infrared Gunn z-band at 9500 Å. Note the additional bright knot to the left of the "visual" condensation.*

obtained at the location of the IR spot (Fig. 6) shows a red continuum with possible photospheric features at 5893 Å (sodium D lines) and at 6160 Å (TiO band head). A very tempting thought is of course that we are actually seeing the protostar itself shining through in the IR. However, we may simply be seeing another condensation imbedded deeper in the dusty globule. To settle the matter more observations and a careful analysis are required.

T Tauri Stars

T Tauri stars are a class of low mass stars characterized by erratic light variations and an emission line spectrum of varying complexity from only Ca II and Balmer lines to a very rich emission line spectrum including lines of Fe II and He I. They are generally found close to or imbedded in dust and are considered to be newly born stars with ages less than a million years. If this region of Puppis is to be regarded as a region of star formation, T Tauri stars should be present. The search for Hα-emitting stars resulted in the detection of about 40 emission line objects. So far 10 have been identified as T Tauri stars (see Fig. 5). Three of them form a group just to the south of the globules implying that stars may already have been formed from this complex. The rest of the identified T Tauri stars are all seen projected against the dark dust streak across the region. The bulk of the data for these stars is still in the reduction phase.

Fig. 5: *A drawing showing the distribution of some of the material in the region. The circular area to the left delineated with a broken line is the H II region RCW 19. The full lines indicate obscuring dust and to the extreme right the complex of globules is sketched in. The locations of the identified T Tauri stars are indicated by 'T'. The positions of some bright foreground stars are given with '*' to facilitate comparison with Fig. 1. North is up and east to the left.*

To summarize this progress report it appears that we have convincing indications for star formation activity in the region of Puppis OB3 in that we have observed several T Tauri stars connected with the dust here. Furthermore we have observed a Bok globule where it appears that a star is forming or very recently was formed inside it. The investigation continues with the final reductions after which it should be possible to present a more comprehensive picture of this apparently not very massive star forming region.

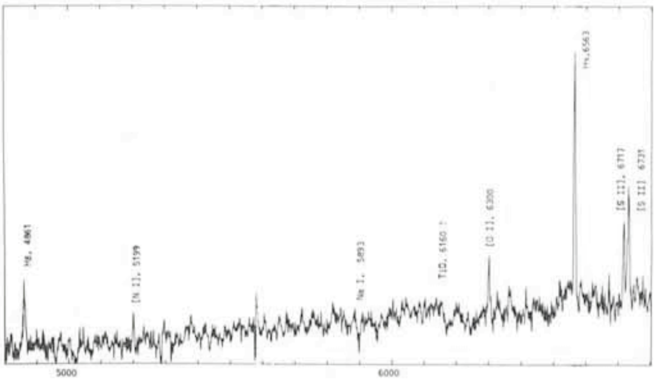


Fig. 6: *An IDS spectrum obtained at the position of the IR knot in the Herbig-Haro object. The wavelength range is 4800 Å to 6800 Å. Note that the intensity scale is increased by a factor 5 relative to that given in Fig. 3. This spectrum has a completely different appearance than that of the visual condensation in that the Balmer lines dominate and that some photospheric absorption features seem to be present.*

Applications for Observing Time at La Silla

Period 31 (April 1 – October 1, 1983)

Please do not forget that your proposals should reach the Section Visiting Astronomers **before October 15, 1982.**

The Ups and Downs of Coordinated Observations

C. Bertout, Landessternwarte Heidelberg-Königstuhl

T Tauri stars are certainly not the only celestial objects for which coordinated observations are of interest. But their behaviour is sometimes so erratic that it is crucial to learn more about the range of the variations and about the correlations between variations in different wavelength domains than is allowed by one-telescope observations. Coordinated observations can overcome this limitation, but bring in their own problems.

The question of the mass-flux in the envelopes of T Tauri stars can serve as a first example of how coordinated observations can help. By the end of the nineteen-fifties, it was accepted that T Tauri stars were newly-formed stars, still associated with the clouds from which they were born, and that they were losing mass. Observational evidence of mass-loss was confirmed when L. V. Kuhi derived, by modeling line profiles, mass-loss rates up to $6 \cdot 10^{-7}\ M_{\odot}\,yr^{-1}$. The belief that T Tauri stars had strong stellar winds went unchallenged until the late sixties, when M. F. Walker reported that a subclass of T Tauri stars, which he named YY Orionis stars, showed spectroscopic evidence for mass accretion. Our group at the Heidelberg Observatory studied active T Tauri stars extensively, and was able to show that a number of them were, at times, apparently accreting material. Even more confusing, Krautter and Bastian (1980, *Astronomy and Astrophysics* **88,** L6) reported changes in the direction of the mass-flow on time-scales of days in DR Tauri, and even found evidence for simultaneous infall and outflow.

In the last years theoretical concerns have also led to questions about the magnitude of the mass-loss rates. It seems extremely difficult to produce the mass-loss rate of $10^{-7}\ M_{\odot}\,yr^{-1}$ often quoted in relation to T Tauri stars without also assuming that the energy input necessary to drive the wind is much larger than the bolometric luminosity of the star. The low X-ray luminosities of these stars likewise imply that a large mass-loss cannot be caused by thermal expansion of the corona, and complicated wind-driving mechanisms must be called upon to minimize the radiative losses. As a result of all these problems, doubts were raised recently about the methods of mass-loss rates determination (cf. DeCampli, 1981, *Astrophysical Journal* **244,** 124).

It seems at this point that both the direction of the mass-flow in T Tauri envelopes and its magnitude are highly uncertain. There seem to be some stars with well-established mass-loss, some with well-documented accretion, some objects in which the flow changes its direction in a more or less random manner, and many stars for which the existing observational material does not allow an unambiguous determination of the flow sign and rate. It will by now be obvious to the reader why world-wide observations that follow the spectroscopic variations twenty-four hours a day can be very useful.

Four observatories participated at the end of 1980 in one such world-wide spectroscopic study of two stars mentioned earlier, YY Orionis and DR Tauri: Okayama Observatory, Heidelberg, ESO, and Lick Observatory. The scientists involved in the project are I. Appenzeller, S. Isobe, M. Walker, B. Wolf, and myself. Originally, we had planned also to observe from the Calar Alto Observatory in Spain, where the instruments are more appropriate for a project of this caliber than the smaller Heidelberg telescope, and where the weather is often good at the turn of the year. Unfortunately, it turned out that for pecuniary reasons, the Calar Alto Observatory was closed between Christmas and New Year, our observing period. Fig. 1 shows the time covered by each participating observatory; bad weather was responsible for the scarce results gained at Heidelberg and only two nights had been allotted to this programme at Lick. That a twenty-four-hour coverage was indeed possible is apparent from the figure.

The main difficulties encountered in the data interpretation are due to the inhomogeneous specifications of the different spectrographs used. We are now trying to reduce the data in such a way as to minimize this problem; but it is a serious limitation to be kept in mind for later, similar programmes. This problem has delayed considerably the interpretation of otherwise very promising observational data.

I should now like to mention a second aspect of the T Tauri stars' properties which makes another kind of coordinated observations desirable: namely, their variations in different spectral ranges. Little is known about possible correlations between these variations. To illustrate the resulting difficulty in data interpretation consider the spectral appearance of the class prototype, T Tauri (Fig. 2). In this figure, I show data from the ultraviolet IUE range to the radio range collected from a number of sources. In the optical and near-infrared ranges, the error-bars represent a variation of one sigma around the average of the measurements. In the UV, far-infrared and radio ranges, the error-bars represent the incertitude on the individual measurements. The solid line is the computed contribution to the spectrum of the gaseous envelope and of the star's photosphere (Bertout and Thum, 1982, *Astron. Astrophys.* **107,** 368). Most of the infrared excess beyond about 2μ is probably due to the newly discovered infrared companion of T Tauri (Dyck et al., 1982, *Astrophys. J.* Letters **255,** L103), although the presence of circumstellar dust is probable in view of the large extinction which can be derived for the star.

Deducing the main physical parameters of the gas emission region from the data shown in Fig. 2 by using the method of Bertout and Thum is in principle a straightforward task.

Because of the emission variability at all wavelengths, a reliable modeling of the envelope would however require simultaneous observations in the far ultraviolet, in the optical (especially in the Balmer jump region) and at two different frequencies in the radio range. This project, requiring simultaneous observing time on one satellite, on two large radio antennas and on an optical telescope in the 3-metre range, has

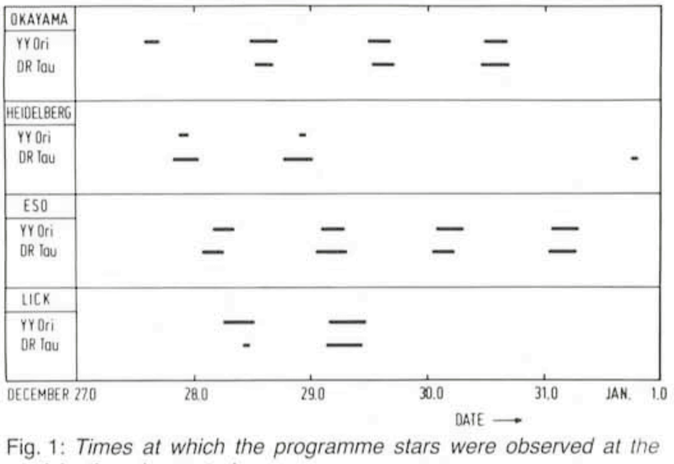


Fig. 1: *Times at which the programme stars were observed at the participating observatories.*

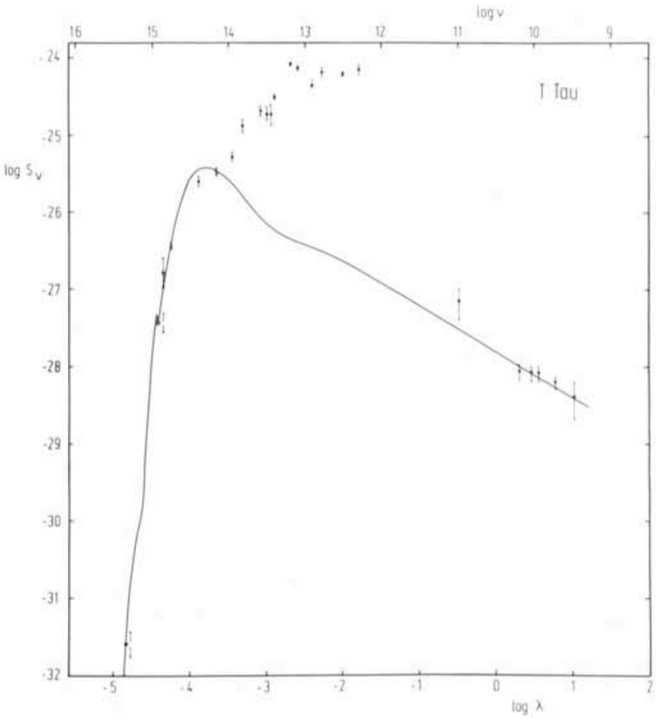


Fig. 2: *Observed energy distribution of T Tauri. The solid line represents the computed contribution of the photosphere and of the gaseous envelope. The units of S_ν are W m^{-2} Hz^{-1}, λ is in cm, ν in Hz.*

not been attempted yet . . . So far, we have contented ourselves with less ambitious, but more realistic, projects.

The most recent of these programmes involved the collaboration of P. Bastien, L. V. Kuhi and myself and was concerned with simultaneous polarimetry, photometry (both at La Silla) and spectrophotometry (at Lick Observatory) of a few stars known for their variable polarization. The goal of this programme, conducted last February, is to try to get clues to the polarization origin. The difficulties which arose this time were not of instrumental, but of a human nature: a mean streptococcus knocked me out at the beginning of the observing run. Fortunately, part of the time could be saved by the kindness of the French cooperants, particularly Auguste Le Van Suu, who agreed to perform the photometric observations. The data are now being reduced.

Although it is apparent from what was said above that coordinated observations are often much more difficult to organize and to conduct than more classical programmes involving only one observer, they are potentially very rewarding. In the *Messenger* **14**, 4, B. Wolf and myself reported observations of two young stars, S CrA and CoD –35°10525, simultaneously at La Silla (spectroscopy) and at San Pedro Martyr, Mexico (13-colour photometry), and a more detailed account of this work has been published recently (*Astron. Astrophys. Suppl.* **47,** 419). The body of observational facts gained during this joint observing run was crucial toward the development of a new and very promising model in which the T Tauri phenomenon is identified with the stellar corona's struggle for expansion into the dense circumstellar medium which still surrounds these young stars (cf. Bertout, 1982, Proc. 3rd European IUE Conference). My conclusion must therefore remain optimistic: it may well be that coordinated observations represent the best way to make further, decisive progress in our understanding of pre-main-sequence evolution.

