No. 9—June 1977

ESO Workshop on Populations in the Magellanic Clouds

The second ESO workshop took place in Geneva, at the ESO Scientific-Technical Centre from April 27 to 29, 1977. Over fifteen groups working in this field in Europe were represented at this workshop. About thirty-five invited scientists from all ESO countries, as well as England, South Africa and Canada, discussed and compared their recent activities, results and future plans.

A series of review talks took place on the first day; they dealt with the stellar populations of the Clouds (photometric and spectroscopic analysis), the variable stars, the radio properties of the Clouds and the Magellanic Clouds as members of the Local Group.

The various groups then presented their activities on the second day. Details were given of the work on the chemical composition of the interstellar matter and supergiant stars which have allowed an analysis of the heavy-element underabundance in terms of the proportion of matter in the form of interstellar gas. An estimate of the supernova rate was given together with some new supernova remnant candidates. Preliminary results on UV observations allowed a rough determination of the reddening law in the Clouds. The structure of the Clouds appeared still to be controversial, in particular for the Large Cloud. More work should be devoted to determine the mass centre of different stellar populations and to compare the rotation curves for the stars and the gas. Photometric and spectroscopic results for different stellar populations were also presented, and the difficulty of finding clear criteria for spectral classifications was emphasized.

A subsequent general discussion showed the importance of the Clouds for our understanding of galactic evolution. It dealt with the rate of star formation in the Clouds and their evolution compared to that of our Galaxy. Further UV observations are necessary to solve the problem of the nature of the grains in the Clouds. IR observations were proposed to determine an evolutionary sequence of nova shells, and to check the assumption of the formation of grains in these shells. Simultaneous optical and X-ray observations, once HEAO B is flying, will be very valuable for the study of supernova remnants and X-ray stellar sources.

J. Bergeron, ESO-Geneva

ANNOUNCEMENT

A conference is being planned at the European Southern Observatory on the topic:

Optical Telescopes of the Future

It is expected that this conference will take place in Geneva, 12–16 December, 1977. Topics will include: large dishes, coherent and incoherent arrays, intensity and speckle interferometry, multi-mirror telescopes, space telescopes, IR heterodyne interferometry, live optics and related aspects of detectors and radio arrays.

Information on this conference should become available during this summer.

PROFILE OF A VISITOR'S PROGRAMME:

A Galactic Window at $l = 311°$

There are reasons to believe that several nearby galaxies (possibly even members of the Local Group) still hide behind the absorbing layers of the galactic plane. Last month, a new, local dwarf elliptical galaxy was discovered in the constellation Carina by a group of astronomers at the Edinburgh Observatory and a thorough investigation of another, the so-

called Circinus *galaxy, was published in* Astronomy&Astrophysics. *The discoverer of this galaxy, Dr. Gösta Lyngå of the Lund Observatory, discusses some aspects of this research and also reports on electronographic observations with the new ESO Spectracon camera.*

The Circinus Galaxy

Distant parts of our own galaxy are obscured from sight by the concentration of dust near the plane of our galaxy. This dust layer also dims the light from external galaxies; there is a "zone of avoidance" of galaxies near the galactic plane. In some longitudes it appears, however, that there is much less than the average amount of dust. This is an interesting fact in itself, but it can also be a fortunate circumstance making distant objects available for observations. Twenty-one years ago Erika Böhm-Vitense (*Publ. Astron. Soc. Pacific*, Vol. **68,** 430, 1956) drew attention to some directions in the galactic plane in which external galaxies are observable near the galactic equator. Other directions of low obscuration have been discovered since then. The usual term for such a field is "galactic window".

A few years ago I accidentally came upon a large unknown galaxy in the southern constellation Circinus (i.e. the Compass) at longitude 311° and latitude –4° when inspecting a plate from the Uppsala Schmidt telescope in Australia. The galaxy was named *Circinus Galaxy* and it

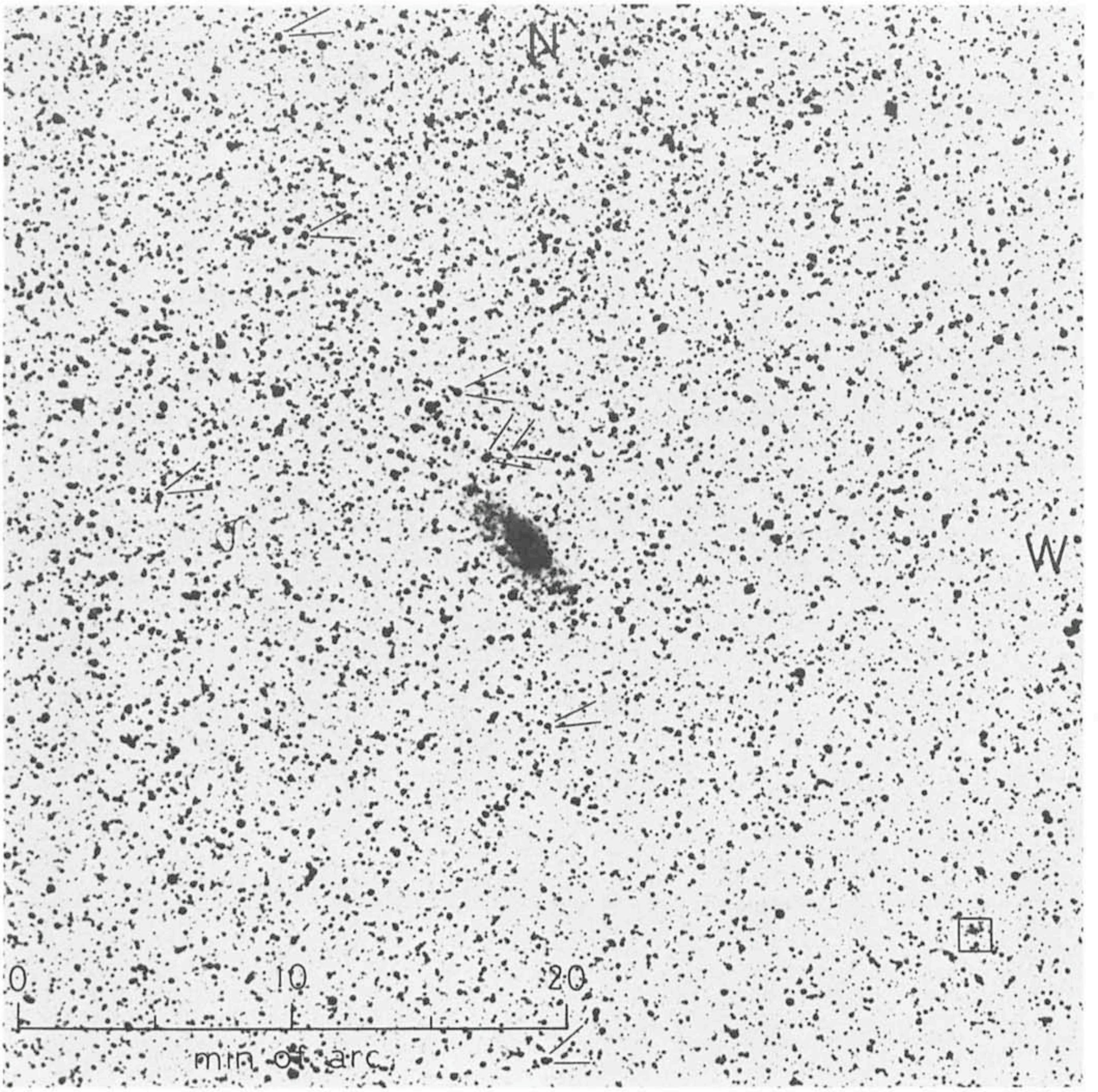


Fig. 1. — *The Circinus Galaxy is in a rich field of stars—some of them very distant. The original is a 90-min exposure in Hα with the Uppsala Schmidt telescope at Mount Stromlo.*

Fig. 2 a. — *A small, extended object (a galaxy?) electrographed with the Spectracon on the ESO 1-metre telescope on La Silla.*

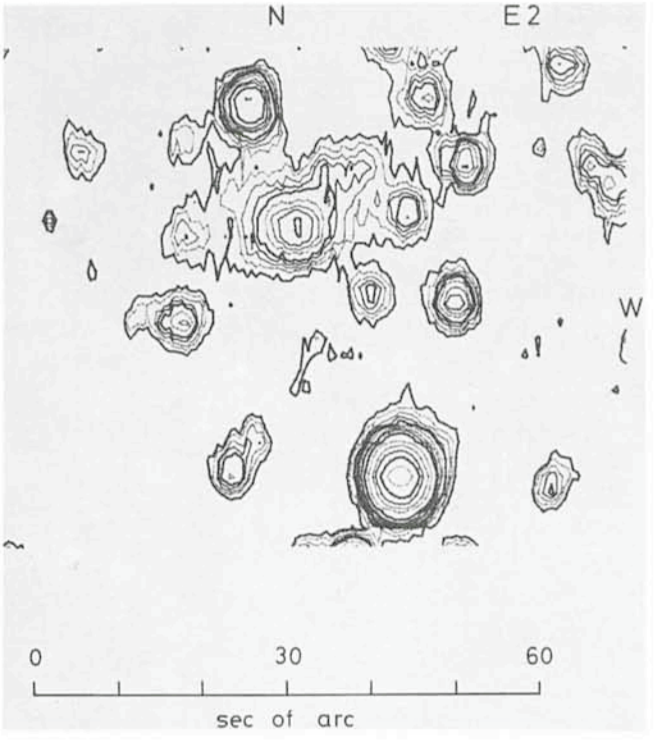


Fig. 2 b. — *Contours from the electrograph of Fig. 2 a corresponding to densities between 0.1 and 1.0 unit. Graph obtained by H. Lindgren with the ASTOL measuring system at the Lund Observatory.*

turned out to be one of the fifty brightest galaxies. A study of the galaxy in optical as well as in radio wavelengths was made in cooperation with several colleagues (Freeman, Karlsson, Lyngå, Burrell, van Woerden, Goss and Mebold, *Astron. & Astrophys.*, Vol. **55,** 445, 1977). The Circinus Galaxy was shown to have a strong radio source in the nucleus and to contain a lot of neutral hydrogen over a large volume. Of other results I shall here only report that the distance is about 4 Mpc, thus placing the Circinus Galaxy just outside the Local Group of galaxies.

Early-type Stars in the Galactic Window

Some important aspects of having a galactic window at l = 311° are that the distribution and motion of stars inside the Sun's galactic orbit can be studied and that the interstellar extinction can be determined in these regions.

There are many early-type galactic stars in the Circinus galactic window and with the 1-metre photometric telescope at La Silla I have observed some of them and determined their distances (*Astron. & Astrophys.*, Vol. **54,** 71, 1977). The field of interest is shown in Fig. 1, where the Circinus Galaxy is in the centre and the richness of the stellar field is obvious. Some stars marked in Fig. 1 seem to be more than 3 kpc away and to have much less interstellar extinction than normal for such distances. This again shows the lack of dust in that particular direction. The photometry from the 1-metre telescope is also a starting point for a future programme which will study the radial velocities of the distant early-type stars in the field.

Electrographic Observations on La Silla

One could well ask if there are more galaxies in the Circinus field. I have in fact noticed some faint, extended objects, and to investigate them closer I have used the new ESO Spectracon electrographic camera. This camera was adapted for use with the ESO 1-metre and 1.5-metre telescopes in cooperation with Dr. Martin Cullum of the ESO-Geneva staff. The great thing with electrography is the linearity of response to light. Fig. 2 a is a reproduction of one of the faint objects and Fig. 2 b shows contours of the plate density corresponding to the luminosity distribution in the object. Compare this information to that of the original Uppsala Schmidt plate; in Fig. 1 the rectangle marks the area of Fig. 2. It is gratifying to have such equipment aiding observations and one can only hope soon to be able to use electrography with the 3.6-metre telescope, giving much larger sensitivity and increased definition for galactic and extragalactic objects.

ESO Santiago Offices Let to UN

On March 7, a lease contract was signed between ESO and the United Nations for the rental of the vacant ESO offices, the previous astro-workshop and part of the storage area at the Vitacura Headquarters in Santiago.

The space rented by the UN had become available after most ESO services had been transferred from Santiago to La Silla. The transfer to the observatory site was part of the reorganization of ESO in Chile, which was initiated in 1975 in order to insure a better functioning of the observatory.

As a result of this reorganization, all technical and most scientific and administrative services are now concentrated on La Silla. Only a few offices and part of the storage area in the basement of the main building in Vitacura are still being used by ESO.

Probable Optical Identification of LMC X-4

Claude Chevalier and Sergio A. Ilovaisky, Observatoire de Meudon

Among the five X-ray sources known to exist in the Large Magellanic Cloud, none has up to now been positively identified with an optical object. However, this situation may change in the near future as X-ray satellites point to the source known as LMC X-4. The existence of this source was announced in 1972 as a result of the first X-ray survey of the sky by the UHURU satellite; it was also detected by the Ariel 5 and SAS-3 satellites and there is now definite evidence for variability, including flares. The rotating modulation collimator system aboard SAS-3 determined the position of LMC X-4 to one arc minute. Inside the error box a large number of stars are visible on the ESO QBS plate (field 86). Very deep objective-prism Schmidt plates taken at Cerro Tololo by N. Sanduleak and A. G. D. Philip showed an OB star near the centre of the error box. A spectrum of this star was taken by E. Maurice in January 1977 with the Echelec spectrograph of the 1.5-m telescope at La Silla; it showed the star to be indeed an early-type luminous object. During our runs at La Silla in February and March 1977 we started a systematic study of this object. One of us (C.C.) measured it photometrically at the 1-m telescope while the other took 124 Å/mm spectra at the 1.5-m using also the Echelec and the Lallemand electronographic camera. In the course of a first run in February at the 1-m we found the star to be variable by 0.1 magnitude from night to night and by a few per cent in the course of the night. Concurrently, W. Hiltner, working at Cerro Tololo, also discovered the variability of this star. In the course of seven consecutive nights in March we obtained *simultaneous* photometric and spectroscopic data. This was supplemented by a few

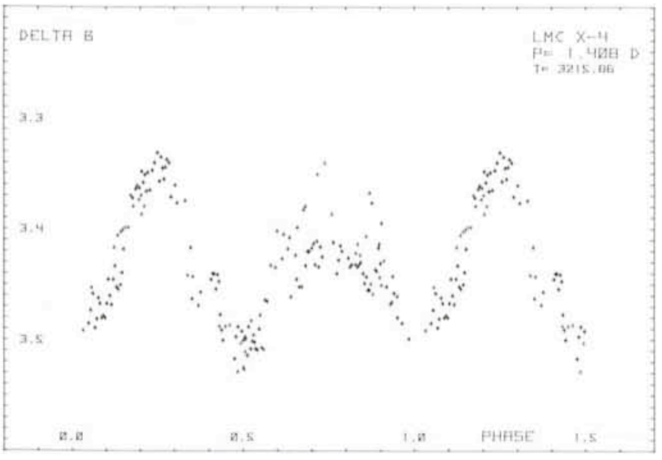


Fig. 1.

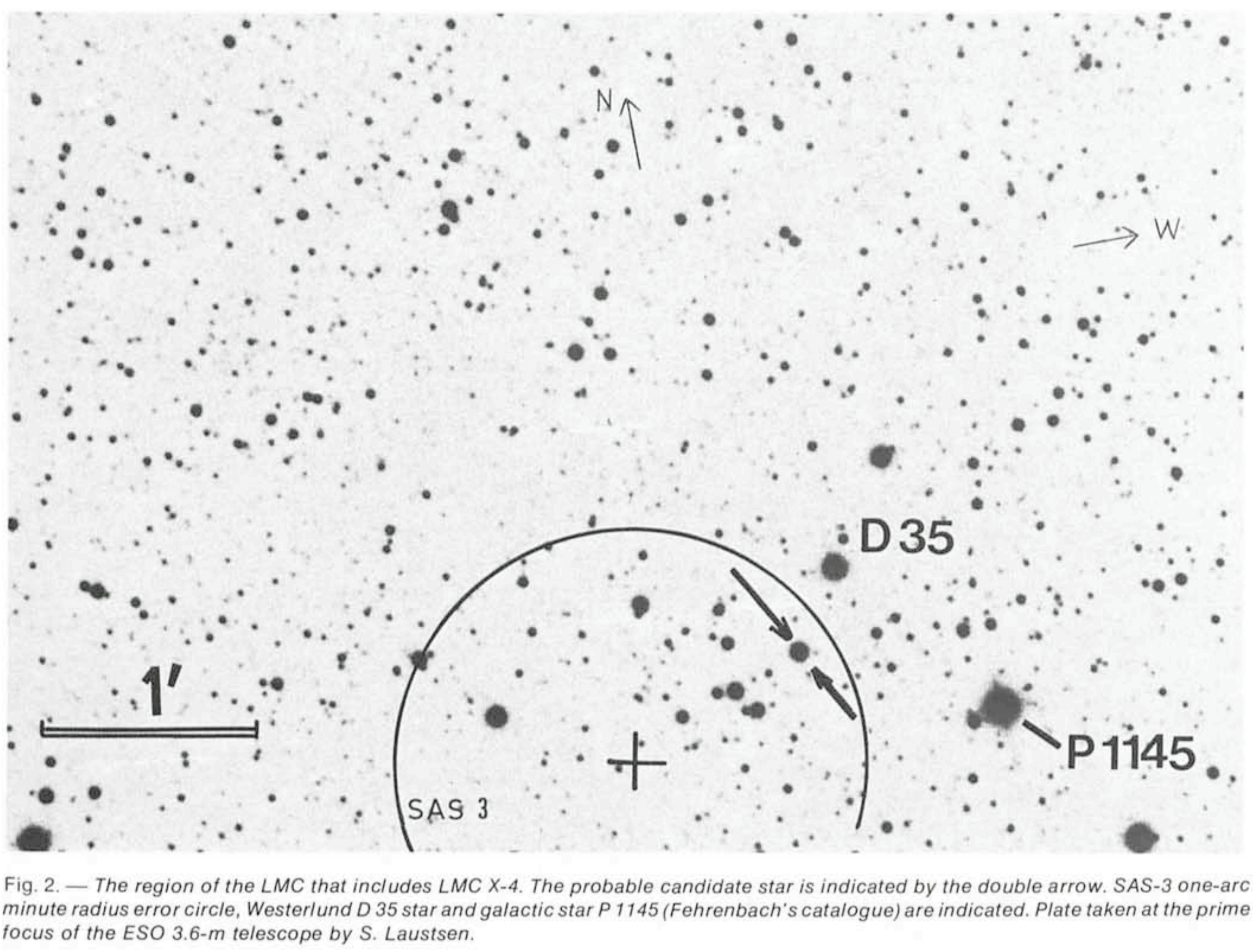


Fig. 2. — *The region of the LMC that includes LMC X-4. The probable candidate star is indicated by the double arrow. SAS-3 one-arc minute radius error circle, Westerlund D 35 star and galactic star P 1145 (Fehrenbach's catalogue) are indicated. Plate taken at the prime focus of the ESO 3.6-m telescope by S. Laustsen.*

nights at the ESO 50-cm during the new moon. The reduction of the photometric data was completed in April and a statistical analysis showed the presence of a regular variation with a period of $1^d.408 \pm 0^d.002$ and an amplitude of 0.15 magnitude. The light curve is double-humped with one maximum being variable in intensity (Fig. 1). Twenty-one electronographic spectra of this star were reduced using the PDS computer-controlled microphotometer of Nice Observatory (CDCA). The spectrum shows H, He I and He II in absorption; the spectral type is about O8 and the mean radial velocity confirms LMC membership. The λ 4686 He II line is also present in emission and it exhibits periodic radial-velocity variations in phase with the light curve. A preliminary value for the semi-amplitude is 450 ±50 km/s. Maximum recession velocity occurs at the time of the variable maximum in the light curve. The underlying λ 4686 absorption line shows approximately constant radial velocity to within ±50 km/s. The optical light curve of this star resembles strikingly those of Vela X-1, SMC X-1, Cen X-3, and Cyg X-1, all positively identified binary X-ray sources with OB-type supergiant companions. However, the orbital period of the LMC X-4 candidate is shorter and the radial velocity of the λ 4686 emission line is larger than in these other systems. In this sense the object is remarkable. Except in Cyg X-1, X-ray eclipses have been found in all the above systems and we hope that future X-ray observations will reveal whether they exist in LMC X-4. If so, the identification will have been confirmed beyond doubt.

A Search for Anomalous Tails of Short-period Comets

Should any future comet display a spectacular sunward spike like the one Comet Arend-Roland exhibited in late April 1957, it would not surprise observers any more. Recent dynamical studies of cometary dust by Z. Sekanina at the Centre for Astrophysics of the Harvard College and Smithsonian Astrophysical Observatories led to the understanding of the behaviour of the sunward, "anomalous" tails or "antitails", to the recognition of the rules that determine the conditions of visibility of these phenomena, and thus to the possibility of their routine predictions.

The astrophysical significance of the anomalous tails is determined by the fact that they are composed of relatively heavy dust particles, whose sizes vary typically from about 100 microns to a few millimetres. The millimetre-sized grains correspond to meteoroids that give rise to the meteor phenomenon, primarily to the one detectable by radar techniques. The submillimetre-sized particles are believed to contribute most significantly to the mass of the interplanetary dust cloud (zodiacal cloud). It thus becomes obvious that studies of anomalous tails are relevant to many aspects of the comet-meteor relationships and to the evolutionary problems of the zodiacal cloud.

Successful Prediction of Antitails

Since Sekanina's formulation of the criteria of visibility in 1973, predictions of anomalous tails have been published by him for two nearly-parabolic comets: Kohoutek 1973 XII and Bradfield 1975 XI. Both predictions were confirmed by observations. The application of the criteria to the past instances led to successful identifications of antitail observations for a number of nearly-parabolic comets, but no positive reports seem to exist for the short-period comets in spite of plentiful opportunities. The apparent absence of anomalous tails among the short-period comets is difficult to reconcile with the well-established associations of meteor streams with a number of these comets, and particularly with the occasional occurrences of the remarkable "meteor storms".

The zodiacal cloud is self-destructive. As shown by F. L. Whipple, it requires a continuous input rate of 10^7 grammes/sec to replenish the mass lost by dissipation. The source that provides the mass input is unknown. However, the mass cannot be supplied by asteroidal collisions as recent investigations of the dust population in the asteroid belt have shown. Likewise, the mass cannot be provided by nearly-parabolic comets, since virtually all dust they release escapes from the solar system to interstellar space. The short-period comets are regarded as another inadequate source, but the present estimates are hardly meaningful. They are based on highly doubtful premises, such as a linear relation between the intrinsic brightness of the comet and its large-particle emission rate. It appears that the detection and photometric investigation of anomalous tails is the only ground-based technique that can resolve the problem of the short-period comets as a potential supplier of the required mass.

The ESO Schmidt Telescope Observes Comet d'Arrest

The absence of reports on anomalous tails of the short-period comets in the past suggests that such formations must be very faint and that only fast cameras might have a chance to detect them. This kind of reasoning led to a collaboration—a very fruitful one, as it turned out later—between Dr. Sekanina and Dr. H.-E. Schuster, who is in charge of the ESO 1-metre Schmidt telescope. Dr. Sekanina's list of the short-period comets with favourable conditions for observing anomalous tails shows almost two dozen cases between the years 1976 and 2000. Periodic Comet d'Arrest, the first comet on the list, was south of the Sun when it developed favourable conditions in October 1976; they persisted as long as the comet could be followed, well into 1977. The anomalous tail was to point to the west of the nucleus. Dr. Schuster took the first plate in mid-November, a 45-minute exposure on a panchromatic emulsion combined with a GG 385 filter. The image of the comet was large and circular. Direct inspection showed no trace of the anomalous tail, but a densitometer scan revealed a definite extension in the anticipated direction at angular distances from the nucleus exceeding 10 arcminutes. Most of the visible coma was apparently due to C_2 which was not filtered out and which entirely obliterated the minor contribution from dust near the nucleus. It became obvious that in order to obtain a more convincing evidence, it was necessary to use a more restrictive filter (a red one) which in turn required a

The tail that extends to the north from Comet d'Arrest on this ESO Schmidt photograph is not anomalous; it is a typical, straight gas-tail, pointing away from the Sun. The line to the left of the comet head is a meteor trail.

The circumstances of this photo are peculiar and illustrate the work with a large Schmidt telescope in a good climate. On the night between October 19 and 20, 1976, ESO night assistant Guido Pizarro obtained several plates for the ESO (B) Survey of the Southern Sky. Each plate was exposed for one hour on blue-sensitive IIa-O emulsion with an ultraviolet-cutting filter GG 385. Immediately after the plate of field No. 352 (R.A. = 01^h13^m; Decl. = –35°00') came out of the water-rinse in the darkroom, Guido was seen running downstairs in great excitement. He had noticed the beautiful image of a bright comet and having no prior knowledge of the position of the known comets, he could not know that it was actually Comet d'Arrest that had accidentally been caught on the plate. It was no fun for the ESO astronomer on duty to tell Guido that "his" comet war already known, but he took it as a man and is still perfectly confident that the day will come when the first real "Comet Pizarro" is found.

considerably longer exposure. On January 22, 1977 Dr. Schuster took the second, 90-minute exposure, using a panchromatic emulsion in combination with a RG 630 filter. Although by then the comet's image became much smaller in size and fainter in brightness, its densitometer tracing showed a well-pronounced extension in the expected direction—the existence of the anomalous tail was confirmed. The scan is now being calibrated and it will shortly be used to calculate the production rate of large dust particles from Comet d'Arrest—the first positive step in the search for a source of the interplanetary dust cloud.