Visiting Astronomers

October 1, 1982 – April 1, 1983

Observing time has now been allocated for period 30 (October 1, 1982–April 1, 1983). As usual, the demand for telescope time was much greater than the time actually available.

The following list gives the names of the visiting astronomers, by telescope and in chronological order. The complete list, with dates, equipment and programme titles, is available from ESO-Garching.

3.6 m Telescope

Oct. 1982: Melnick/Terlevich, Crane/West/Kruszewski, Shaver/Robertson, Mouchet/Motch/Bonnet-Bidaud, Westerlund/Lindgren, Azzopardi/Breysacher/Lequeux/Maeder/Westerlund, Ulrich/Boisson/Péquignot, Dennefeld, Epchtein/Braz/Nguyen-Quang-Rieu, Koornneef/Lequeux, Engels.

Nov. 1982: Engels, Sibille/Chelli/Léna/Foy/Perrier, Ortolani/Gratton, de Vegt, Chevalier/Ilovaisky/Hurley/Motch, Alcaíno/Liller, Thé/Alcaíno, Marano/Braccesi/Zitelli/Zamorani, Bonoli/Battistini/Fusi, Pecci/Marano, Azzopardi, Azzopardi/Breysacher/Lequeux/Maeder/Westerlund, Wouterloot/Brand.

Dec. 1982: Ulfbeck/Christensen/Hviid/Thomsen, Collin-Souffrin/Ulrich, Hawkins/Meisenheimer/Röser, Pakull/Motch/Ilovaisky/van Paradijs, de Ruiter/Zuiderwijk, Witzel/Biermann/Fricke, Israel/Koornneef, Koornneef/Israel/de Graauw, Rouan/Leger.

Jan. 1983: Rouan/Leger, Lindblad/Jörsäter, Fusi Pecci/Battistini/Buonanno/Corsi, Grewing/Schulz-Lüpertz, Geyer/Nelles/Hopp, Bergeron, Danziger/de Ruiter/Kunth/Lub/Griffith, Henrichs/van Paradijs/Pakull/Motch/Ilovaisky/Chevalier, D'Odorico/Gillet/Moorwood, Moorwood/Glass, Moorwood/Salinari.

Feb. 1983: Moorwood/Salinari, Landini/Salinari/Moorwood/Oliva, Weigelt, Möllenhoff, Richter/Huchtmeier/Materne, Bertola/Galletta, Ardeberg/Lindgren/Nissen, Persi/Ferrari-Toniolo/Tapia/Carrasco/Roth, Groot/Thé/Lamers/Hearn, Motch/Mouchet/Ilovaisky/Maraschi.

March 1983: Motch/Mouchet/Ilovaisky/Maraschi, Eichendorf, Tarenghi, Ardeberg/Lindgren/Nissen, Kunth, Reimers/Koester, Motch/Pakull/Ilovaisky, Jörgensen/Norgaard-N. de Loore/Burger/van Dessel, Cetty-Véron.

1.4 m CAT

Oct. 1982: Gillet, Barbuy, Spite, F. and M., Gratton/Ortolani.

Nov. 1982: Brand/de Vries/Habing/Wouterloot/de Graauw/Israel/van de Stadt.

Dec. 1982: Pallavicini/Pakull, Ferlet/Dennefeld, Ferlet/Dennefeld/Gry/Vidal-Madjar, Ferlet/Maurice, Querci, F. and M.

Jan. 1983: Querci, F. and M., Querci, F. and M./Bouchet, Querci, F. and M./Yerele, Pohl, Baade, Louise/Maurice, Holweger/Kovacs.

Feb. 1983: Holweger/Kovacs, Floquet/Faraggiana/Gerbaldi, Danks/Lambert, Ardeberg/Maurice, Andersen/Gustafsson/Nissen.

March 1983: Andersen/Gustafsson/Nissen, Nissen, Reimers/Hempe, Ardeberg/Maurice, Ruiz/Melnick.

1.5 m Spectrographic Telescope

Oct. 1982: Chmielewski, Spite, F. and M., Bues/Rupprecht, Melnick/Quintana, Rafanelli/Schulz, Dennefeld/Stasinska, Trefzger/Grenon.

Nov. 1982: Caplan/Deharveng, Fricke/Kollatschny/Schallwich/Yorke, Alloin/Pelat.

Dec. 1982: Duerbeck/Seitter, Pakull/Motch/Ilovaisky/van Paradijs, Lub/de Ruiter, Moffat/Seggewiss, Wargau/Rahe/Drechsel.

Jan. 1983: Wargau/Rahe/Drechsel, Grewing/Krämer/Schulz-Lüpertz, Grewing/Schulz-Lüpertz, Schoembs/Barwig/La Dous/Stolz, Materne/Hopp, Kohoutek, Pauls/Kohoutek, Leitherer/Bastian, Rufener/Waelkens.

Feb. 1983: Rufener/Waelkens, Milano/Russo/Smaldone/Vittone, Boisson, Dumont/Maurice, Viotti/Giangrande/Altamore, Wolf/Appenzeller/Stahl, Kudritzki/Heber/Hamann/Hunger/Simon.

March 1983: Kudritzki/Heber/Hamann/Hunger/Simon, Praderie/Felenbok/Talavera/Catala, Ardeberg/Maurice, Galletta/Bettoni, G., Véron, de Loore/Burger/Breysacher/van Dessel, de Loore/Burger/van Dessel/Stalio, Lodén.

1 m Photometric Telescope

Oct. 1982: Kubiak/Smak, Bues/Rupprecht, Kubiak/Smak, Bues/Rupprecht, Mouchet/Motch/Bonnet-Bidaud, Beck/Wielebinski/Schnur, Westerlund/Lundgren, Nguyen-Quang-Rieu/Lebertre/Epchtein.

Nov. 1982: Nguyen-Quang-Rieu/Lebertre/Epchtein, Engels, Alcaíno, Marano/Braccesi/Zitelli/Zamorani, Liller, Thé/Alcaíno, Richtler.

Dec. 1982: Brosche/Geyer/Lentes/Hänel, Geyer/Hänel, Westerlund/Thé/de Jong, Fusi Pecci/Battistini/Buonanno/Corsi, Habets/Thé/v. d. Heuvel, Mouchet/Motch/Bonnet-Bidaud.

Jan. 1983: Mouchet/Motch/Bonnet-Bidaud, Mauder, Schallwich/Fricke/Mattila/Schnur, Beuermann/Krautter, Ritter/Vogt, Drechsel/Rahe/Wargau.

Feb. 1983: Drechsel/Rahe/Wargau, D'Odorico/Gillet/Moorwood, Landini/Salinari/Moorwood/Oliva, Moorwood/Salinari, Persi/Ferrari-Toniolo/Grasdalen, Eichendorf, Motch/Mouchet/Ilovaisky/Maraschi.

March 1983: Motch/Mouchet/Ilovaisky/Maraschi, Lindroos, Lauberts, de Loore/Burger/van Dessel, Lauberts, van der Hucht/Thé.

50 cm ESO Photometric Telescope

Oct. 1982: Liller, Beck/Wielebinski/Schnur, Moreno/Carrasco.

Nov. 1982: Thé/Alcaíno, Caplan/Deharveng.

Dec. 1982: Westerlund/Thé/de Jong, Schoembs/Barwig/La Dous/Stolz, Habets/Thé/v. d. Heuvel.

Jan. 1983: Habets/Thé/v. d. Heuvel, Moreno/Carrasco, Schallwich/Fricke/Mattila/Schnur, Schober.

Feb. 1983: Schober, Milano/Mancuso/Russo/Severino/Smaldone/Vittone, Milano/Russo/Smaldone/Vittone, Wolf/Appenzeller/Stahl, Groot/Thé/Lamers/Hearn, Lindroos.

March 1983: Lindroos, Doazan/Thomas/Bourdonneau, Lagerkvist/Rickman, Moreno/Carrasco.

GPO 40 cm Astrograph

Nov. 1982: Duflot.

Dec. 1982: Amieux.

Jan. 1983: Mauder.

Feb. 1983: Debehogne/Mourao.

March 1983: Dettmar/Gieseking.

1.5 m Danish Telescope

Oct. 1982: Prévot, Imbert.

Nov. 1982: Imbert, Ardeberg/Lindgren, Quintana, Fricke/Loose/Thuan, Arp/Kruszewski/Pedersen/Surdej/Swings, Crane/West/Kruszewski, Danziger/Shaver/Pedersen, Sol.

Dec. 1982: Lyngå/Wramdemark.

Jan. 1983: Lyngå/Wramdemark, Hawkins/Meisenheimer/Röser, Lindblad/Jörsäter, Chevalier/Ilovaisky/Hurley/Motch, Pedersen/Pizzichini, Ortolani/Gratton, Louise/Maurice.

Feb. 1983: Andersen/Nordström/Olsen, Mayor/Burki.

March 1983: Mayor/Burki, Mayor/Mermilliod, Tarenghi, Jörgensen/Norgaard-N., Motch/Pakull/Ilovaisky, Shaver/Robertson, Krautter/Reipurth.

50 cm Danish Telescope

Oct. 1982: Kubiak.

Nov. 1982: Vanbeveren.

Dec. 1982: Maitzen/Weiss/Hensberge.

Jan. 1983: Maitzen/Vogt, Nelles, Baade.

Feb. 1983: Baade.

90 cm Dutch Telescope

Nov. 1982: Trefzger/Blaauw/Pel, Seggewiss/Nelles.

Dec. 1982: Mouchet/Motch/Bonnet-Bidaud.

Jan. 1983: Mouchet/Motch/Bonnet-Bidaud, Habets/Thé/v. d. Heuvel, Greve/van Genderen/Danziger, Beuermann/Krautter/Ritter/Vogt.

Feb. 1983: Groot/Thé/Lamers/Hearn.

March 1983: Groot/Thé/Lamers/Hearn, v. Paradijs/v. d. Woerd, Cuypers.

61 cm Bochum Telescope

Oct. 1982:	Sterken Group.
Nov. 1982:	Sterken Group.
Dec. 1982:	Sterken Group.
Jan. 1983:	Kohoutek, Sterken Group, Kohoutek, Pauls/Kohoutek, Sterken Group.
Feb. 1983:	Sterken Group.

PERSONNEL MOVEMENTS

STAFF

Arrivals

Europe

KERK, Elizabeth (NL), Administrative Assistant (Personnel), 1. 9. 1982
STOFFER, Christina (CH), Secretary/Typist (Scientific Division), 1. 11. 1982

Chile

GILLIOTTE, Alain (F) Optical Technician (TRS), 13. 9. 1982

Departures

Europe

BUCHER, Beate (D), Secretary (Personnel), 30. 9. 1982
VERSCHUREN, Rita (B), Secretary (Scientific Division), 17. 9. 1982

Chile

SCHNUR, Gerhard (D), Astronomer 30. 9. 1982
LE SAUX, Paul (F), Systems Analyst/Programmer (TRS), 31. 10. 1982

FELLOWS

Arrivals

Europe

RICHTER, Otto-Georg (D), 1. 9. 1982
BANDIERA, Rino (I), 1. 10. 1982
OLIVA, Ernesto (I), 1. 10. 1982

Departures

FERLET, Roger (F), 30. 9. 1982

ASSOCIATES

Arrivals

Europe

FREDRICK, Laurence (USA), 6. 7. 1982
CHEN, Jian Sheng (Chinese), 12. 7. 1982
CHOUDRY, Amar (USA), 1. 9. 1982
LUCY, Leon (UK), 1. 9. 1982
SALVATI, Marco (I), 1. 11. 1982

Departures

Europe

MILLER, Richard (USA), 30. 9. 1982

Observations of Bipolar and Compact H II Regions

T. Neckel, Max Planck Institute for Astronomy, Heidelberg

Several investigations carried out during the last years at the Max Planck Institute for Astronomy in Heidelberg have dealt with the bipolar compact H II region S 106. The essential structural features of this object are: (i) There is only a single exciting star in the centre of the nebula, (ii) this star is surrounded by a disk of dust that we are seeing edge on. This disk of dust divides the nebula into two "lobes". It causes a visual extinction of the central star of about 20 magnitudes, for which reason it can be photographed only at infrared wavelengths (Eiroa, C., Elsässer, H., and Lahulla, J. F. 1979, *Astronomy and Astrophysics* **74,** 89), whereas the light of the central star can get through the disk in the perpendicular direction. A digitized near infrared photograph of S 106 taken by Elsässer and Birkle with the 1.23 m telescope of Calar Alto is shown in Fig. 1.