Drs. Schuster and Sekanina both look forward to their continuing collaboration. Their next target is Periodic Comet Encke, for which a successful search for an anomalous tail at the forthcoming apparition must be conducted within a few days in mid-October 1977—the only period when the comet is sufficiently far away from the Sun in the sky to allow long exposures and, simultaneously, the anti-tail projection conditions are favourable.

Optical Identification of a Strong Southern Radio Source

There is good reason to believe that one of the strongest, so far unidentified southern radio sources has finally been photographed with the ESO Schmidt and 3.6-m telescopes.

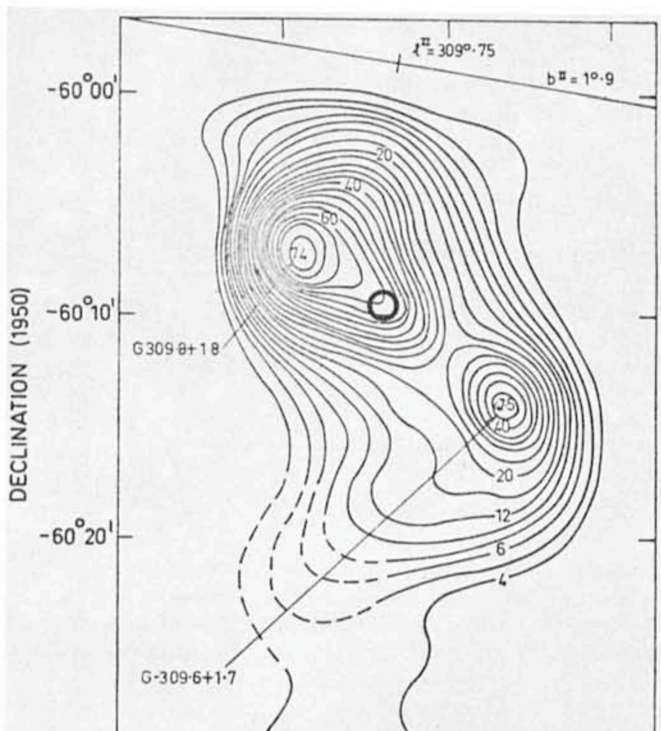


Fig. 1.— *Reproduction of the radio map of G 309.8 + 1.8/G 309.6 + 1.7 at 408 MHz by Shaver and Goss* (Austr. J. Phys. Astrophys. Suppl., **14,** *104, 1970) with the position of the ESO object indicated as an open circle.*

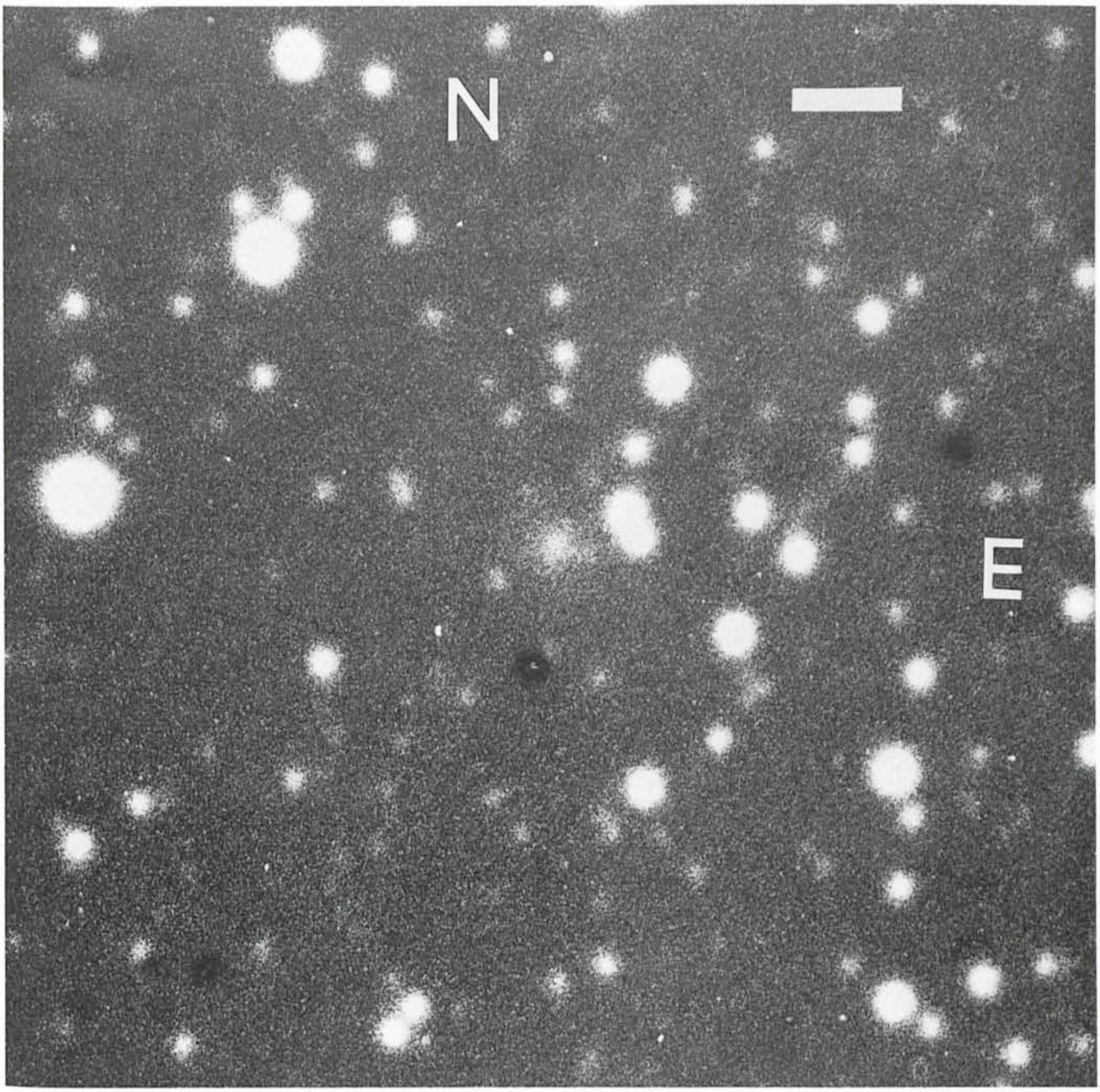


Fig. 2. — *Enlargement from plate No. 591 obtained by Dr. S. Laustsen with the ESO 3.6-m telescope on March 16, 1977. Emulsion and filter: H_2O-sensitized IV-N + RG 10 (7000–9000 Å). Exposure 40 min. The scale is indicated with the small bar which has a length of 10 arcseconds. The central, diffuse image is clearly non-stellar and has a diameter of about 10" on the original plate. The dark spots are sensitization marks which are virtually impossible to avoid on infrared plates. The seeing deteriorated during the exposure, from about 1" to 3".*

The radio source in question will be well known to most radio astronomers: G 309.8 + 1.8/G 309.6 + 1.7. It has about ten other designations, MHR 29, Milne 27/28, etc. . . . and has been observed by Australian radio astronomers for more than a decade. The G 309.8 + 1.8 source is the stronger of the two with 136.5 f.u. at 408 MHz. It is a double source and from the structure and spectral index, it appears to be extragalactic. However, due to its proximity to the galactic equator, it has until now defied optical identification. As mentioned in another article in this issue of the *Messenger* (p. 1), there are only few "windows" that allow us to look through the obscuring dust layers in the galactic plane and nature did not provide us one for the present radio source.

The interstellar extinction (obscuration) is strongly wavelength-dependent in the sense that blue light is absorbed much more than red light and the extinction is even less in the infrared. Very deep blue-sensitive plates were taken with the ESO Schmidt telescope in the direction of MHR 29 but nothing could be seen at the position of the radio source except galactic stars. It soon became obvious that the only hope lay in the infrared, and on March 11, 1977 a 90-min Schmidt exposure was obtained on sensitized IV-N infrared emulsion (7000–9000 Å). This emulsion is normally much slower than the standard astronomical infrared emulsion I-N, but by careful treatment (water + very quick dry), IV-N becomes quite a bit faster than I-N. This infrared Schmidt plate was carefully scrutinized by ESO astronomers H.-E. Schuster and R.M. West and they agreed that a very faint, apparently *non-stellar* object was seen right on top of the radio position.

There was obviously need for confirmation and another ESO astronomer, Dr. S. Laustsen, who was working with the 3.6-m telescope immediately agreed to take a corresponding deep IV-N plate with the large ESO telescope. However, since at that date only a blue-optimized Gascoigne corrector was available, it was not clear whether the 3.6-m would do much better than the Schmidt in the infrared. The first 90-min infrared plate was rather dark because of the nearby Moon, but a second 40-min exposure three days later clearly brought out a non-stellar object as seen on the Schmidt plate. This 3.6-m photo is reproduced here. A further red plate (127-04 + RG 630) barely showed the object, confirming its infrared colour.

Photometric infrared observations were soon after made by Dr. W. Wamsteker of ESO with the 1-m telescope. He detected an infrared source at the same position and the measurements (1.6 to 5 microns) are being reduced. The ESO astronomers are now preparing their observations for publication.

The 1950 position of the optical candidate is R.A. = $13^h43^m23^s.57$; Decl. = $-60°09'30''.1$, i.e. in very good agreement with the most recent radio positions of this source. From the infrared photos there is little doubt that we see the very heavily reddened centre of a galaxy, but further observations are obviously desirable in order to learn more details. It will not be easy to obtain an optical (probably infrared) spectrum but the effort would be worthwhile.

Progress Report 3.6-m Telescope

A piece of good news can be reported: the Cassegrain focus of the 3.6-m telescope is operational. The technical staff around the instrument has, it seems, already acquired a considerable routine in getting a piece of equipment to work. It all went very smoothly with the Cassegrain, the mechanical installation, the electronic control, the optical alignment and tests and finally the astronomical tests and further software development.

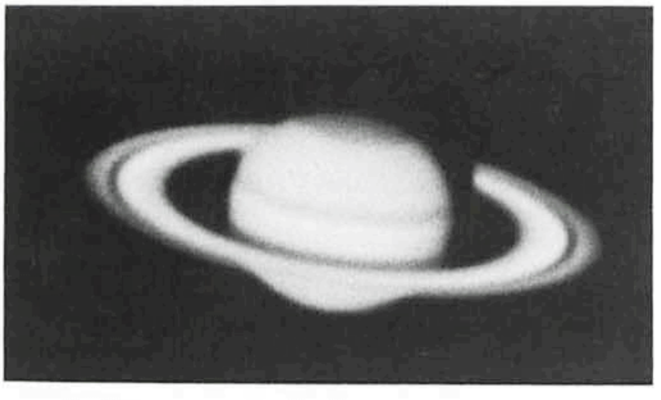
Like for the prime focus we are testing the Cassegrain photographically by a small-field camera. The first photographs were taken during the night of April 19/20 and a good number of test plates have been taken since then. We are entirely satisfied with the performance of the instrument and it seems that the optical specifications have been met with a good margin.

The first Cassegrain instrument, the photometer, will be installed in June. In the meantime we continue mainly in prime focus, which astronomically is more interesting for photographic work.

In prime focus we have by now accumulated some 700 plates of which many are under evaluation by astronomers in the ESO countries.

May 11th, 1977 *S. Laustsen*

Saturn Photographed at the Cassegrain Focus of the ESO 3.6-metre Telescope



This test photo of the giant planet Saturn was obtained by ESO astronomer Dr. S. Laustsen on April 28, 1977. It is one of the first taken in the Cassegrain focus (behind the main mirror). At the time of the exposure, Saturn was only 30° above the La Silla horizon and the seeing was medium, 2". Untreated IIIa-J + GG 385; exposure time 0.06 second.

The distance to Saturn was 9.05 A.U. (1.4 x 10^9 km) and the planet subtended an angle of 18 arcseconds. Total magnitude $+0^m.5$. Original scale 10"/mm.

STAFF MOVEMENTS

Since the last issue of the "Messenger", the following staff movements have taken place:

ARRIVALS

Munich
None

Geneva
None

Chile
Anthony C. Danks, British, astronomer (from July 1, 1977)

DEPARTURES

Munich
None

Geneva
Felix Hoffmann, German, senior technical assistant

Chile
Robert Havlen, American, astronomer
Raúl Villena, Peruvian, senior civil engineer
Manfred Windel, German, technical assistant (mechanical)

ARRIVALS AT SCIENTIFIC GROUP

Takuya Matsuda, Japanese (May 1—July 31, 1977)
Patrice Bouchet, French, "coopérant" in Chile
(from April 1, 1977)

The French H II Region Programme in the Large Magellanic Cloud

M. F. Duval

In parallel with the photometric and spectrometric observations of LMC stars undertaken at the Marseille Observatory, and for which E. Maurice recently presented a summary (*The Messenger*, No. **7**, December 1976), interferometric observations of H II regions have been made from 1969 to 1973 at La Silla.

Dr. Marie France Duval (before: Chériguène) has studied the gaseous content of the Large Magellanic Cloud in collaboration with other French astronomers, mainly from the Marseille Observatory. She summarizes the main results of the La Silla observations.

Evidence of an Extended H II Region in the Centre of the LMC

During their first mission, in 1969, Y. Georgelin and G. Monnet used a 4-inch refractor equipped with a Perot-Fabry interferometer, giving a mean dispersion of 25 Å mm^{-1}

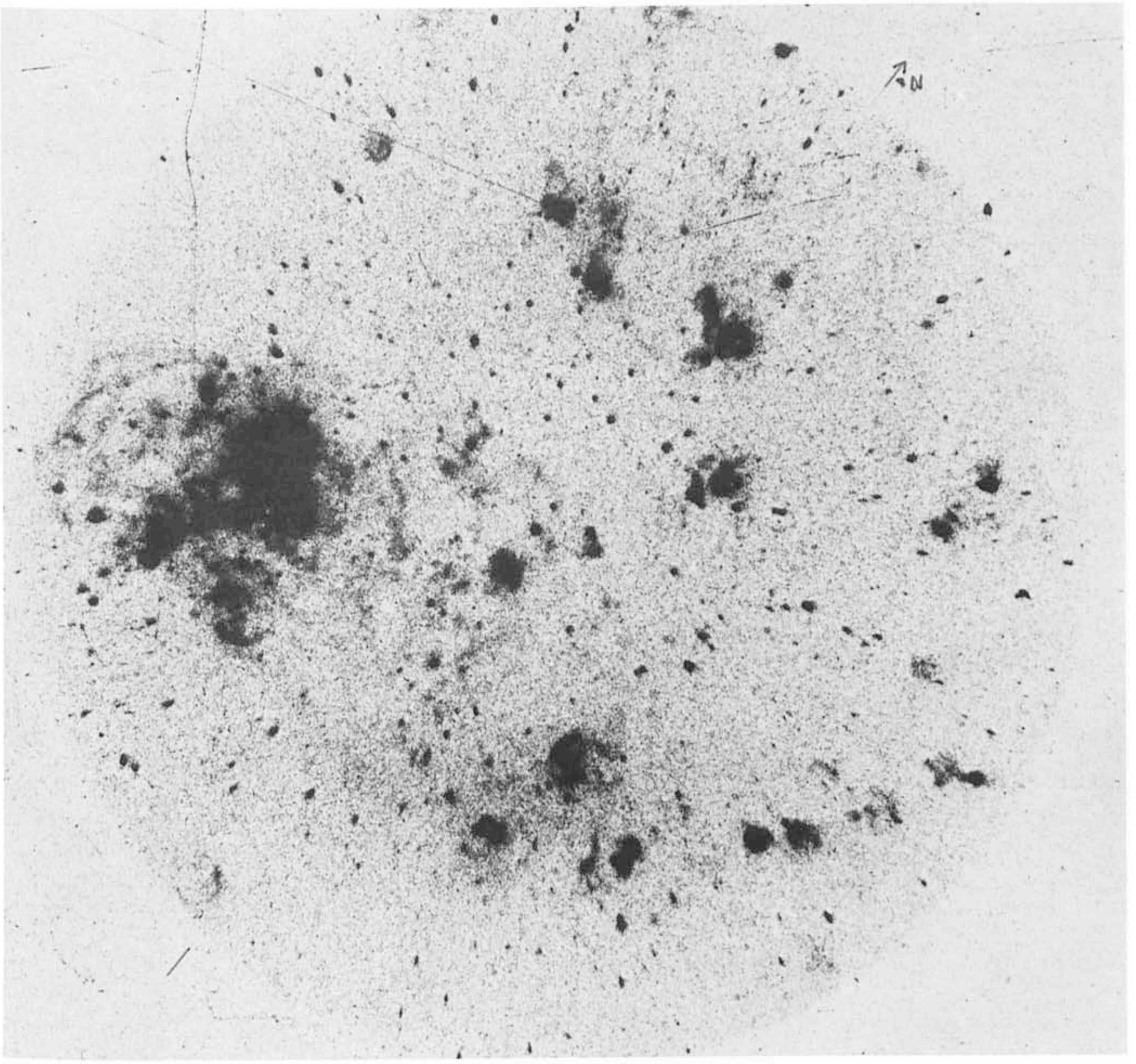


Fig. 1. — *Monochromatic photograph of the LMC in Hα (interference filter 8 Å wide). Field of view: 4°5. Note the elliptical, extended H II region of size 1° x 2°.*

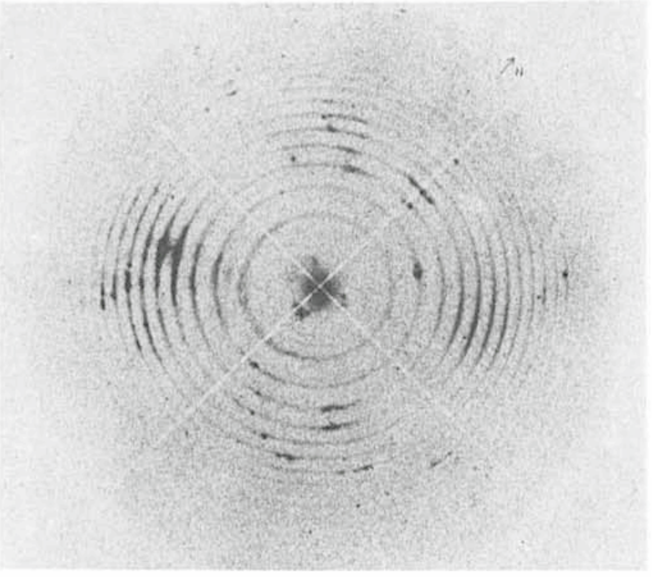


Fig. 2. — *Perot-Fabry interference rings projected on the same fields as in figure 1.*

at Hα, and obtained 11 plates covering circular fields of 4°5 in diameter.

A monochromatic photograph in Hα was also taken, which corroborates the presence of a very large ionized region of 1° x 2°, centred at 5^h30^m, –69°30′ (Fig. 1), as previously discovered from the radio continuum emission at 1410 MHz (Mathewson and Healey, 1964). The low velocity dispersion ($\simeq$ 7 km s^{-1}) and the differential rotation measured for this region lead us to suppose that the emission comes from an ionized hydrogen disk not thicker than 200 pc.

Kinematic Results

The first plates resulted in considerable progress in the radial-velocity determination of H II regions and of the ionized hydrogen disk: 250 radial velocities were published by Y. Georgelin and G. Monnet in 1970 (*Astrophys. Letters* **5,** 213). The radial-velocity programme was continued in 1970 and 1973 during two observing runs at the 150-cm telescope by M. F. Duval and G. Monnet who obtained 70 interferograms covering circular fields of 20 arc min, from which a total of not less than 1,500 points were measured; they represented 101 regions listed by Henize (1956) and 41 other regions of 12′ x 12′ (larger than Henize's size limit). The results were published in 1972 and 1974 (*Astron. & Astrophys.* **16,** 28; "CNRS colloque sur la dynamique des galaxies spirales", 439).

Rotation and Mass of the LMC

The centre of the LMC bar (5^h24^m, –69°8) being the only well-defined geometrical point, we tried to specify its systemic velocity. Considering previously published results on the radial velocities of the H II regions as well as our own determinations, we adopted the following value: 34 ± 3 km s^{-1} (assuming a local galactic rotation velocity of 250 km s^{-1} and a solar motion with respect to the L.S.R. of 16 km s^{-1} in the direction of l = 53°, b = 25°). This value is slightly different from that of 44 km s^{-1} determined by means of stars at the Marseille Observatory (Prévot, 1972). The position angle of the major axis was calculated to be the same as for stars, i.e. 180°.

Assuming, as a first approximation, a circular rotation around the centre of the bar, we calculated the rotation velocity as a function of the distance from the centre. Figure 3 shows clearly the differential effect, and confirms the northward displacement of the symmetry centre of the rotation curve.

The mass estimated from this curve is 0.7×10^{10} $M_\odot$; whereas the theoretical model proposed by G. de Vaucouleurs and K. C. Freeman—which uses the distance between the centre of the bar and the centre of the disk (40′ ± 6′), the positions of the neutral points of such a system and the angular velocity of the disk (45 km s^{-1} kpc^{-1})—gives the following masses with our values:

$$M_{disk} = 1.2 \pm 0.6 \times 10^{10}\ M_\odot$$
$$M_{bar} = 1.9 \pm 1.5 \times 10^{9}\ M_\odot$$

The Large Magellanic Cloud is a very interesting system for the dynamical study of barred galaxies because of the wealth of kinematic results obtainable with H II regions (dispersion less than 10 km s^{-1}) and stars. This work integrates very well into a more general study of barred galaxies of types SBb to IBm that the author is now carrying out in the northern hemisphere.

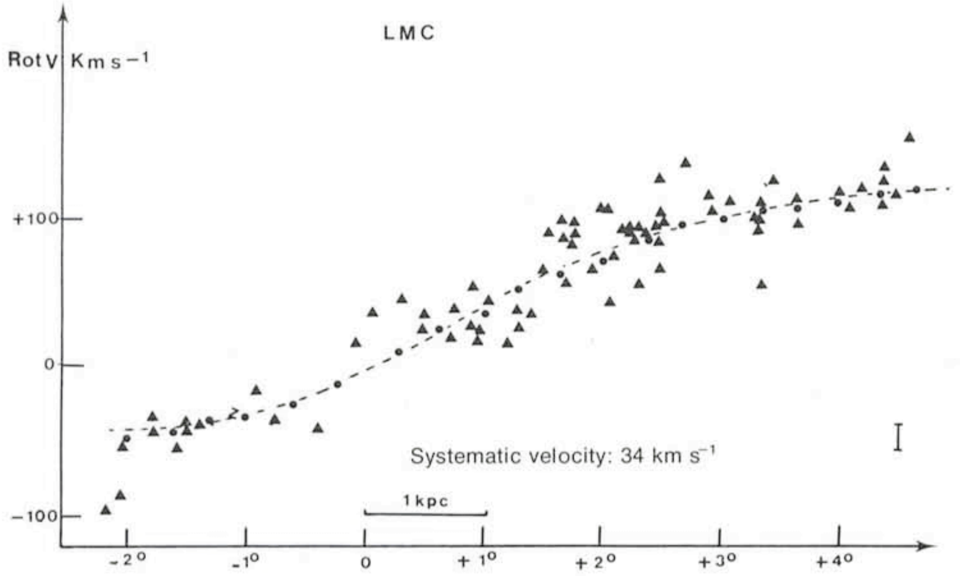


Fig. 3. — *Rotational curve of the LMC (the tilt angle i = 63°, the major axis' position: 180°).*

New Observations of Close Binary Systems

K. Walter

Surely, Algol systems and W UMa stars are evenly distributed over the whole sky, and close binaries with circumstellar matter in their surroundings can therefore be observed from the northern as well as from the southern hemisphere. But the number of really *outstanding* eclipsing variables of this kind—like U Cep with its strange light-curve outside the eclipses, which has been known since the days of Dugan, and with its spectral peculiarities—is not large, and it may therefore be considered very worthwhile to test southern eclipsing binaries in the hope of discovering new, particularly interesting systems. Let us first consider the systems of Algol type, i. e. systems in which the light minima are well defined and the light-curve outside the minima is reasonably flat; the prototype is β Persei, also called Algol.

Professor Kurt Walter from the Astronomical Institute of the Tübingen University is a frequent visitor on La Silla. Together with another German astronomer, Dr. H. Duerbeck, he has collected a large and very accurate observational material from which it appears that much more information is present in the light-curves of close binary stars than earlier generations of astronomers would ever have dreamt of. Various estimates show that a large part, possibly about 50 per cent, of all stars are double and it is therefore of obvious importance to gain insight into the mass-transfer processes that are at work in close systems and which apparently play a large role in their evolution.

Though spectroscopists began already in the forties to study gas streams and rings which they found in these binaries, photometric observers only much later succeeded in giving valuable contributions to the problems of circumstellar matter in close binaries. However, they could then not only confirm the results of the spectroscopists but often give important new insight into the mechanism and the position of the circumstellar matter.