S 106 is associated with a massive molecular cloud containing OH and H_2O masers. From spectroscopic observations Solf (1980, *Astronomy and Astrophysics* **92,** 51) has shown that the ionized gas is flowing radially toward the polar lobes at supersonic speed. The kinematic age is about $5 \cdot 10^3$ yr. These observations and the structural properties support the idea that S 106 is an H II region in a very early stage of evolution excited by a star recently formed out of a disk-shaped cloud which is probably rotating around an axis perpendicular to it.

Among the H II regions compiled in the Sharpless catalogue there is no other object of the same kind. Only a few objects show some similarity to S 106, for example S 269 and S 270. The distance to S 106 is about 500 pc, and its angular diameter is approximately 2 arcmin; consequently more distant objects of comparable linear size are too small for recognition in available H II catalogues. In order to get—if possible—a more extensive sample of similar objects H. J. Staude and I have carefully searched the Palomar atlas for bipolar and related objects. Since the typical appearance of a bipolar nebula is found only if we are looking edge on onto the disk of dust, "monopolar" nebulae may also be bipolar. The best example is the R Monocerotis nebula, which looks like the southern lobe of S 106. Cantó, Rodriguez, Barral and Carral (1981, *Astrophysical Journal* **244,** 102) have shown that this nebula is bipolar, and that the second lobe is optically obscured by the disk of dust.

At present we have compiled a list of 40 possible bipolar nebulae found on the Palomar atlas. Some of them are very likely genuine bipolar nebulae. Others resemble the R Monocerotis nebula, probably they are halves of bipolar nebulae. During the last 3 years we have carried out several observing programmes in order to get information concerning the nature of these objects. We will now consider the first results for three of them shown in

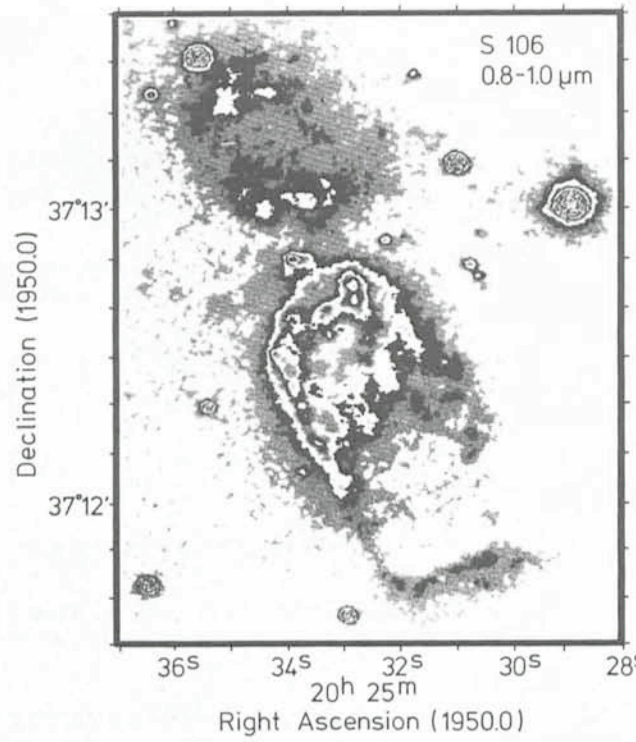


Fig. 1: *A digitized photograph of S 106 taken by H. Elsässer and K. Birkle at the 1.23 m telescope of Calar Alto.*

Fig. 2a – 2c (enlargements from the Palomar atlas). The most typical bipolar nebula in this sample is the first one, with the preliminary designation Anon $6^h56^m.7$-4°. A digitized red photograph of this object, taken by K. Meisenheimer with an image-tube camera attached to the 2.2 m telescope of Calar Alto is shown in Fig. 3. The resemblance to S 106 (see also Staude, H. J., Lenzen, R., Dyck, H. M., and Schmidt, G. D., 1982, *Astrophysical Journal* **255,** 95) is very striking. At present we don't have an infrared photograph for this object and no image from the exciting star which is probably located within the central dust lane.

Early information concerning the hidden star was obtained from a spectrum taken in October 1980 at the ESO 1.5 m telescope, shown in Fig. 4a. This spectrum contains the Hα and Hβ lines, but not the forbidden lines of [O III] at 4959 Å and 5007 Å. From the known relationship between the ratio [O III] / Hβ and the spectral type of the exciting star (see for example Chopinet, M. and Lortet-Zuckermann, M. C. 1976, *Astronomy and Astrophysics, Supplement Series* **25,** 179), one infers a spectral type B0 or later for this star. Additional information was obtained with the 100 m radio telescope in Effelsberg in cooperation with Dr. Chini and Dr. Wink of the Max Planck Institute for Radio Astronomy. At 6 cm (4.8 GHz), a source was found exactly in the centre of the dust lane. The flux of this source is S (4.8 GHz) = 0.05 Jy. Since the 2.8 cm receiver at the 100 m telescope came out of order when we started to observe the nebula at 2.8 cm, we can't decide whether this nebula is optically thin or not. However, in the absence of these additional observations we *assume* the nebula to be optically thin so that we may apply the relation between the radio continuum flux S_ν and the number of Lyman continuum photons N_c' emitted by the exciting star as given by Mezger, Smith and Churchwell (1974, *Astronomy and Astrophysics* **32,** 269):

$$N_c' = 4.761\ 10^{48}\ a(\nu, T_e)^{-1} \left[\frac{\nu}{\mathrm{GHz}}\right]^{0.1} \left[\frac{T_e}{\mathrm{K}}\right]^{-0.45} \left[\frac{S_\nu}{\mathrm{f.\,u.}}\right] \left[\frac{d}{\mathrm{kpc}}\right]^{2}$$

For T_e we assume the quite common value 8,000 K. If we take the numbers for N_c' given by Panagia (1973, *Astronomical Journal* **78,** 929) for different spectral types, we find the distance d for a given spectral type.

We obtain an independent relation between spectral type and distance from infrared measurements carried out by R. Lenzen and myself at the 1.23 m telescope of Calar Alto. These observations are shown in Fig. 5a. Unfortunately it is not possible to get an unambiguous solution for spectral type, extinction and distance from these measurements. For nearly all spectral types one can find combinations of extinction and distance which allow a fit of the observations. One simultaneously determines the extinction A_V and distance modulus a = 5 log d – 5 from a least square fit of the linear equation

$$\Delta_\lambda = a + A_V X_\lambda, \text{ where}$$

Δ_λ is the observed magnitude minus absolute magnitude corresponding to the chosen spectral type, and X_λ is the interstellar extinction law, for which we use Schild's curve (1977, *Astronomical Journal* **82,** 337).

In the case of our nebula Anon $6^h56.7^m$-4° we use only the J,H,K measurements to find these A_V, d combinations since an IR excess seems to be present in L, probably caused by radiation from hot dust. This relation between spectral type and distance is also shown in Fig. 6. It

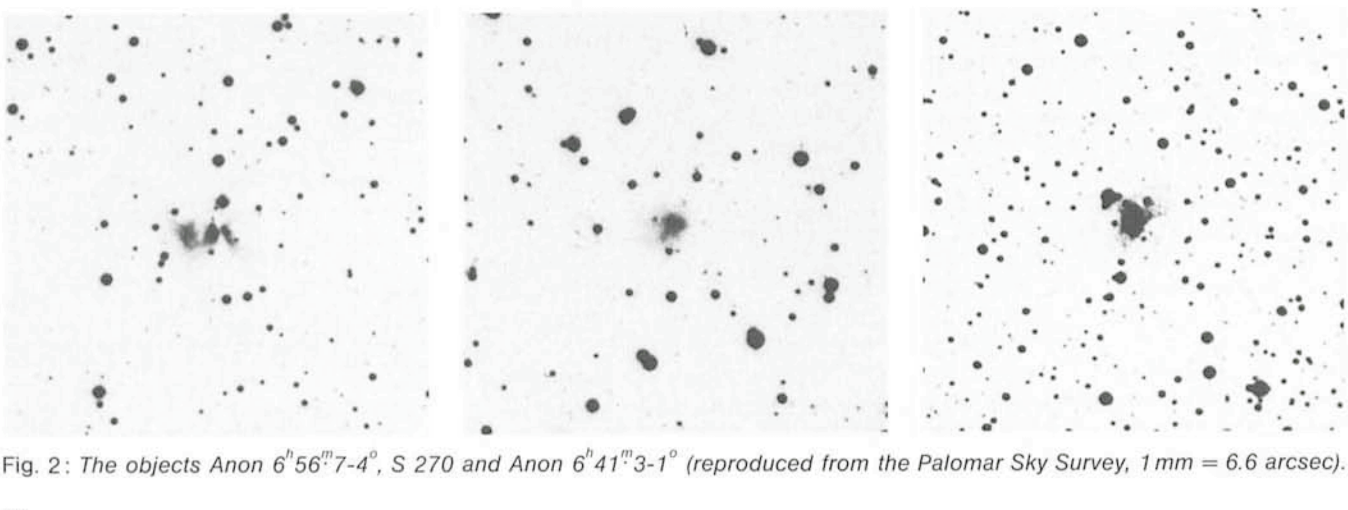


Fig. 2: *The objects Anon $6^h56^m.7$-4°, S 270 and Anon $6^h41^m.3$-1° (reproduced from the Palomar Sky Survey, 1 mm = 6.6 arcsec).*

Fig. 3: *A digitized photograph of the object Anon 6ʰ56ᵐ 7–4° taken by K. Meisenheimer at the 2.2 m telescope of Calar Alto.*

intersects the $d(S_{4.8\ GHz})$ curve at spectral type B0.5 in agreement with the spectral type otained from the [O III] / Hβ ratio. The most probable values for the central star are therefore: spectral type B0.5 V, visual extinction $A_V = 13.7$ magnitudes, d = 1.4 kpc. From the apparent diameter of 50 arcsec results a linear diameter of 0.35 pc which is nearly the same as the diameter of S 106. A further similarity to S 106 is the low galactic latitude of b = – 0.1°.

The next object is the very small H II region S 270. Its appearance on the Palomar atlas blue print is that of two diffuse spots of similar size (Fig. 2b). The spectrum (Fig. 4b) is that of a low excitation H II region. From the absence of the [O III] lines we conclude that the exciting star is of spectral type B0 – B2. The energy distribution of the object, again measured on Calar Alto, in the UBVRIJHKL passbands is shown in Fig. 5b. In L an IR excess is present again. However, it is also impossible to find a fit through UBVRIJHK alone. The best explanation seems to be the one illustrated in Fig. 5b, which corresponds to a B1 V star with $A_V = 12.2$ magnitudes and d = 1.7 kpc, resulting from J,H,K alone. The observed intensities in

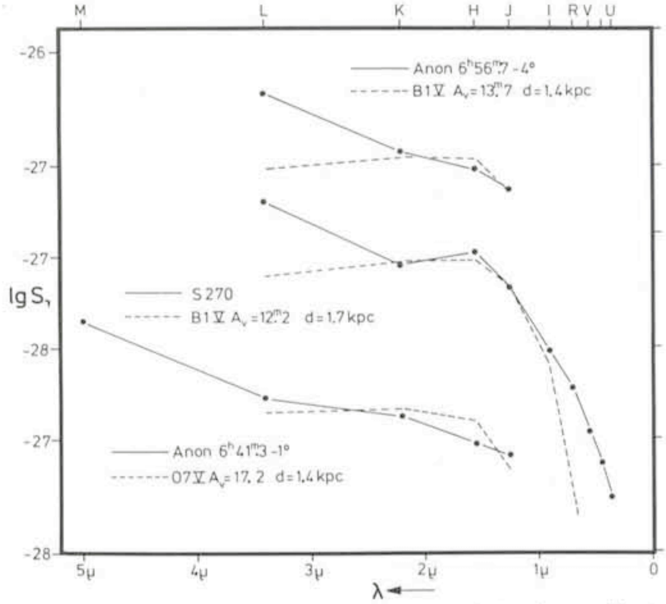


Fig. 5: *The observed energy distributions of the three objects (solid lines) and the computed fluxes for the stated combinations of spectral type, visual extinction and distance.*

UBVR are much higher than the computed values from the above combination of spectral type, extinction and distance. Possibly we see at these wavelengths predominantly scattered light from the central star; this assumption is strengthened by the fact that the spectrum shows a strong continuum in addition to the emission lines.

The spectrum of the third object, Anon $6^h41^m.3-1°$, shows strong [O III] lines. From the ratio [O III] / Hβ ~ 2 follows a spectral type of O7 for the exciting star, which is visible on the POSS infrared print. Its energy distribution in the range J,H,K,L is compatible with a star of spectral type O7 V, $A_V = 17.2$ magnitudes and a distance d = 1.4 kpc. An infrared excess appears in M only. The linear diameter of this nebula is also 0.4 pc, very similar to the diameters of S 106 and Anon $6^h56^m.7-4°$. Whether this nebula is half of a bipolar nebula or not must be clarified by further observations.