Photometry of Algol-type systems

The photometric consequences of the presence of circumstellar matter in typical Algol systems have been largely underestimated for a long time. Although the gas stream which is flowing from the secondary, subgiant component to the bright and massive primary component is almost invisible in broad-band photometry, this stream becomes photometrically observable chiefly by absorbing the light of the primary at those orbital phases, where it is placed between the terrestrial observer and the primary star; variations in the gas stream in this position may also cause a variation in the measured intensities as sometimes seen by comparing observations at the same phase of the light-curve from different nights.

Another effect which may disturb the light-curve within and outside the eclipses is the light coming from "hot spots" arising on the surface of the bright primary component at regions where the particles of a gas stream strike the atmosphere of this star at large velocities. The additional light of the luminous regions is directed towards us during one-half of the orbital revolution. In order to get a reliable photometric solution of a system (i. e. to determine its geometrical and photometric properties by means of the observed light-curve), the influence of hot spots and the absorption effects must be carefully taken into account at the evaluation of the light-curve. Several typical Algol systems which have been thoroughly investigated in this way show that the primary eclipses are actually composed of *two* eclipses: that of a star with a normal luminosity distribution across the stellar disc and a second eclipse of the additional light. When the exact geometry of the system is known, the phases of disappearance and reappearance of the additional light enable us to fix the position of the luminous region(s). It is somewhat surprising that the hot spots are mainly situated near the poles of the accreting primary component.

For a thorough study of a typical Algol system that aims at a full description of the binary model including the effects of circumstellar matter, very precise measurements must be made that uniformly cover the light-curves. As an example, observations from more than fifty nights are needed for systems with periods of a few days. Of course the continuous observation of an Algol star outside eclipse (nearly constant light) over a long part of a night would be a waste of time. Therefore during the night the observer frequently changes from one system to another in order to get the maximum of valuable information about them for a minimum amount of observing time and an optimal distribution of the observed phases. Thus the observation is often not a simple task, it is dependent on observing and weather conditions, and it also requires day-time work to keep at least a rough check on the actual state of the coverage of the light-curves by the observations. Sometimes the difficulties caused by missing phases are overcome by exchange of observing time with colleagues.

Observations on La Silla

The 50-cm ESO photometric telescope on La Silla has been found to be a very useful instrument for observations of this kind. Four Algol systems have now been observed by us on La Silla, and for each of them clear indications of interstellar matter were found. For three of them—RW Ara, XZ Sgr, X Gru, systems with periods between 4.4 and 2.1 days and very deep total primary eclipses—the model expected for typical Algol systems (Walter, *Astrophys. Space Sc.* **21**, 289 (1973)) could be confirmed. The intensity of the observed hot spots near the visible pole of the primary components were 1–2 % of the intensity of the uneclipsed system and does by far not reach the intensity of the hot spots of the U Cep system (ca. 8 %), but U Cep is also known for its exceptionally large mass flow. From these results we may state that the existence of gas streams flowing towards the polar regions of the massive component in Algol systems seems to belong to the normal picture. Moreover the paths of the transfer of matter towards polar regions hint to the presence of magnetic fields.

There are open questions about the models of close binaries with orbital periods of about two days and shorter. Observations obtained on La Silla during several years have shown that X Gru (P = $2^{\mathrm{d}}.1$) and V 505 Sgr ($1^{\mathrm{d}}.2$) have slightly variable light-curves outside the eclipses. Apparently some other phenomenon is here added to the characteristics of the Algol systems as described above. As matters now stand, the origin of this variability may be surmised on the basis of results from recent investigations of two systems with similar periods, U Cep ($2^{\mathrm{d}}.5$) and TV Cas ($1^{\mathrm{d}}.8$). It appears that the long-period variations of the light-curves are controlled by the precessional periods of the rotational axes of the primary components. This as yet unknown and quite unexpected property of close binaries which is closely connected with the gas streams flowing towards the primary components may be realized by accurate photometric observations of the shape of the total eclipse, as it was shown for U Cep (Walter, *Astron. & Astrophys.*, **42**, 135 (1975)) or by observations of the light-curves outside primary eclipses like for TV Cas, where periodical fluctuations could be found and explained in this way from the reduction of observations obtained over six years (in preparation for publication). Recalling earlier experiences of observers with W UMa variables the question arose, whether it would not be worthwhile to test some southern W UMa variables by means of a good instrument under the clear Chilean skies.

W UMa Variables

In 1975, Dr. H. Duerbeck and I began to observe some W UMa stars on La Silla. We decided to observe them with an unusual method. Because of the suspected transient characteristics of the light-curves of very close binaries, we decided not to observe our three programme stars, ST Ind, RV Gru and AE Phe, in the usual way, where each star is continuously observed for as long a time as possible to get a complete light-curve within a few nights. We went the opposite way and tried to distribute the observations of all programme stars as uniformly as possible over the whole allotted observing period of about two months, with the aim of obtaining in this way true *mean* light-curves and also accurate *deviations* of the individual observations from these curves. Indeed all three observed variables showed systematic, time-dependent deviations. They were present in the case of RV Gru and AE Phe in a very clear manner and indicated a periodic behaviour. Thus the results of 1975 strengthened our suspicions about the transient characteristics of W UMa light-curves.

In the astronomical literature some large variations of W UMa light-curves have been reported, among them the very interesting case of AH Vir (Binnendijk, *Astr. Journ.* **60,** 372 (1965)). This variable was found in 1957 to exhibit a light-curve for which three-quarters of the phases were several hundredths of a magnitude lower than that in 1955; and one-quarter, a descending branch, did not change. Almost exactly the same was observed in 1976 with AE Phe, as compared to 1975. Additionally, during the 1976 observations the gradual return to a light-curve very similar to that of 1975 could be followed. It is difficult to believe that the repetition of such a peculiar variation of the light-curve, as observed first in AH Vir and now in AE Phe, should not be caused by a typical property of the close binary model. But to answer the question what really happens within these systems, many more observations, photometric as well as spectrographic, are needed.

What Does the Helium Abundance in Young Stars Tell Us About the Universe?

Dr. Poul Erik Nissen from the Astronomical Institute of the Århus University in Denmark has recently used the ESO 1-metre telescope to investigate the very early moments of the Universe just after the "Big Bang"! Many people may wonder how a comparatively small telescope can penetrate into the area of astronomy that is normally reserved for the largest telescopes. The surprising answer is given by Dr. Nissen in the following introduction to the theoretical and practical aspects of his programme:

According to current cosmological theories the Universe has expanded from a hot dense state—the so-called "Big Bang Primeval Fireball". The isotropic microwave background radiation can be explained as emitted from this Fireball and cooled down to a temperature of 3 degrees Kelvin due to the expansion of the Universe. Furthermore the model of the Fireball predicts that the ratio between the number of helium and hydrogen atoms in the Universe should be in the range from 0.07 to 0.10, which agrees well with the ratio of 0.10 observed for interstellar gas and young stars. However, most of the accurate helium abundance determinations refer to gas and stars that are rather close to the Sun. It is therefore of great interest to extend helium abundance determinations to more distant objects in order to see whether a helium-to-hydrogen ratio of 0.10 is really universal.

The Echelle Spectrophotometer

The helium abundance of O and B stars can be determined from equivalent widths of helium absorption lines. Normally equivalent widths are measured on photographic spectrograms of stars, but this method is cumbersome and limited to the brightest stars. In order to observe the strength of helium lines for rather faint stars I have therefore developed a photoelectric method that is based on the use of the echelle spectrophotometer shown on Fig. 1. In this instrument a spectrum is formed by an echelle grating on a rotatable wheel with different exit slots. The light passing one of the slots is imaged on a photocathode and the intensity measured by pulse-counting techniques. Thus the intensity ratio of nearby spectral bands can be observed just by turning the wheel forth and back. Quite narrow

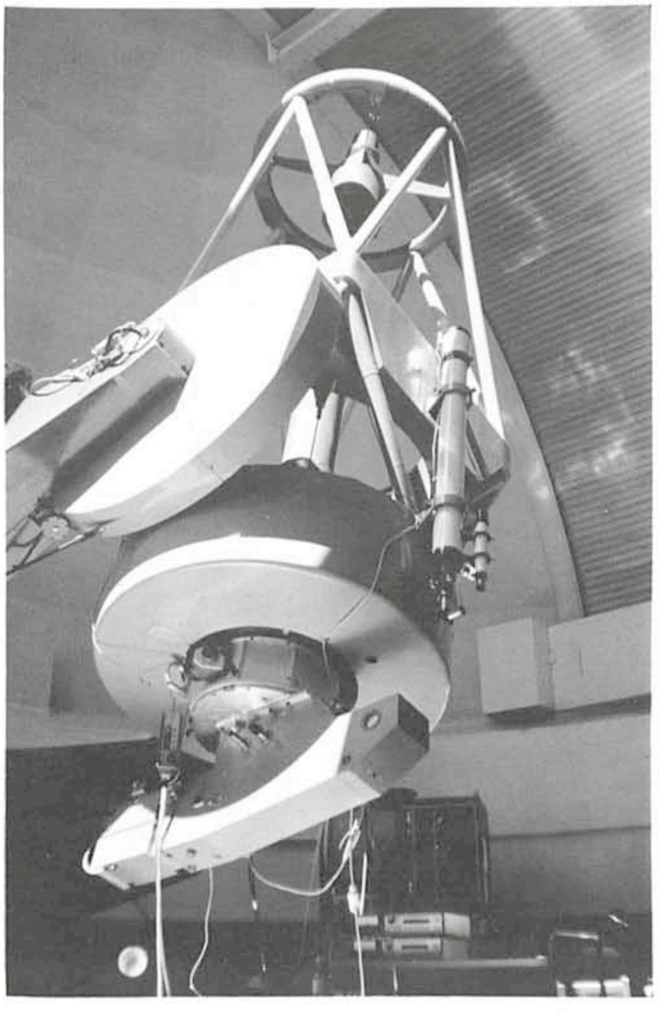


Fig. 1. — *The echelle spectrophotometer attached to the ESO 100-cm telescope on La Silla.*

spectral bands can be accurately defined, because of the high linear dispersion of the instrument (2 Å/mm). In the case of the helium abundance observations, the stellar flux in a 14 Å wide band centred on the strong helium absorption line at 4026 Å is first measured. Then the combined flux of two 6 Å wide continuum bands on each side of the helium line is measured. The ratio of the two measurements expressed in magnitudes, i.e. I(4026) = 2.5 log (flux ratio), is then an index of the equivalent width of the helium line, because the flux in the line band decreases with increasing strength of the absorption line. Normally 10^5 photons are counted in the two spectral regions, which takes half an hour of integration time for a 10th magnitude star observed with the 100-cm telescope on La Silla. The corresponding accuracy of I(4026) is 0.005 magnitude.

Models

In order to derive the helium-to-hydrogen ratio of a star, I(4026) is compared with the β index, that is a measure of the strength of the H_β hydrogen absorption line. From models of stellar atmospheres with different values of the effective temperature, the surface acceleration and the helium-to-hydrogen ratio, one can compute relations between I(4026) and β. Fig. 2 shows such relations for 3 different values of the helium-to-hydrogen ratio. From left to right along a given curve the effective temperature decreases from 30,000°K to 20,000°K, which corresponds to the spectral range B0–B3. The curves of constant helium-to-hydrogen ratio are not affected very much by a change in the surface acceleration, and furthermore the diagram is used only for young stars that lie on the main-sequence, i.e. with nearly the same value of the surface acceleration.

Observations

The observations of I(4026) have been obtained with the 193-cm telescope at Observatoire de Haute-Provence, France, and the ESO 100-cm telescope on La Silla. They include several hundred northern and southern B stars, most of them members of clusters or associations. As an example the observations of I(4026) and β for stars in the h + χ Persei cluster and in the Scorpio-Centaurus association are shown in Fig. 2. It is seen that the mean helium-to-hydrogen ratio of stars in Sco-Cen is close to 0.10, whereas the mean value for stars in h + χ Persei is found to be 0.06 ± 0.005.

The other results from the observations may be summarized as follows. Stars in our local region of the Galaxy, i.e. field stars that lie within 500 pc from the Sun, and the Sco-Cen, Orion, and Lacerta associations, have a helium-to-hydrogen ratio of 0.10 ± 0.01. The NGC 6231 cluster, that lies in the Sagittarius spiral arm, 2,000 pc away from the Sun, is also found to have a helium abundance of about 10 %. On the other hand the Cepheus III association and the h + χ Persei cluster, both situated in the outer regions of our galaxy, 1,000 and 2,000 pc away respectively, have a helium-to-hydrogen ratio of 0.06 only. Thus the main conclusion from the work is that a helium-to-hydrogen ratio of 0.10 is *not* universal. Significantly lower values are found in our galaxy.