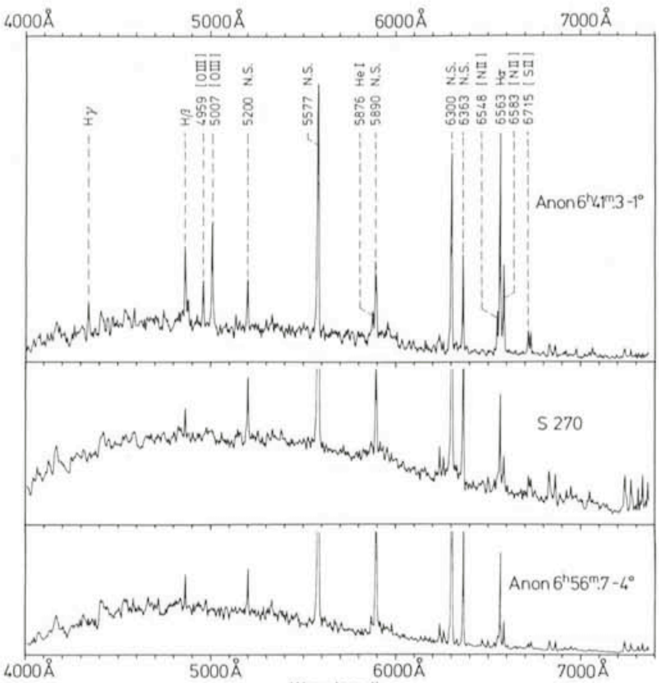


Fig. 4: *PDS spectral scans of the objects discussed in this paper taken with the Boller and Chivens spectrograph at the ESO 1.5 m telescope. The ordinates give log density.*

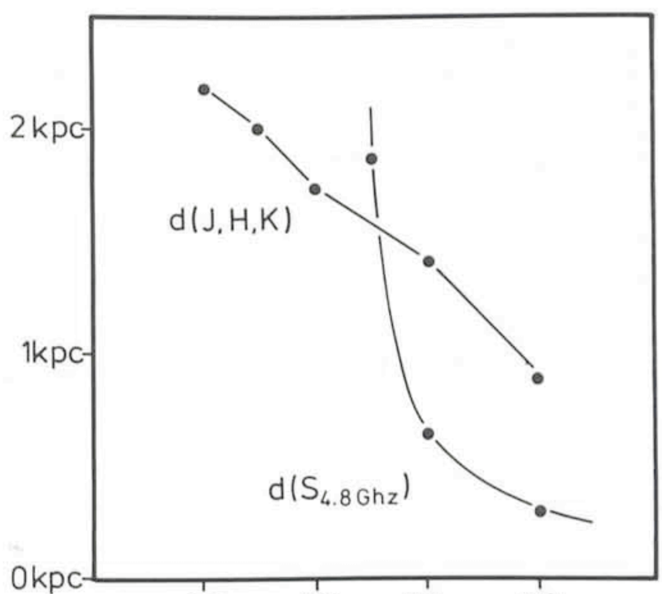


Fig. 6: *The relationship between the distance of the object Anon 6ʰ56ᵐ 7–4° and the spectral type as derived from the J,H,K data and from the 4.8 GHz flux.*

Sulfur Abundances in Gaseous Nebulae

A. R. Condal, Atmospheric Environment Service, Toronto

The determination of abundances in planetary nebulae (PN) and H II regions is important for studying the present and past chemical composition of galaxies. Its derivation from the spectral-line intensities involves basically the following steps:

(i) Since gaseous nebulae are optically thin in the observed emission lines the numbers of emitting atoms or ions are proportional to the observed line intensities. Therefore, the relative intensities of the relevant nebular lines must be measured spectrophotometrically. (The spectrum is usually normalized to $I(H_\beta)$ or $I(H_\alpha) = 100$.)

(ii) Atomic data, e.g. transition probabilities and target areas for collisional excitation, are used to deduce the electron temperature, Te, and electron density, Ne, of the nebular plasma from the intensities of the forbidden lines of selected ions.

(iii) Once values of Te and Ne are adopted, the relative line intensities may be used to determine the ionic abundances (relative abundances of the corresponding ions with respect to hydrogen).

(iv) The total abundances of the elements can be obtained after an estimation of what fractions of the atoms of a given element exist in the observed stages of ionization.

The main difficulties with this procedure are that, first, the great range of intensities found in a nebular spectrum requires the use of detectors with a high dynamic range and linear response in the wavelength range of interest and, secondly, that only a small fraction of the atoms are in ionic stages which produce optical lines and, therefore, approximate estimates must be made for all other stages. This is currently done by computing detailed models of individual nebulae for comparison with observed line strengths and by the ionization correction-factor (ICF) procedure, which is based on the assumption that the degree of ionization of an element can be predicted from its ionization potential. In particular, Peimbert and Costero (1969) used the identity between the ionization potential of O^+ (35.1 eV) and S^{++} (34.8 eV) to derive total sulfur abundances under the assumption of $S^{+3}/S^{++} = O^{++}/O^+$. Depending upon the element and the temperature of the ionizing star, the ICF technique is accurate to factors of 2 or 3. In some cases large discrepancies are observed, e.g. abundances derived for different positions in a nebula, and sulfur abundances have been found to be the least accurate among the elements which are usually observed in gaseous nebulae.

Sulfur is multiply ionized in gaseous nebulae. S^+ has its strongest forbidden lines at λλ6716, 6731Å, while S^{++} can be measured from the weak and temperature-sensitive λ6312Å line or from the stronger and less temperature-sensitive lines at λλ9060 and 9532Å. S^{+3} has been measured from the infrared line at 10.5 μm in just a few objects by Dinnerstein in 1980. Therefore, the problem with the sulfur abundances has been the lack of detectors with a good response in the 1 μm region to accurately determine S^{++} by observations of the [S III] λλ9060, 9532Å lines and that S^{+3} and higher ionization states are not optically detectable. This problem is especially important in high excitation PN, e.g. NGC 2440 or NGC 7027, where a significant amount of sulfur can still be in the form of S^{+4} and higher states.

Solid-state image sensors, e.g. Reticons and CCD's, have a very high quantum-efficiency between λλ6000 and 10000 Å, a large dynamic range, and an almost linear response. The present availability at the La Silla Observatory of a Reticon system thus permits us to obtain accurate intensity line ratios in the near infrared region, from which the S^{++} abundances can be derived. On November 1980 and May 1981 a study of galactic PN together with PN and H II Regions in the Magellanic Clouds (MC) was carried out using the 1.5 m telescope equipped with a Boller and Chivens Cassegrain spectrograph and the ESO Reticon system. A dispersion of 173 Åmm^{-1} was used, giving a spectral range from about λλ6300 to 10000 Å, with a resolution of about 5 Å $diode^{-1}$ (see Fig. 1). The Reticon, which was cooled by liquid nitrogen, was maintained at a temperature of −100°C. The continuum spectrum of a tungsten lamp was used to remove instrumental sensitivity variations, the wavelength scale was defined by the spectrum of a HeAr lamp. A correction for the instrumental response function and differential atmospheric extinction was also applied to the data. The data were reduced using the IHAP data reduction system available at La Silla and Garching and also by using the PDP11 Computer system at the Max-Planck Institute for Astronomy in Heidelberg. One manuscript has been completed and already accepted for publication and in this article I would like to share some results and observing experiences at La Silla with the readers of the *Messenger.*

In both of my trips to La Silla the Reticon system functioned without problems. The main source of error in the final, relative intensities was the overall read-out noise. No systematic errors as a function of wavelength or intensity were detected and lines with intensities, $I > 0.8\ I\ (H\alpha)$ have an observational error of the order of 8 per cent or less. For lines with $0.8\ I\ (H\alpha) > I > 0.25\ I\ (H\alpha)$, the observational error is in the range 10–25 per cent, while lines with $I < 0.2\ I\ (H\alpha)$ have observational errors of the order of 30 per cent or greater. The overall efficiency of the system is between 2.5 and 3 per cent at about 8000 Å for a slitwidth of 3 arcsec. This value is in excellent agreement with the 3

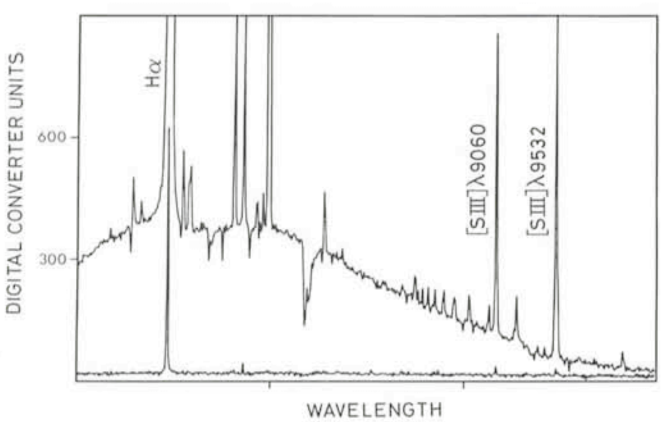


Fig. 1: *6000–10000 Å spectra of nebulae.*
Upper trace: Spectrum of IC 418, a galactic planetary nebula.
Lower trace: Spectrum of N 81, a H II region in the Small Magellanic Cloud.

per cent reported by the ESO staff at 8500 Å using the 3.6 m telescope. Fig. 1 shows the near-infrared spectra of two gaseous nebulae: IC 418, a galactic PN, and N 81, a H II region in the Small Magellanic Cloud. Exposure times are 10 and 30 min. respectively.

The Y-axis represents analog to digital converter units (ADC). The system is set such that 1 ADC corresponds to the rms noise, which is about 1,000 counts. Saturation of an individual diode occurs at about 4×10^6 counts or about 4,000 ADC units. Therefore, a signal of 600 ADC (Hα line of N 81) corresponds to about 15 per cent of the saturation level of the detector.

The [S III] λλ 9060, 9532 Å lines were detected in N 8, N 54, N 81, N 153, P 40 (nebulae in the MC) and in 15 galactic southern PN, while in N 2, P 8 (PN in the MC) and 108–76°1, K 648 (galactic halo PN) the [S III] doublet was detected below a 3σ level or not at all.

TABLE 1: Total Sulfur Abundances

	Log (S/H +12
41 PN	6.80 ± 0.28
22 PN with $O^{++}/O^{+} > 10$	6.82 ± 0.23
11 PN with $2 < O^{++}/O^{+} \leq 10$	6.78 ± 0.33
8 PN with $O^{++}/O^{+} \leq 2$	6.77 ± 0.39
H II Regions	6.85 ± 0.21
Sun	7.22 ± 0.13
Orion	7.34

Reference: Natta et al. 1980.

Table 1 (after Natta et al. 1980) shows our present knowledge of the total sulfur abundances in nebulae. These figures indicate that the average sulfur abundance for galactic PN is lower than the one in the Sun and the Orion Nebula. Consequently, one of the first concerns has been to compare the Reticon sulfur abundance with the ones reported by Natta et al. (1980). So far, and for galactic PN only, my values for log (S/H)+ 12 range from 6.35 ± 0.20 to 6.75 ± 0.33, depending on the object and ICF method used. In any case, my results seem to confirm a total sulfur abundance in PN lower than the one in the Sun and in the Orion Nebula. A large number of questions remain to be answered. For example, (1) Is the value of log (S/H) + 12 for galactic PN and PN in the MC lower than the equivalent value for H II regions? (2) To what extent do the sulfur abundances in the MC match the ones in the Galaxy?, and (3) Since sulfur is a nucleosynthesis product, to what extent do the answers to the two previous questions influence models of galactic evolution?

As in previous runs, the La Silla staff was very friendly and cooperative, and excepting the search for uninvited vinchucas to my bedroom (I found two), the days were quiet for sleeping.

This work was done while the author was with the Max-Planck Institute for Astronomy in Heidelberg.

References:

Dinnerstein H. L., 1980, *Ap. J.* **237**, 486.
Natta, A., Panajia, N., Preite-Martinez, A., 1980, *Ap. J.* **242**, 596.
Peimbert, M., Costero, R., 1969, *Bol. Obs. Tonantzintla Y Tacubaya*, **5**, 3.

Asteroid Rotation – Hunting for a Record: 1689 Floris-Jan

H. J. Schober, Institute for Astronomy, Graz, Austria
J. Surdej, Institut d'Astrophysique, Liège, Belgium

Introduction

Last year, in June 1981 – *ESO Messenger* No. 24, p. 22–23 – H. J. Schober published a report on "Spinning Asteroids and Photometry". There he mainly gave a general introduction about what can be done using UBV photometry in order to derive physical properties of asteroids such as geometric forms, diameters, reflectance on the surface, bimodality of asteroids with respect to typology.

A special effort was made to report about the activities to deal with asteroids as "variable objects" like variable stars – showing lightcurves with defined rotation rates to be derived. Among asteroids it was stated that the longest rotation periods found before 1975 were not larger than 20 hours – followed by 654 Zelinda $31^{h}.9$ (1975), 393 Lampetia $38^{h}.7$, 128 Nemesis $39^{h}.0$ (1979), 709 Fringilla $52^{h}.4$ (1979) and 182 Elsa $80^{h}.00$ (1980), the latter corresponding to $3^{d}.33$.

The Asteroid 1689 Floris-Jan

Combined observations were undertaken in 1980, when measurements were carried out for the asteroid 1689 Floris-Jan between Oct. 7 and Nov. 6, 1980. H. J. Schober observed this object at Cerro Tololo, CTIO, Chile (0.6 and 0.9 m telescopes), J. Surdej at ESO, Chile (0.5 m telescope), and a few points were delivered additionally by A. W. Harris and J. W. Young from JPL, Pasadena, at Table Mountain Observatory (0.6 m telescope). The brightness of the asteroid was only between 13.50 to 14.00 in V. During a few nights even simultaneous measurements were made at ESO and CTIO, using different comparison stars; they do overlap perfectly – proving the high quality of our measurements – the results will be published in detail in *Astronomy and Astrophysics.*

The surprising result is that 1689 Floris-Jan shows a double-wave lightcurve with primary and secondary extrema as many asteroids, with an amplitude of 0.40 magnitude, but with a resulting rotation period of

$$P = 145^{h}.0 \pm 0^{h}.5 \ (\triangleq 6^{d}.042 \pm 0^{d}.021)!$$

beating the record of 182 Elsa. Due to the colours derived for 1689 Floris-Jan it should not be a S-type asteroid and, depending on the albedo assumption, its diameter is found to be rather small, in the range 9 to 27 km.

The rotation period of six days for 1689 Floris-Jan is the longest one ever published for an asteroid. The histogram in Fig. 1 shows the exceptional position of 1689 Floris-Jan among the more than 300 published asteroid rotation

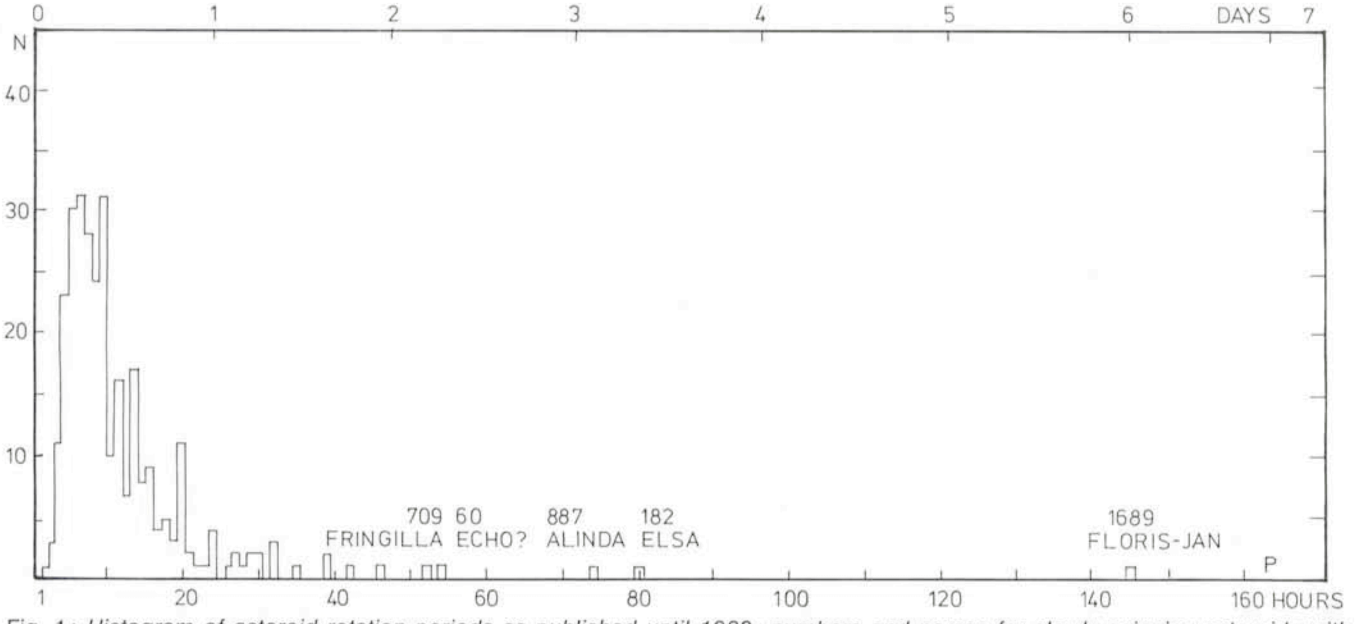


Fig. 1: *Histogram of asteroid rotation periods as published until 1982; numbers and names for slowly spinning asteroids with periods longer than 50 hours are given. The long rotation period P = 145.0 hours for 1689 Floris-Jan is clearly exceptional.*

rates. In addition, it must be stated that – in opposition to what should be expected – there are indications that small asteroids are not necessarily fast rotators. Among all asteroids with rotation periods longer than 50 hours there appear to be no objects larger than 100 km. It is still premature for a final conclusion, but it seems that small asteroids prefer also slow rotation rates, whereas larger objects with diameters larger than 200 km (roughly 30 asteroids) prefer to rotate faster with periods of the order of only 8–29 hours!

We are waiting even for other surprises: 1981 QA, also a small asteroid with a 0.8–2 km size is reported to rotate also in only six days approximately – and new exciting results are to be expected for 288 Glauke, a 30 km sized S-type asteroid.

Good luck for all hunters!

The Atmospheric Transmission at La Silla at 230 GHz

J. Brand, Sterrewacht Leiden

Introduction

From April to November 1981, ESO La Silla was host to a team of observers from the Netherlands, forming the "CO group". During this time they applied themselves to detecting radiation of the CO molecule at 230 GHz, using the CAT and their own heterodyne (sub-)millimetre wave receiver.

In general the importance of CO observations lies in the fact that CO is, after molecular hydrogen, the most abundant molecule in interstellar space while its (dipole) rotational transitions can be much more easily detected than the very weak (quadrupole) rotational transitions of H_2; the rotational levels of CO are believed to be excited by collisions with other particles, mostly H_2, and therefore, by studying the distribution and kinematics of CO one gets indirect information on those properties of H_2.

So far, most information on the distribution of molecular clouds in the Galaxy is based on observations of the ^{12}CO $J = 1 \rightarrow 0$ rotational transition at 115 GHz. Such observations have been carried out mainly from northern hemisphere observatories and were therefore limited to $\delta > -40°$. Incidental observations from the southern hemisphere have been made using optical telescopes, due to the lack of mm telescopes. As the CAT, being just installed, was not yet scheduled for general use, ESO agreed to allocate us all day time and about half of the night time in the above-mentioned period. We have used this telescope to survey the galactic plane in the fourth quadrant, to observe molecular clouds associated with HII regions and to make maps of a few dark clouds. Since this was the first time the CAT was used so extensively, we encountered several telescope problems. Pointing, for instance, was off by a few degrees in some directions. Extensive star pointing sessions showed the offset to be systematic and a correction programme was developed bringing the absolute pointing accuracy 1′ to 2′. This problem is less serious for observers using the spectrograph since the stars can be seen on the TV screen and thus centered (the correction programme is also implemented for these observers, however); the tracking capability of the CAT is good.

Other problems arose from the fact that the CAT was not designed for this type of operation. The most persistent of these typically frequency-related problems is the reflection of local oscillator signal from the receiver on dome and telescope surfaces, causing variable standing waves in the spectra. We were able to suppress these

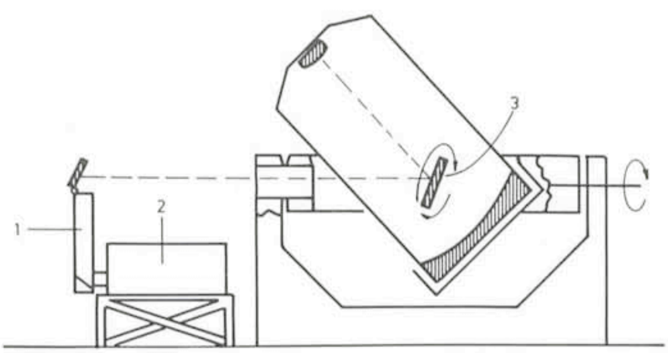


Fig. 1: *The ESTEC sub-mm heterodyne receiver as it was installed in the CAT dome. The light coming from the Nasmyth mirror in the telescope is reflected into the receiver by the flat mirror on top of the aluminium tube. Cables carrying the signal from the receiver to the computer (not shown) are guided through the light tunnel connecting the CAT building with that of the 3.6 meter telescope (drawing of telescope adopted from ESO Users Manual).*
1. Aluminium tube, with polyethylene lens (not visible) and flat mirror. 2. ESTEC receiver. 3. Nasmyth mirror.

standing waves to some extent by putting mm-wave-absorbing material around the secondary mirror turret and using a wobbling mirror inside the receiver.

At our observing frequency of 230 GHz atmospheric water vapour is the main absorbant. The dry climate at La Silla allows this radiation to pass through the atmosphere without too much attenuation. In this paper we give information on the atmospheric condition during our stay at La Silla, monitored by means of skydipping procedures.

General System Description

The receiver has been built at ESTEC (Nordwijk, the Netherlands) in collaboration with the observatory at Utrecht and it has been in operation since 1978. It can be tuned within the frequency range 200 to 400 GHz, which corresponds to wavelengths between 1.5 and 0.75 mm. In this range many of the essential rotational transitions of the light molecular species are situated. In the receiver the signal is brought down to a lower, intermediate frequency (about 1.2 GHz), for which suitable (i.e. low noise and high resolution) detection devices exist. Down conversion is accomplished by mixing the incoming signal with a local oscillator signal at about the same frequency; mixing takes place in a non-linear element, in our case a room temperature Schottky barrier diode. Details of the receiver and its operation are given by Lidholm and de Graauw (1979).

For detection, the signal is fed into two 256-channel filterbanks, with a width per channel of 1 MHz and 250 kHz respectively, corresponding to 1.3 kms^{-1} and 0.3 kms^{-1} velocity resolution. The available velocity ranges are respectively 333 kms^{-1} and 83 kms^{-1} (both centered at the same velocity). A computer integrates the signals from the filterbanks and the result is stored on magnetic disk. Our data-taking computer also contains a telescope pointing programme and mapping routines and was linked to the CAT computer allowing us to operate the telescope from our control room and to carry out long observing sessions without having to interfere. Observations were made in the position switching mode, where the signal from a reference position is subtracted from that of the source position, resulting in the net signal from the source position, relative to a zero baseline level. Typically, one pair of source-reference measurements takes 2 × 100 sec.
Fig. 1 shows the CAT/ESTEC receiver combination during operation.