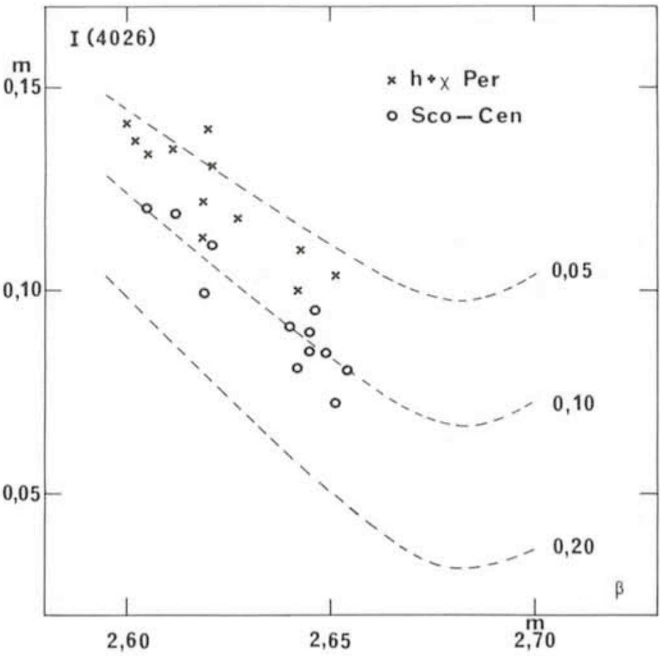


Fig. 2. — *The β-I(4026) diagram for stars in the h + χ Persei cluster and the Scorpio-Centaurus association. The curves give the relation between β and I(4026) as computed for model atmospheres of main-sequence B0–B3 stars with three different values of the helium-to-hydrogen ratio: 0.05, 0.10 and 0.20.*

"Big Bang"

As mentioned in the beginning, the model of the Big Bang Primeval Fireball predicts values of the helium-to-hydrogen ratio from 0.07 to 0.10. The value found in h + χ Persei and the Cepheus III association is slightly out of this range. No mechanisms are known that can deplete the interstellar gas of helium, but in view of the uncertainty of the absolute values of the helium-to-hydrogen ratio, the discrepancy is not serious. The difference in helium abundance that is found between stars in the outer regions of the Galaxy and stars in the local and inner regions is more interesting, because it means that a considerable amount of helium has been formed since the Big Bang Primeval Fireball. Possible sites for this helium production are massive stars or the so-called "little Big Bangs" in the centre of our galaxy.

HD 80383: The Faintest Known β Cep Variable

Until recently no β Cephei stars fainter than 7^m were known, but now observations on La Silla by Dr. Ulrich Haug of the Hamburg Observatory seem to have pushed this limit to 9^m. He found light variations in HD 80383, a faint B star in the southern constellation Vela, which are typical of the β Cep class of hot, pulsating stars. Dr. Haug reports about his interesting discovery:

The high number of β Cephei (or β Canis Maioris) variables among the bright stars allows us to predict β Cephei characteristics for about 5 per cent of all stars of spectral types B0 to B3. Nevertheless there are no confirmed variables of this type among the stars fainter than 7th magnitude.

During my last observing run on La Silla in January 1977 I found that the photometric data for HD 80383 leave almost no doubt that this is a new β Cephei star of about 9th magnitude. HD 80383, which was on my observing list for "interstellar absorption in Vela", was discovered to be variable in 1976. When a period of only 4.45 hours became evident already at the beginning of my observations in 1977, many measurements were made during each available night. Very quickly the amplitudes of the light variations turned out to be variable. This excludes the possibility of an eclipsing or aspect variable double star. But both the period and the beat period (about 10 days) make the classification as a β Cephei star highly probable.

This is also supported by a discussion of the photometric parameters given in the table for the variable and another B-type star in my Vela programme which is being used as comparison, CPD −54° 2147.

M_{bol} and log T_{eff} can be calculated either from UBV and β according to relations applied to other β Cephei stars by Lesh and Aizenman (*Astron. & Astrophys.* **22,** 229 (1973)) or from uvby and β according to similar relations used by J. Scott Shaw (*Astron. & Astrophys.* **41,** 367 (1975)). The results, $M_{bol} \approx -5.4$ and log $T_{eff} \approx 4.35$, show that HD 80383 is situated well above the main-sequence in the Hertzsprung-Russell-Diagram, in a domain known as "the instability strip" of β Cephei stars.

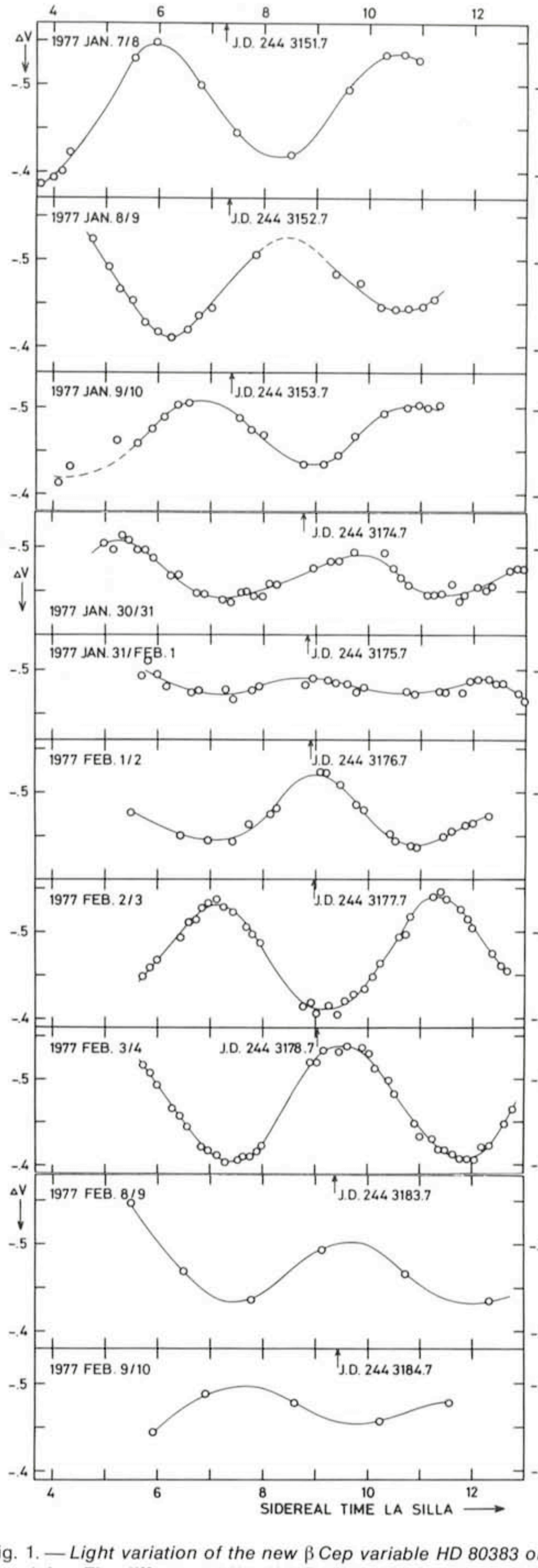


Fig. 1. — *Light variation of the new β Cep variable HD 80383 on ten nights. The difference ΔV = V (HD 80383)–V (CPD −54° 2147) is adopted from the on-line V measurements. Note how the amplitude is variable and how the beat phenomenon may be recognized, in particular on the nights of Jan. 31/Feb. 1 and Feb. 9/10.*

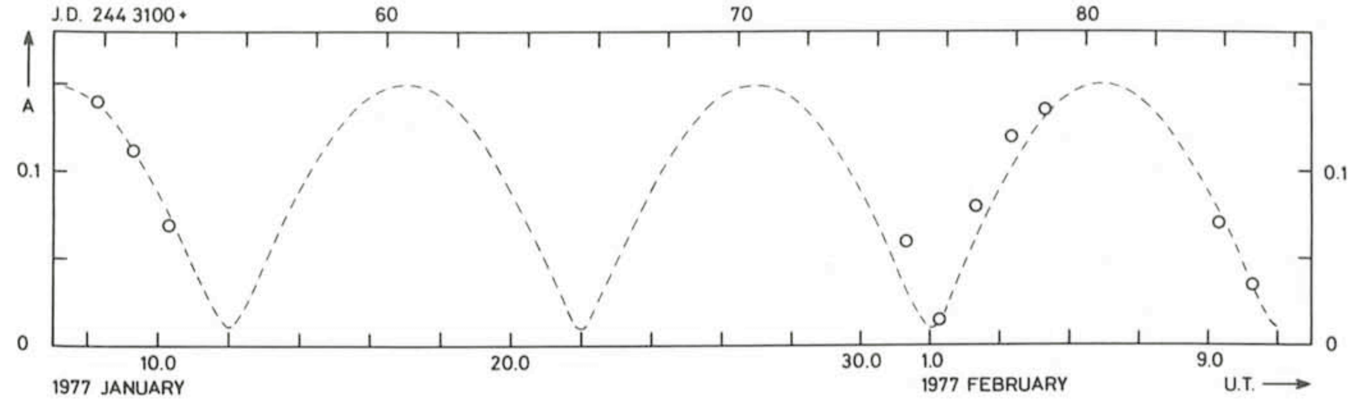


Fig. 2. — *The mean amplitudes A of the light variations for the observing nights early 1977. The beat period is around 10 days.*

The new variable looks like a quite normal member of its class. Remarkable are the maximum amplitudes (0.15 mag) of its light variations which are inferior only to those of BW Vul (0.2) and ν Eri (0.18). Large changes of radial velocity are to be expected. Their observation by means of slit spectra should be the next step in the investigation of HD 80383.

The detection and analysis of this star would have been impossible without the data-acquisition system of the ESO 50-cm photometric telescope which was used for all observations. I am obliged to the ESO staff for their help during the observations and to Dr. Kohoutek and Dr. Surdej for additional measurements on February 8 to 10, which are clearly important for the determination of the beat period.

Photometric results for the new β Cep-type star and its comparison star.

	HD 80383	CPD −54° 2147
V	(9.13)	9.603
B–V	0.041	0.095
U–B	−0.702	−0.596
y	(9.12)	9.595
b–y	0.101	0.130
m_1	0.019	0.028
c_1	0.111	0.189
β	2.626	2.650

The Recovery of Adonis

The ESO 1-metre Schmidt telescope has just played an important role in the successful recovery of a long-lost minor planet.

Forty-one years ago, Dr. E.J. Delporte of the Uccle Observatory in Belgium reported the discovery of a small planet (1936 CA) with an unusually fast motion. It was soon found that the new planet was very close to the Earth and when the preliminary orbit was computed it became apparent that it was of the Earth-crossing type, also known as "Apollos", cf. *Messenger* No. 8, p. 3. It was baptized *Adonis* and although it rapidly diminished in brightness due to increasing distance from the Earth, it was possible to follow it for two months through the world's largest telescope in 1936, the 100-inch reflector on Mount Wilson, just above Los Angeles.

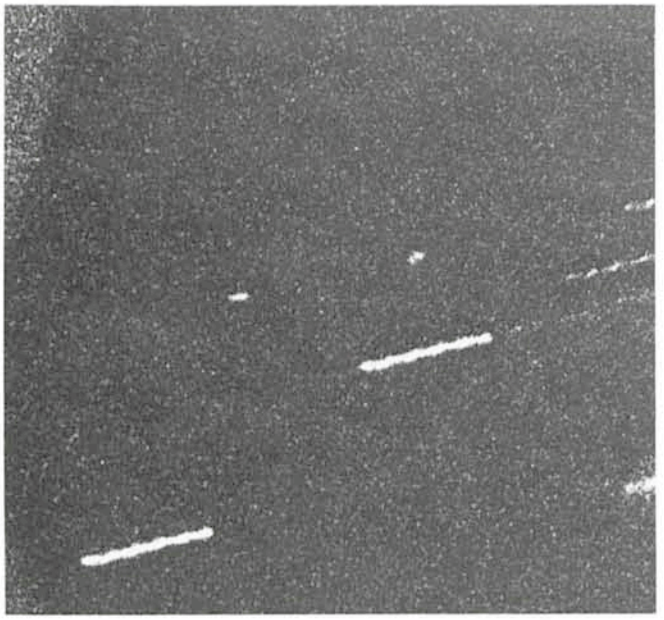
Experience shows that in order to determine orbits of minor planets with an accuracy sufficient to assure that they will never be lost again, it is normally necessary to observe them for many months during several oppositions. This was of course not possible with Adonis—its close 1936 approach to the Earth was a one-time performance—and it was soon placed on the list of "probably lost planets".