Atmospheric Transmission

Atmospheric transmission can be derived from a so-called "skydip", in which the telescope is pointed at several successive elevations, all at the same azimuth. In our case a skydip usually consisted of measurements at

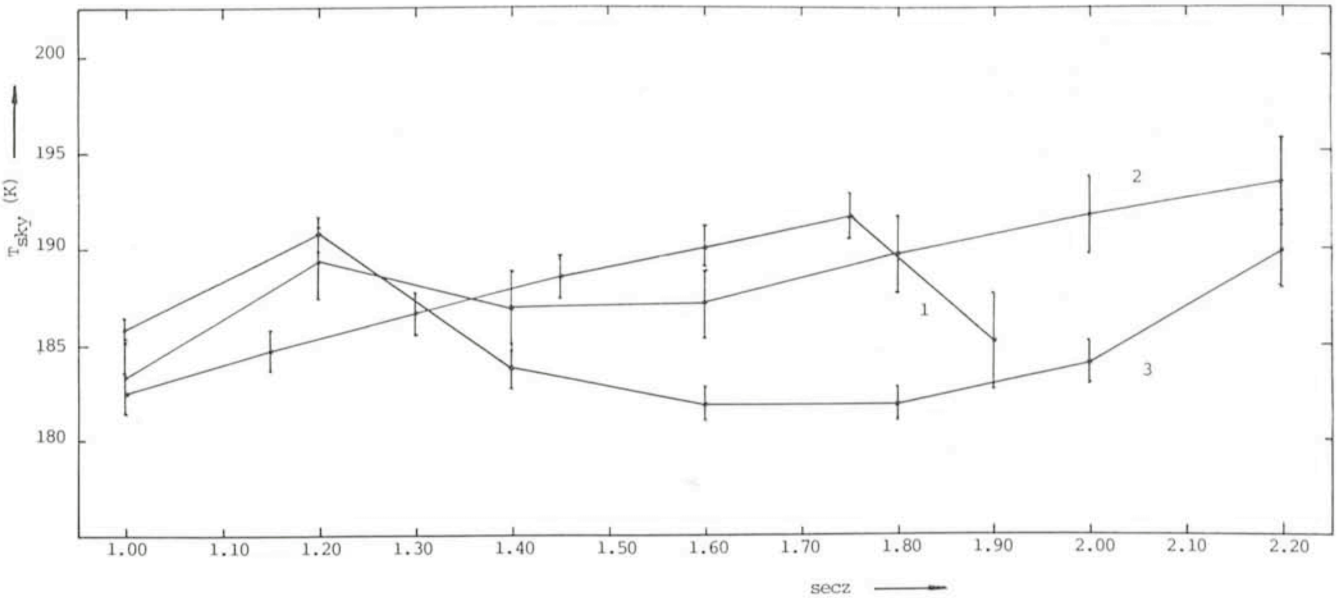


Fig. 2: *Three characteristic skydip results (sky temperature vs. secz)*: series 1: *Az = 210° (SW)*; series 2 and 3: *Az = 90° (E) (series 3 shows a partly inverted atmospheric temperature profile).*

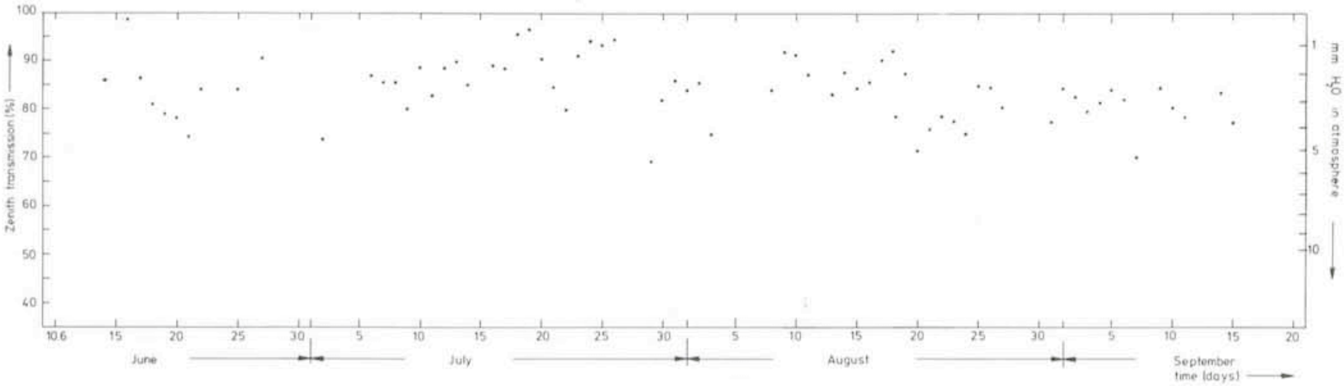


Fig. 3: *Average daily zenith transmission (left-hand scale) and atmospheric water vapour content (right-hand scale) derived under the assumption of a constant efficiency of 35% as a function of time. Gaps indicate days we did not observe. This was mostly due to windspeeds of more than 100 km h^{-1}. Other causes were: check-up of equipment and re-alignment (30/6 and 1/7); humidity close to 100% (3/8 to 7/8, and 30/8); snow and ice (12/9 and 13/9).*

six elevations, covering the interval secz = 1 (elevation = 90°; z = zenith distance) to secz = 2 (elevation = 30°). Higher values of secz (lower elevations) cannot be reached because of the construction of the CAT.

At each elevation the signal from the sky is compared with the signal from a piece of "eccosorb" absorber at ambient temperature (~ 285 K), giving the sky brightness temperature. From those observations, the optical depth of the atmosphere at zenith and an efficiency factor (accounting for losses in the telescope and for radiation entering the receiver from directions other than that of the source) can be determined, by fitting a theoretical curve through the data with these two unknowns as free parameters. This procedure assumes an exponential relation to exist between sky brightness temperature and secz. During our stay at La Silla we made over 200 skydips, providing information on atmospheric conditions in the period 14 June to 15 September 1981 (the October and November data have not yet been reduced). In Fig. 2 we show characteristic skydip results for two different azimuths. The measured points are indicated by filled circles. For reasons of clarity points pertaining to the same dip have been connected by straight line sections. (Each point is an average over several measurements; the vertical bars indicate the uncertainty in this average.)

Series 1 is the average of a number of skydips performed at azimuth = 210° (direction SW; azimuth (Az) is defined here as being 0° to the north and increasing from N to E).

Series 2 and 3 show characteristic dips at Az = 90° (east). Seventy-two per cent of all skydips were performed in the SW direction, and nearly all of these (96 %) feature a smooth increase of sky temperature with increasing secz, as illustrated by series 1. In all these cases a satisfactory fit to the data could be made. The efficiency factor was found to be 0.35 (± 0.03 s.d.). All remaining skydips (28 % of the total) were performed to the east. The majority of these (62 %) show a run of sky temperatures with secz as series 3, which is partly inverted. Since in this case the assumed exponential relation between temperature and secz is absent, no meaningful values for zenith opacity and efficiency factor can be derived from these by our fitting procedure. Therefore it was assumed that the same efficiency factor applies to skydips performed at different azimuths, leaving only one unknown (the zenith opacity) in the fitting procedure. All formerly unsolvable eastern skydips have been reduced along this line. The zenith opacities thus obtained were transformed into atmospheric transmission percentages and shown in Fig. 3. Also indicated is the corresponding amount of H_2O in the atmosphere (using $\tau = 0.067$/mm H_2O; van de Stadt, internal memo). The data in Fig. 3 are average daily (0:00 UT – 24:00 UT) transmissions. The absolute uncertainty in these numbers is about ± 5 %. We have not observed every day during the indicated period: gaps in Fig. 3 indicate days during which we could not observe at all. This was usually due to windspeeds of more than 100 km h^{-1} under which circumstances we were not allowed to open the dome. Other causes that play a role are time lost through check-up of our equipment and re-alignment, humidity close to 100 % and precipitation (snow and ice). Apart from weather conditions on a particular day, the number of points that make up a "daily average" in Fig. 3 also depends on whether observing time was allocated to us 24 hours a day or only during daytime. In short, Fig. 3 gives a representative picture since we did not observe only when ESO regulations did not allow us to; the data are not biased by picking out days with seemingly good

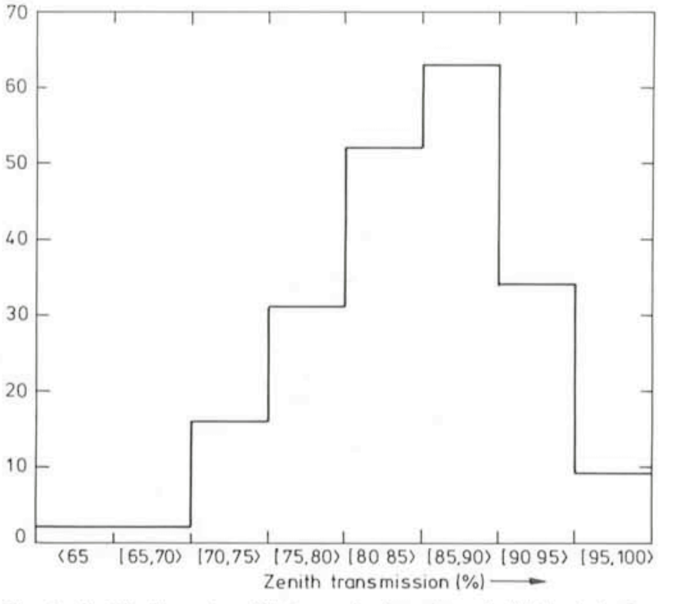


Fig. 4: *Distribution of zenith transmissions from individual skydips (assuming a constant efficiency of 35 %).*

observing conditions only. It can be seen that in general over the indicated period of time atmospheric transmission at 230 GHz was quite good, roughly between 80 % and 90 %, as can be seen more clearly from Fig. 4, which shows the distribution of zenith transmissions. The lowest transmission obtained from individual skydips are 46 % and 57 %. Translated into more usable terms this means that the amount of water vapour usually varied between 3.3 mm and 1.6 mm. On a whole, transmission was best in July and August which is possibly due to the season, winter bringing along less humidity.

To conclude, La Silla appears to be a good site for mm-wave observations, with 230 GHz transmissions very often between 80 % and 90 % (3.3 mm to 1.6 mm H_2O). We have noted, however, that the observed atmospheric temperature profile depends on the azimuth of the observations. Practically all temperatures measured in a SW direction increase with increasing secz. As a contrast, in the east the temperature profile in many cases deviates systematically from what we expect in that it is partly inverted. This difference may be due to the fact that in the east one is looking towards the Andes mountain range while in the SW the topology of the land is different, which may cause a difference in H_2O concentration. This interpretation is somewhat complicated by the fact that the CAT features a Nasmyth mirror, which has a slightly different vignetting at different azimuths, possibly causing the efficiency factor to differ accordingly. We are not able to estimate the influence of this effect on the basis of presently available material.

Acknowledgement

We are very much indebted to the people of the technical staff at La Silla, who were always willing to give their support when problems arose.

Reference

Lidholm, S. and de Graauw, Th: 1979, Fourth International Conference on Infrared and Millimeter Waves and their Applications, Florida 1979, p. App. 38.

A New System to Eliminate Gear Backlash in Telescopes

J. F. R. van der Ven, ESO-La Silla

Preloading a telescope geardrive, to eliminate backlash, always has been a major design aspect in telescope engineering. One of the oldest systems was to preload each axis with a steel cable, wrapped around the axis and loaded with a sufficient heavy weight, to keep the mating flanks of the gearwheel in contact under all circumstances, e.g. during windforces, unbalance, etc.

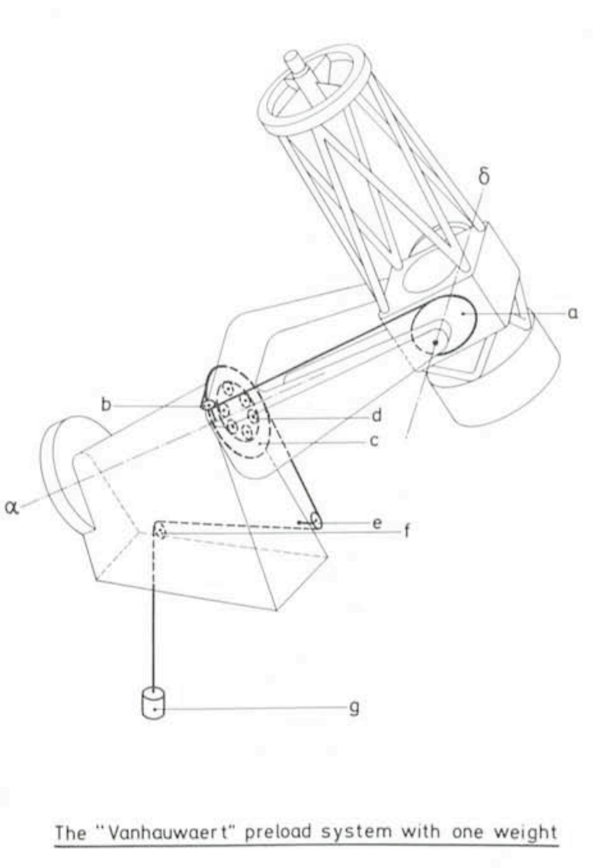
This system is still in use. To preload the polar axis is quite simple, but for the declination axis, it requires a number of rollers to guide the cable inside the polar axis. In several cases this gives problems, due to the necessary cabling, oilducts, etc., that have to pass also.

Therefore, other systems have been applied, e.g. splitgears, double-gear systems, etc. The disadvantage is the extra friction that results. Preloading the gears by two counteracting motors on each of the axes is often applied today. It is however a rather expensive solution. Besides these systems, there are more. It is not the place here to go into all of them in detail.

Mr. Vanhauwaert, of the Astro Workshop at La Silla, got an interesting idea to preload both telescope axes with one weight, that moreover avoids passing of the cable inside the polar axis. This idea is illustrated by the sketch and functions as follows:

The cable disk A is rigidly attached to the telescope tube. The cable end is fixed to this disk. The cable, loaded by weight G, is guided by cable roller B, and passes the big ring-shaped disk C. Further it is guided by the rollers E and F. The main features of this system are the roller B, that is fixed on the fork, and the ring-shaped disk C that can rotate freely about the polar axis over the rollers D. The preload moment about the polar axis results from the cable force at roller B multiplied by the distance between this force and the polar axis centre.