Is Adonis Retrievable?

Dr. Brian Marsden of the Smithsonian Observatory has one of the best existing computer programmes for orbit determinations and he was not so sure that Adonis was irretrievably lost. In any case, he decided to invest some effort in the problem of finding Adonis again and he therefore started a careful integration of the Adonis orbit to bring it from 1936 to 1977. Starting with the relatively few observations from early 1936, he computed the gravitational influence of all nine planets (Pluto included!) on the tiny object, day by day, and was able to determine where it would have been at any date afterwards. This process involves unavoidable errors because of the short interval of the 1936 observations and the long time interval to 1977. In general, the errors tend to increase with the time and serious troubles develop when the small planet passes close by one of the larger planets, as for instance when Adonis came within 6 million kilometres of Venus in 1964. However, the final result was that Dr. Marsden, after having followed Adonis not less than sixteen times around the Sun (Adonis' orbital period is about 2 ½ years) was able to predict that it would make another close approach to the Earth in early 1977.

A Search for Adonis

In November 1976, Dr. Marsden alerted the big Schmidt telescopes around the world and asked them to be on the lookout for Adonis in late January and early February 1977. Because of the full moon on February 4 and hoping to improve the chances of recovering Adonis, H.-E. Schuster used the ESO Schmidt telescope during two nights in January to search for Adonis, but this effort was not rewarded. When searching for minor planets for which the orbits are not accurately known (as was the case for Adonis), one normally predicts expected positions, corresponding to various values of the perihel time T, i.e. the last time the planet went through the point of the orbit closest to the Sun. The uncertainty of T was estimated to be about ± 16 days for Adonis. Dr. Schuster searched for



The confirmation of the recovery of Adonis came from this ESO Schmidt plate (No. 1996, obtained on February 24, 1977 UT). Adonis is seen as two spots in the centre. The telescope was set to follow the expected motion of Kowal's candidate (see text) during 20 minutes, by means of a command to the Schmidt telescope computer that specified the tracking in R. A. and Declination. After the first exposure the telescope was reset to the initial position and a second 20-min exposure was made. Since Adonis had moved, a second image was formed. The stars were exposed as two straight lines on top of each other. The positions of the Adonis-images allowed Dr. B. Marsden to confirm the identification with the long-lost planet and to secure its orbit.

Adonis at the positions where it would have been seen if ΔT was negative, i. e. if Adonis passed somewhat *earlier* than expected through the perihel.

A similar search was carried out by Charles Kowal at the Palomar Observatory in the middle of February. On a plate taken on February 16 he found a small planet that appeared to move in the direction that was expected for Adonis. It took some time to find this object among the myriads of stars on the plates and it was only one week later that a telegram was received on La Silla about Kowal's possible Adonis candidate. The Moon was moving near to the object, but the ESO reaction was swift. Not only was the object quickly found on an ESO Schmidt plate, but it could be photographed on *five* consecutive nights (February 24 to 28), thereby securing five vital positions and definitely proving that Adonis had finally been recovered after almost half a century!

It also became clear that Adonis went slightly *later* than expected through the perihel (in December 1976)—that was why the ESO January plates did not show it.

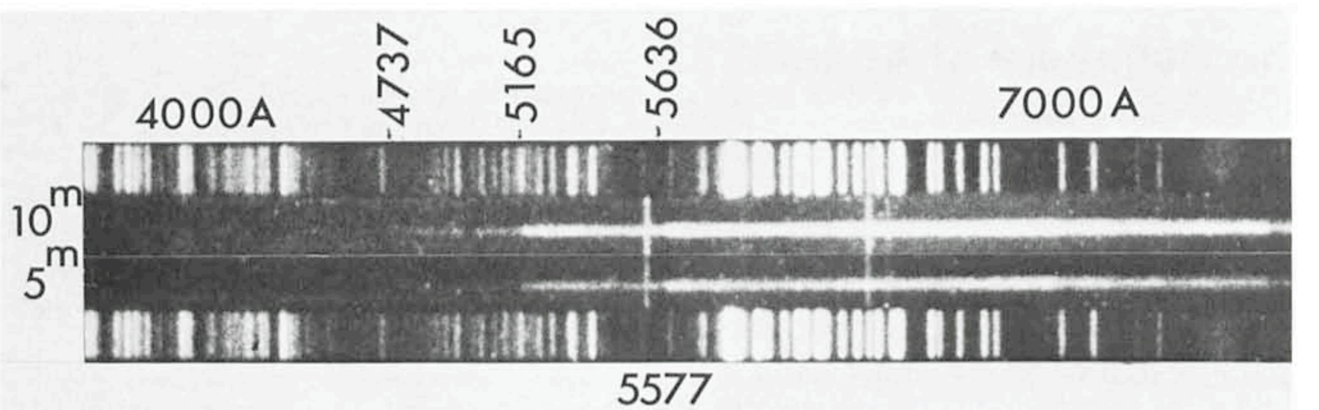
Adonis Secured

Once recovered, it was found that Adonis was somewhat fainter than expected, about 18^m. Due to an inconvenient cloud-out at Palomar in March it seemed for some time that the ESO positions would be the only ones to be secured before Adonis became too faint. However, it was detected again at the very plate limit on a March 13 ESO Schmidt plate and was later identified with great trouble on a few plates taken around March 20 with the large reflector at the Harvard Agassiz station.

Due to this commendable collaboration between the orbit computing and the observing astronomers, Adonis is now secure and will presumably never be lost again. The success is in a certain sense comparable to the discovery of Neptune in 1848 which was a similar joint effort. It is of course true that modern computers have facilitated the work involved in orbital computations, but one should not forget that a programme is never better than the theory that underlies it and the people who use it. The ESO people who participated in this recovery feel privileged to have been involved in an astronomical achievement that is bound to become a classic.

AN EXTREMELY RED STAR (Continued)

In the last issue of the *Messenger* we reported (p. 12) the presence of an extremely red star on a set of ESO Schmidt plates. It was possible to obtain two spectra of this star on the night between March 12 and 13, 1977, by means of the image-tube spectrograph attached to the 1-m telescope at the Las Campanas Observatory of the Carnegie Institution



Two spectra of the extremely red star, obtained at the Las Campanas Observatory, just north of La Silla. The original dispersion was 284 Å/mm and the exposure times were 5 and 10 minutes. Blue is to the left (4000 Å) and red is to the right (7000 Å). The three Swan bands of the C_2 molecule are indicated above. The strongest night-sky line is the green 5577 Å oxygen line. The comparison spectrum (on either side of the stellar spectrum) is from a Neon-Iron arc.

of Washington. The observation was carried out by Dr. R. M. West of ESO (editors always have to do the job!) who was taking spectra of ESO/Uppsala galaxies. The dispersion was the same as for the galaxies: 284 Å/mm from 3700 Å to 7200 Å.

The spectra are reproduced here and solve the "mystery" of the very red star: it is nothing but a "normal" *carbon star.* The typical bands of diatomic carbon (C_2) are seen at 4734 Å, 5165 Å and 5636 Å; they are known as the Swan bands. It can also be easily understood why the star appears so red: there is simply no light in the blue end of the spectrum, below 4700 Å!

Quite a number of carbon stars are known in the southern Milky Way. The most comprehensive catalogue was published in 1971 by the former ESO Director in Chile, Professor B. Westerlund, who is now at the Uppsala Observatory in Sweden. This catalogue comprises 1,124 carbon stars, but since it starts south of declination –22°, the present star is not included.

Carbon stars were recognized already in the 19th century by astronomers like Father Secchi who classified the brightest stars visually through a small spectroscope. Since then the classification of carbon stars has undergone vast improvements and it is now generally believed that they are giant stars. It is very difficult to measure the temperature of a carbon star because of the heavy molecular bands in the blue, but most have temperatures around 3,000–4,000°K. The reason for their massive carbon-overabundance is not well understood.

Note added in proof:

Dr. N. Sanduleak of the Warner and Swasey Observatory has kindly informed us that this star is no. 744 in "A General Catalogue of Cool Carbon Stars" compiled by Dr. C. B. Stephenson (1973). Unfortunately this catalogue was not available at ESO/Geneva.

Some Recent Developments in ESO

While the successful completion of the ESO 3.6-m telescope was making the headlines, some other important developments were hardly noticed.

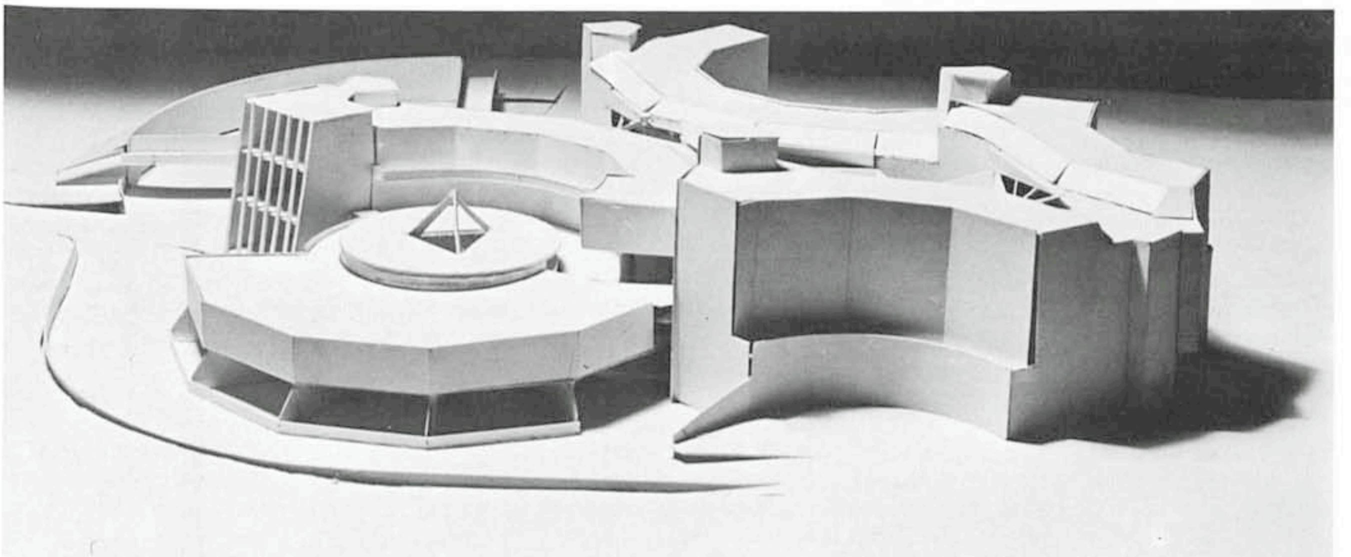
Auxiliary Construction Programme Nearing Completion

On La Silla, construction activities have been making rapid progress: the warehouse, the maintenance workshop, the four new Pelícano "dormitories" and the club house, the office and library building as well as the astro-workshop have been completed and are already in full use. The Pelícano water-treatment plant, the new heating plant and the gasoline station are finished or almost finished. Thus the Auxiliary Construction programme is now virtually completed.

Green Light for the ESO Headquarters Building

In Europe, an important step has been made towards the construction of the future ESO Headquarters in Garching. At its meeting of April 22, 1977 the Working Group created by the Council to deal with the planning of the Headquarters approved the plans submitted by Fehling and Gogel architects in Berlin. On the basis of these plans, tenders will be invited later this year, and construction activities are expected to start at the beginning of 1978. According to the time schedule, the building should be ready in the course of the second half of 1979. It will then house all ESO European activities carried out at present in Geneva and Garching.

A model of the building shown below will already give our readers an idea of the future appearance of the ESO Headquarters. The architects assure that the final product will significantly surpass this model in structural stability!



Architects cardboard model of the European Headquarters building to be constructed at Garching. The view is from the rear of the building and does not show the main entrance.

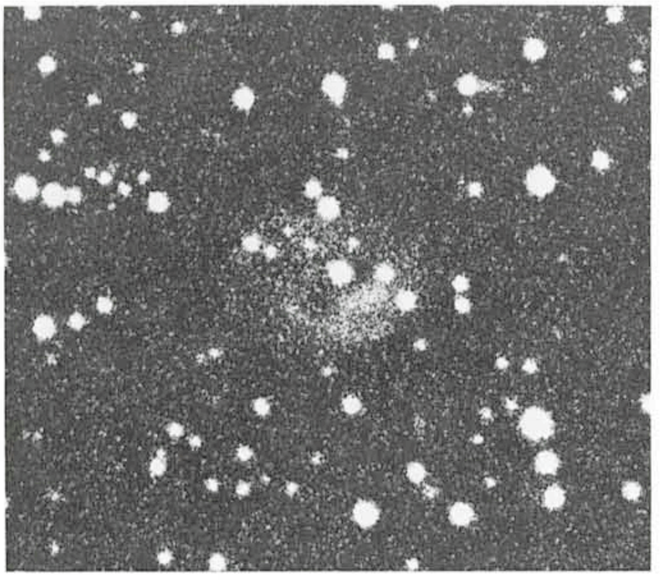
A New Planetary Nebula

On ESO Quick Blue Survey plate No. 869 (field 263), a small galaxy cluster may be seen in the NW corner. The three largest galaxies were included in ESO/Uppsala list No. IV which was published in February 1977 (Holmberg et al., *Astron.&Astrophys. Suppl. Ser.* **27,** p. 295) as ESO 263-IG01, 263-G02 and 263-IG03.