This system has been realized on one of the telescopes at La Silla about half a year ago, and proved to function very well.



The "Vanhauwaert" preload system with one weight

Progress on the 3.5 m "New Technology Telescope" (NTT)

R. Wilson, ESO

Almost two years have gone by since the first article on the NTT written by my former colleague Wolfgang Richter appeared in the *Messenger* (1).

In spite of the disruption due to the move from Geneva to Garching and the loss at that time of *all* the mechanics staff who had worked on ESO telescopes, we can, I think, be satisfied with the progress made. Quite fundamental to this progress is, of course, the funding. This depended on the entry of Switzerland and Italy (announced in the *Messenger* No. 27 and 28 respectively) into ESO. We in the NTT team are particularly happy about these events, for otherwise the NTT could not have become a "real" project with a "real" budget. The approved budget is about DM 24 million (1982), including transport and contingency, which is less than one third of the budget of the existing ESO 3.6 m telescope at La Silla (about DM 68 million – 1974).

How is it possible to aim to build a telescope of about the same aperture only 12 years later than the start of the 3.6 m, at less than one third the price? The answer is the application of new technology which should not only give the reduced price but also *improved* quality and performance.

The principal new technology features are the following:

1. *Weight reduction:* This can only be achieved by lightening the primary mirror since its weight escalates by a chain reaction going through the whole system.

2. *Altazimuth mounting:* This is the oldest form of telescope mounting whose comeback is due to modern electronics which enables 2-axis tracking. The advantages mechanically and spacewise from the symmetry to gravity are self-evident. The advantages in cost and compactness far outweigh, in our view, the disadvantages of the field rotation and the zenith singular point with the accompanying telescope and field inversions.

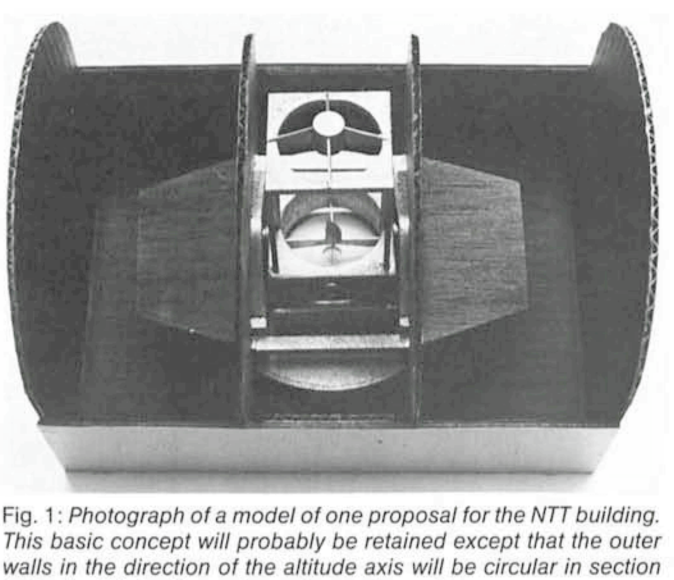


Fig. 1: *Photograph of a model of one proposal for the NTT building. This basic concept will probably be retained except that the outer walls in the direction of the altitude axis will be circular in section instead of flat with quarter spheres above them.*

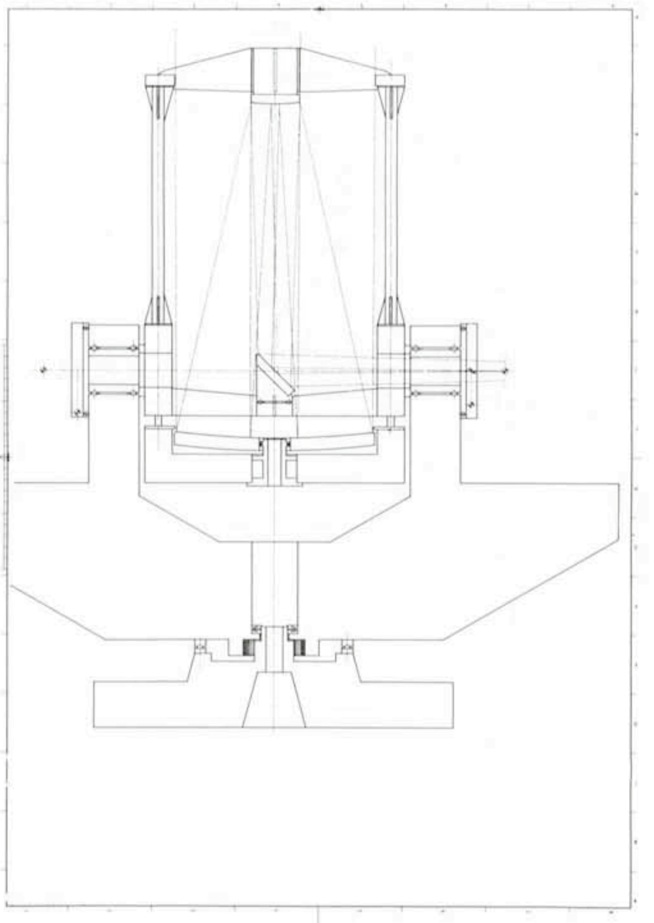


Fig. 2: *Basic geometry of the NTT (schematic).*

3. *A unique type of focus:* Multi-focus (universal) telescopes are very expensive and the gains have often proved illusory because of maintenance and operating complications. After much discussion, the choice was made for a *Nasmyth*-type focus with 2 principal fixed stations on the altitude axis. The principal motivation for the Nasmyth choice was the maintenance and operating simplicity of a light tube undisturbed by instrument weight or exchanges at the upper or lower ends. Prime focus direct imagery can be effectively replaced with a reduced field by focal reducer solutions. No IR wobbling secondary is envisaged, but the single secondary and Nasmyth mirror mounts will be designed to be as "clean" as possible.

In general, the existence of the ESO 3.6 m telescope as a general-purpose instrument available in parallel favours a more specialized design for the NTT.

4. *A compact building without a classical dome:* Our basic model here is the MMT building on Mt. Hopkins which undoubtedly represents a major advance in telescope technology. Fig. 1 shows a photograph of a single model we have prepared for a possible rotating building, but this will certainly still be modified. At what height the rotation would take place is also still open. At present we are considering as the most probable final form the following:

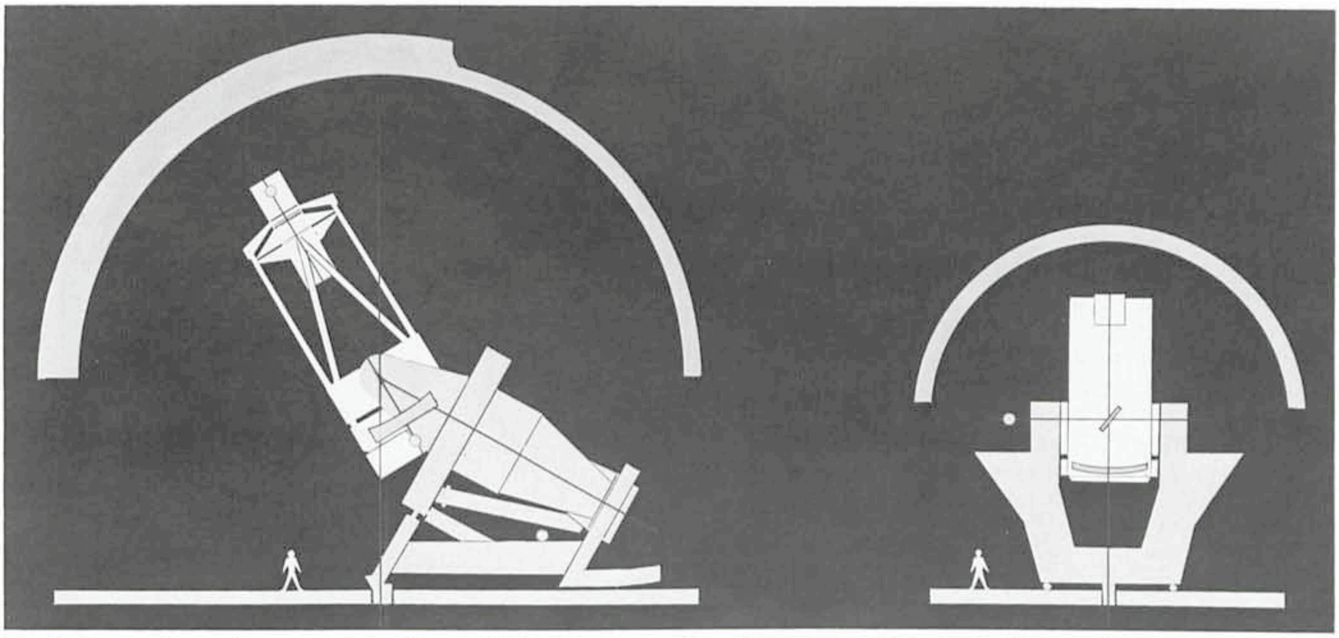


Fig. 3: *Comparison of "sweep circles" for the ESO 3.6m conventional telescope and the NTT, showing the compactness of the latter in comparison.*

- One starts with a cylindrical building with a hemispherical dome as was illustrated in ref. (1).
- This is cut in half vertically. Between the two halves a piece of square section is added, covered by a half-cylinder.
- The telescope is placed in the square section and the protecting half-cylinder consists essentially of windscreens. In this way, flexibility exists between maximum ventilation (windscreens fully open) and maximum wind protection (windscreens closed to leave a horizontal slit width similar to the telescope aperture).
- The quarter-sphere dome elements on each side of the half-cylinder are separated off by an insulated wall and house the instruments.

5. *A systematic closed loop active optics concept providing automatic opto-mechanical maintenance:* This is closely linked to the weight reduction aspect of Point 1 above. It is a natural technological response to the higher flexibility of thinner mirrors. The aim, which seems perfectly feasible, is to achieve *always* effectively diffraction-limited performance: the telescope monitors its own optical quality and corrects itself as required. The principles are discussed in detail in refs. (2), (3), (4).

6. *Atmospheric seeing correction:* This is far more difficult than the correction of the quasi-stable telescope errors of Point 5. It is hoped to make a start on image motion correction as has been reported by Angel (5). Because of the limitations of the isoplanatic angle (that angle over which the "seeing" function remains sensibly constant, which is about 2 arcmin for image motion and only about 10 arcsec for the highest seeing frequencies), it is better to deal with the essentially different aspects of active optics of Points 5 and 6 by different technical approaches.

7. *Remote control:* We consider this an essential feature of a telescope which bears the name NTT. It is a highly emotive subject among astronomers because it implies a radical change in their professional life style. But we believe that nothing can bring bigger gains in efficiency, provided it is carried through all aspects of operation and scheduling.

8. *"Maintenance-friendly" electronics:* Future telescopes will all be totally dependent on electronics for all their functions. The stable configuration of the NTT should be a big asset in assuring good reliability; but it is also essential that breakdowns can be rapidly resolved by systematic diagnostics and module replacements.

9. *Instrumentation:* "Carousel" or transverse carriages for a variety of instruments can be logically applied to a building of the type envisaged. However, to keep changes to an absolute minimum, 3 basic instruments are at present planned for the NTT:

- A long-slit spectrograph for the visible (standard instrument at one Nasmyth focus),
- IRSPEC, the IR spectrograph currently under development for the 3.6 m telescope (standard instrument at the other Nasmyth focus),
- Direct imaging by a focal reducer and CCD camera of a 30 arcmin field.

By the time the NTT is operating, fiber optics coupling may also play a major role.

The above general characteristics have led to the following design features for the optics of the NTT:

- Prime focal ratio f/2.2.
- Secondary (Nasmyth) focal ratio f/11.
- Ritchey-Chrétien configuration. This gives optimum field correction for the mirror system. This field (30 arcmin) is not only useful astronomically but essential for the offset guide star choice, since this is used not only for auto-guiding but also auto-focusing and auto-image-correction.
- The basic concept provides for a primary blank of meniscus form of aspect ratio 1:15.

Fig. 2 shows (schematically) the basic geometry of the telescope and Fig. 3 the immense reduction of building and dome size compared with the present ESO 3.6 m telescope. For the latter, the circle above the telescope effectively represents the dome whereas for the NTT it is simply the "sweep circle".

Particular attention is being given to the *pointing* accuracy of the NTT. In view of the considerable mechanical simplification of the altaz mount, the specification for the *absolute pointing accuracy (including initialization) is 1 arcsec rms.* If this is reliably achieved, the operating comfort in the optical as well as IR regions will be a major asset.

The auto-guider will be of the same type of TV system used most successfully on our 3.6 m telescope (6). The auto-focusing and auto-image-correction will get its information from an image analyser using the SHACK modification (7) of the Hartmann method with a CCD as on-line detector. The active optics control is simply a systematic on-line application of methods we have been using routinely for the past six years to test and analyse off-line the image quality of telescopes both at La Silla and in other observatories. The method is based on a least squares polynomial analysis of the wavefront to determine the terms like decentering coma, astigmatism and spherical aberration which are amenable to correction by intervention in the telescope, and was first used with great success on our ESO 3.6 m telescope (8), (3). In the NTT, the image analyser will feed the polynomial coefficients to the computer which calculates the centering change (for the coma) or primary support force changes (other errors) to correct the image. Details are given in ref. (4) and the scheme is shown schematically in Fig. 4.

Thus the "brain" of the NTT is the image analyser with its computer and the "heart" is the active primary support and secondary mirror control. All normal correction operations will take place without any disturbance to the observation–indeed the observer will be unaware they are happening.

The active primary support is a "soft", force-based system which is a natural development of the principle of the astatic lever, the commonest form of support in conventional telescopes. Hydraulic systems are also being considered but it is not easy to improve on the simple mechanical lever system first applied by Wm. Lassell in 1841 (9). Our consultant, Dr. Schwesinger, who also designed the novel primary cell of our CAT telescope (10), has designed an axial support with 78 supports and a special push-pull radial support which gives *passively* the same quality as our 3.6 m telescope specification, although the NTT primary mirror has an aspect ratio 2 ½ times thinner.

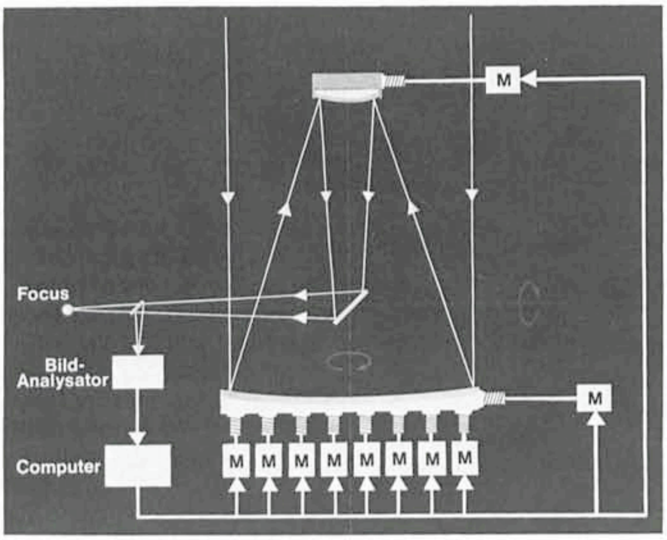


Fig. 4: *Principle of closed-loop active optics control for automatic opto-mechanical maintenance.*

A fundamental aspect of any new technology telescope is the choice of material for the primary mirror. Speculum metal was used from the invention of the reflector by Newton and Cassegrain about 1670 until about 1860 when silvering of glass was invented by Foucault and Liebig. "Normal" glass was replaced by low expansion borosilicate glass in the 1930s and this in turn by fused silica in the 1950s and 1960s, and then by zero expansion glass ceramic in the 1970s. In conventional, passive telescopes, the gain from zero or nearly-zero expansion was immense, though it has often led to carelessness with heat sources resulting in poor "dome-seeing".

Thinner mirrors and active optics make a critical look at this whole technical area necessary. If the thermal capacity and wall thickness of low expansion glasses can be reduced in light-weighted ("egg-crate") structures then this much cheaper material becomes very interesting, as Angel has shown (11). Also the dome seeing aspects are better than with solid zero-expansion blanks. Similarly, metal in solid or structured form re-assumes great interest, since modest warping can be corrected actively and its internal thermal time constant is vastly better than that of any glass. If Sir William Herschel's 20 foot focus speculum had not been pretty good, the foundations of the NGC catalogue would not have been laid! Our recent SHACK-Hartmann tests of the Merate 1.37 m metal mirror (pure aluminium) telescope in Italy have revealed optical performance no different after 14 years of use from many normal "glass" mirror telescopes. There is a modest amount of astigmatism (1.1 λ) which may come from warping but could equally have been there originally or be induced by the primary or secondary mounts. If the decentering coma and this astigmatism were corrected, this telescope would give 1 arcsec images (diameter for 80 % energy concentration).

For the NTT a two pronged approach is therefore foreseen: a "glass" type mirror still to be chosen when complete offers are available, and an aluminium mirror if this latter can be procured.

Since the entry of Italy in May, the NTT has entered the "engineering" phase.

This must be so, as the completion date for "first light" is scheduled to be 1. 1. 1987, a hard schedule for a telescope involving new technology. The project staff in the "Telescope Group" currently consists of 4 people, soon to be expanded to 6. This staff has to deal with other problems as well, so there is no possibility, in general, to do in-house detailed design. Only the conceptual design will be done in-house apart from certain areas like the primary cell.

The NTT is seen as an excellent test bench for the VLT (Very Large Telescope) project which should soon be defined. Work on the NTT and on projects like the Texas 7.6 m (12) indicate that extension to 8 m dimensions with monolithic primaries should be perfectly feasible.

ESO has two exciting telescope projects. We must do our utmost to ensure that our observatory is equipped with telescopes as advanced and efficient as those anywhere in the world. It is our belief that the NTT will fulfil this aim.

References

(1) W. Richter: "New Technology Telescope", *The Messenger*, No. 27, Sept. 1980, p. 19.

(2) R. N. Wilson: "Image quality and high resolution in future telescopes", *Proceedings of the ESO Conference on Scientific*

Importance of High Angular Resolution at IR and Optical Wavelengths", Munich 1981, p. 67.

(3) R. N. Wilson: "Image quality considerations in ESO telescope projects", *Optica Acta*, **29** (7), July 1982, p. 985.

(4) F. Franza and R. N. Wilson: "Status of the European Southern Observatory New Technology Telescope", *SPIE Conference on "Advanced Technology Optical Telescopes"*, Tucson, March 1982, Paper 332-11 (SPIE Proceedings Volume 332).

(5) J. R. P. Angel: "Very Large Ground-Based Telescopes for Optical and IR Astronomy", *Preprints of the Steward Observatory* No. 356, 1982, p. 15.

(6) M. Tarenghi and M. Ziebell: "The European Southern Observatory Automatic Prime Focus Camera and the General Problem of Remote Control", *SPIE Conference on "Instrumentation in Astronomy IV"*, Tucson, March 1982, Paper 331-58 (SPIE Proceedings Volume 331).

(7) B. Platt and R. V. Shack: *Optical Sciences Center Newsletter*, University of Arizona, Tucson, **5** (1), March 1971, p. 15.

(8) F. Franza, M. Le Luyer and R. N. Wilson: "ESO 3.6 m telescope: The adjustment and test on the sky of the PF optics with the Gascoigne plate correctors", *ESO Technical Report* No. 8, Oct. 1977.

(9) Wm. Lassell: "Description of an observatory erected at Starfield, near Liverpool", *Memoirs of the Royal Astronomical Society*, XII, 1842, p. 265.

(10) G. Schwesinger: "Support configuration and elastic deformation of the 1.5 m prime mirror of the ESO Coudé Auxiliary Telescope (CAT), *ESO Technical Report* No. 9, March 1979.

(11) J. R. P. Angel and J. M. Hill: "Manufacture of large glass honeycomb mirrors", *SPIE Conference on "Advanced Technology Optical Telescopes"*, Tucson, March 1982, Paper 332-38 (SPIE Proceedings Volume 332).

(12) J. G. Barnes III, ed.: *Proceedings of the 300 inch Optical Conference, March 1982.* Dept. of Astronomy, UT Austin, to be published shortly.

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Una visita en Sud America

Disfrute de una estadía en el Hotel La Silla, el mejor hotel de Sud America con su tan única atmosfera extraterrestre! Los espera su calificado personal de experimentados hoteleros, jefes de cocina, etc., ansiosos todos de satisfacer sus deseos ...... hasta el más mínimo detalle. Naturalmente nuestro espacioso restaurant de tres estrellas ofrece un completo surtido de exquisitas comidas y deliciosos tragos (conocedores usualmente eligen "Delicia Orion" o "Centauro Especial"). El servicio cempleto durante 24 horas incluye nuestra ya mundialmente famosa "Cena de medianoche para los miradores de estrellas", por eso - no olvide: No pierda la oportunidad de una estadía en EL HOTEL LA SILLA – una experiencia maravillosa! C. M.

Comité de los Usuarios

El Comité de los Usuarios se reune una vez al año. Cada representante trae de sus colegas nacionales una larga lista de quejas, sugerencias y expresiones de gratitud para ESO.

Se encuentran presentes el Director General, el Director en Chile, a veces el Jefe de TRS, el Jefe de la Sección de Astrónomos Visitantes y varios de los principales astrónomos e ingenieros.

ESO, the European Southern Observatory, was created in 1962 to ... establish and operate an astronomical observatory in the southern hemisphere, equipped with powerful instruments, with the aim of furthering and organizing collaboration in astronomy ... It is supported by eight countries: Belgium, Denmark, France, the Federal Republic of Germany, Italy, the Netherlands, Sweden and Switzerland. It operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where twelve telescopes with apertures up to 3.6 m are presently in operation. The astronomical observations on La Silla are carried out by visiting astronomers – mainly from the member countries – and, to some extent, by ESO staff astronomers, often in collaboration with the former. The ESO Headquarters in Europe are located in Garching, near Munich.
ESO has about 120 international staff members in Europe and Chile and about 120 local staff members in Santiago and on La Silla. In addition, there are a number of fellows and scientific associates.

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La agenda comienza con un resumen de parte del Director General: estado de los proyectos de telescopios más importantes, instrumentación futura y otros asuntos. Luego el Director en Chile y el Jefe de TRS describen las condiciones presentes en que se encuentran los instrumentos, los problemas que han surgido y aquellos que se esperan. Luego estos puntos son discutidos por el Comité.

Luego los representantes de los varios países miembros presentan sus ideas sobre diferentes detalles de las actividades en La Silla e igualmente sobre las facilidades que ESO proporciona a astrónomos visitantes en Garching. Es agradable notar cuán bien ESO acepta críticas razonables. En muchas ocasiones ESO está en condiciones de complacer las peticiones o bien se llega a un compromiso. Y en caso de que algún punto no pueda ser resuelto, es tarea de los representantes nacionales hacer llegar esta información a los colegas que han planteado el problema. En todos los casos se ha notado que es de beneficio ventilar las opiniones.

Progreso con el "Telescopio de Nueva Tecnología" de 3.5 m (NTT)

Desde septiembre de 1980 cuando el primer artículo sobre el Telescopio ESO de Nueva Tecnología de 3.5 m fue publicado en "El Mensajero", el diseño para este instrumento ha hecho progresos satisfactorios.

Con la entrada de Suiza e Italia a ESO se ha asegurado el financiamiento para este proyecto. El presupuesto aceptado asciende a aproximadamente 24 millones de marcos alemanes, lo que corresponde a menos de la tercera parte de los costos del existente telescopio de 3.6 metros.

Sólo aplicando nuevas tecnologías será posible construir un telescopio de 3.5 m a un precio tan relativamente bajo.

Las principales características de la nueva tecnología son las siguientes:

- *Reducción del peso:* Sólo sera posible usando un espejo primario más delgado y liviano ya que su peso es decisivo para el peso total del instrumento. Como un espejo más delgado tendrá una mayor flexibilidad, estará equipado con un nuevo sistema de soporte controlado por computadora el cual corregirá automáticamente cualquier deformación asegurando así una siempre óptima calidad óptica del espejo.
- *Un tipo único de foco:* Se ha elegido un foco de tipo Nasmyth, especialmente por su fácil mantención y operación.
- *Un edificio compacto sin la clásica cúpula:* Figura 1 en pag. 24 muestra un modelo de un edificio de tal índole. Sin embargo, su estudio se encuentra aún en una fase inicial y seguramente el modelo tendrá modificaciones.
- *Instrumentación:* Para mantener los costos bajos y un mínimo de cambios de instrumentación se han previsto sólo tres instrumentos para el telescopio.

Se espera que el telescopio entrará en funcionamiento en enero de 1987 – un muy corto lapso para un telescopio con tanta nueva tecnología.

Con este proyecto de telescopio y aquel del VLT (Very Large Telescope – Telescopio Muy Grande) ESO demuestra su mayor esfuerzo para asegurar que su observatorio se encuentre equipado con telescopios tan avanzados y eficientes como aquellos en otros lugares del mundo.

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