Spectroscopic observations were carried out in March of the three objects and to some surprise it was found that the second object, 263-G02 is not a galaxy but a planetary nebula in the Milky Way! The low-dispersion spectrum also showed that the central star is of spectral type O.

What is the reason for this mistake? First of all, the coincidence with the galaxy cluster, but also because the structure in the gaseous envelope of the planetary may remind us of some sort of spiral arms. The "nucleus" was described as: Bright, or star?, but many galaxies have similar intensive nuclei. Clearly one can never be quite sure of the nature of such an object before a spectrum has been obtained.

The correct name of the object is now 263-PN02.



Enlargement from the original ESO Schmidt plate of the new planetary nebula ESO 263-PN02.

The Control System of the ESO 3.6-metre Telescope

The first visiting astronomers to the 3.6-m telescope are expected to show up sometime in October 1977. Continuing the Messenger *series of descriptions of the various parts of the large telescope, Dr. Svend Lorensen from ESO/Geneva here introduces the control system for which he has written the software. Unlike most of the mechanical parts of the telescope, the control programme will interact directly with the observers and it is of great importance that it is "astronomer-friendly". Those who have used the system so far are very happy with its performance and it is good to know that further improvements can easily be inserted into the very flexible system whenever this will be required.*

The control system of the 3.6-m telescope as it will be available to the visitors later in 1977 features the possibilities already known from some of the ESO telescopes: a highly accurate programmable digital servo-system, and a good deal of other facilities aiding the observer to obtain reliable measurements. The control system—as it is designed with an integral minicomputer—is on purpose an open-ended system. The continuous development will stay compatible with the present description, and add a growing number of options—hopefully to the pleasant surprise of the future observers.

Operation Modes

The control system basically has five operation modes:

Guide: The telescope is tracking. With the handset a small correction rate can be applied. The dome follows the telescope as necessary with low speed (0.1 degree/sec).

Set: The telescope is tracking. With the handset a medium correction rate can be applied. The dome follows as necessary.

Offset: The telescope is tracking. With the handset steps can be applied. The dome follows as necessary.

Slew: The telescope does not track. With the handset the telescope can be moved with high speed (1 degree/sec). The dome does not follow the telescope.

Preset: The telescope goes with high speed to a given position. The dome goes with high speed (1.5 degree/sec) to the corresponding position.

All the tracking rates, correction rates, and offset amounts can be assigned within reasonable limits by commands at the terminal. The correction rates and offset amounts are multiplied with sec δ before they are applied in α.

Control Panel

The relevant part of the control board consists of three units. The first contains a normal CRT terminal. It is primarily used to input all commands which are not defined by push-buttons: coordinates of objects, rates of tracking, filters at the Cassegrain adaptor, etc. Furthermore a good deal of messages show up on the screen, some of interest for the observer, others more to the benefit of the maintenance team. All the transactions of this terminal are logged on a disc file for later analysis.

The next section contains a TV monitor with a selector switch. It can be connected to the cameras of the prime-focus guide probe, the Cassegrain-focus guide probe, or the Cassegrain centre field acquisition. Remote control of the high voltage of the cameras as well as of the shutters are also provided.

The third section consists of digital displays and illuminated push-buttons to command and show all basic telescope functions. This panel is logically divided into three rows. At the top row the sidereal time and the actual telescope coordinates are continuously displayed with a resolution of 0.1 second and 1 arcsecond, respectively. At the centre row a general-purpose display and eight buttons give the choice between Cassegrain focus, air-mass, zenith distance, hour angle, the coordinates of the Casse-

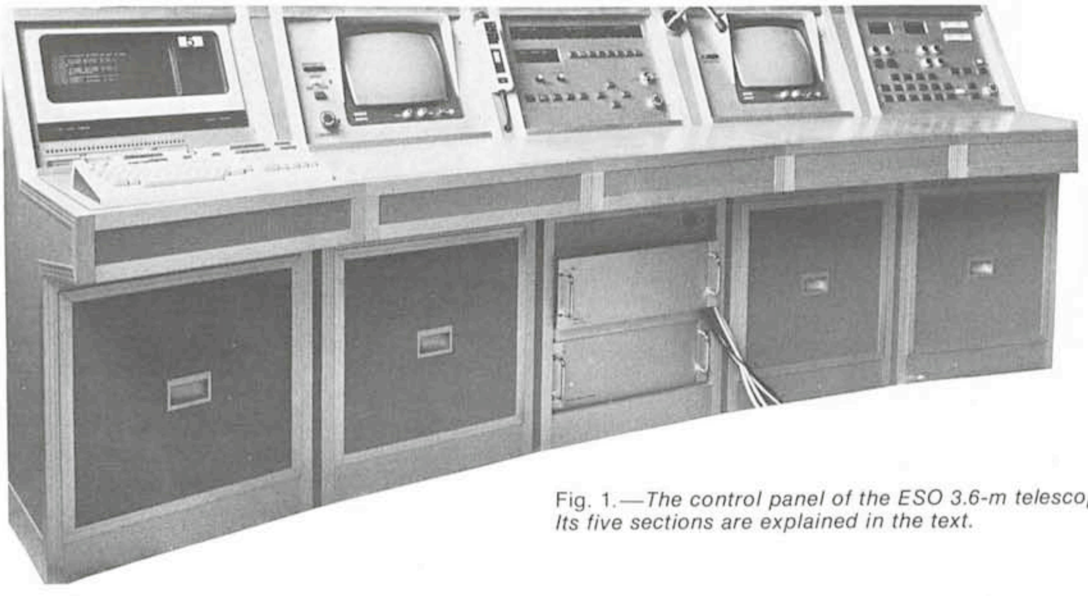


Fig. 1.—*The control panel of the ESO 3.6-m telescope. Its five sections are explained in the text.*

grain guide-probe position, and a chronometer used e.g. for exposure time.

In the lowest row five illuminated buttons display the actual operation mode and allow the choice of a new mode. Four buttons command the movement of the telescope in the positive or negative α or δ direction. The standard handsets which are located in the prime cage, the Cassegrain cage, and the control cabin contain the same functions, except the slew mode.

Encoder System

All the encoders of the telescope's axes (α, δ, coudé mirror 5, Cassegrain guide-probe stage) are incremental encoders with one zero-pulse per revolution. As the electronics are never switched off, except for maintenance, they perform effectively as absolute encoders. The encoder system uses the zero-pulses to detect and recover errors due to lost or superfluous pulses, thus maintaining long-term stability. The zero-points of any of the hereby defined coordinate systems can be adjusted by a simple command at the terminal.

The α and δ axes have each two different encoders: a medium-resolution (6 arcseconds) encoder is connected to the gear train of the drive motors. It is used to provide the basic coordinate system for displays and the preset mode. A high-resolution (0.05 arcsecond) encoder is coupled via a friction wheel directly to the big gearwheel. It maintains the digital servoloop of the drive system, which is enabled for all tracking. We have found that the stability of the latter is high enough to make 10-minute photographic exposures without any guiding corrections.

The basic reference system for positions and rates is presently the true mechanical system of the telescope. When at the beginning of 1978 the deviations between this system and an ideal telescope system are established, all positions and rates will be referred to this virtual telescope.

Dome, Hatches and Windscreen

The dome has a 6 metre wide slit, which can be closed by four independent hatches. For observation, one or more of these hatches are driven up towards or past zenith, leaving an aperture of 13 metres (37 degrees altitude). This aperture can then be further covered by a windscreen with a 6x6 metre square aperture.

The dome and the optional windscreen are moved automatically in steps, whenever necessary, to follow the celestial object. The opening of the hatches is suggested by the control system, but only executed at the observer's command.

Adaptors

The simplified prime-focus adaptor has only little remote control. It is mainly designed for local operation, where control is available for focus, guide-probe position, guide-probe field TV monitor, a standard handset to control the telescope and an intercom system.

The Cassegrain adaptor is designed for full remote control and the construction was described in the last issue of the *Messenger* (No. 8, p. 14). The available commands are the useful combinations of the many optical elements: large-field viewing, focus test, guide-probe viewing, slit viewing, move guide probe to given position, etc.... The handset of the telescope can also be assigned to the guide probe XY-stage in order to scan for a guide star and to centre it.

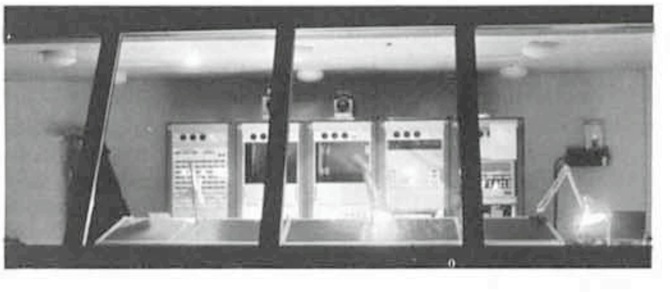


Fig. 2.—*The control room on the observing floor of the 3.6-m telescope building on La Silla. It is separated from the dome with insulating glass panels. In the front the top of the control panel (Fig. 1) and behind the electronic racks. This photo was made at night and does not show the busy night assistants in the room (exposure time 5 minutes with available light; B. Dumoulin).*

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 six countries: Belgium, Denmark, France, the Federal Republic of Germany, the Netherlands and Sweden. It now operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where nine 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 will be located in Garching, near Munich, where in 1979 all European activities will be centralized. The Office of the Director-General (mainly the ESO Administration) is already in Garching, whereas the Scientific-Technical Group is still in Geneva, at CERN (European Organization for Nuclear Research), which since 1970 has been the host Organization of ESO's 3.6-m Telescope Project Division.

ESO has about 120 international staff members in Europe and Chile and about 150 local staff members in Santiago and on La Silla. In addition, there are a number of fellows and scientific associates.

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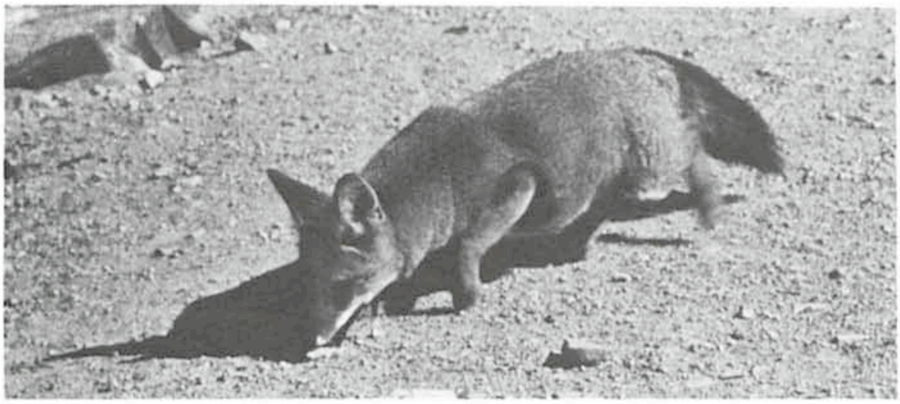

ESO photographer B. Dumoulin made this photo of one of the elusive La Silla foxes near "Casa Laustsen". Attracted by a delicious tidbit it came forward from its hide among the stones and rocks on La Silla. The suspiciously voluminous middle part of its small body seems to indicate that this particular fox has learned to supplement its meager natural food sources in the desert by other methods ...

B. Dumoulin, fotógrafo de la ESO, ha tomado esta fotografía de uno de los evasivos zorros cerca de la "Casa Laustsen". Atraído por un delicioso bocado ha salido de su guarida entre las piedras y rocas en La Silla. La sospechosa voluminosa parte media de su pequeño cuerpo parece indicar que este zorro en particular ha aprendido a suplir sus pobres fuentes naturales de alimentación en el desierto por otros métodos ...

ALGUNOS RESUMENES

Luz verde para la sede europea de ESO

Se ha dado un paso importante hacia la construcción de la sede europea de ESO en Garching. El Grupo de Trabajo creado por el Consejo para tratar con la planificación de la sede ha aprobado los planos presentados por los arquitectos, y se espera que la construcción comenzará a principios del año 1978.

El edificio, que deberá estar terminado en la segunda parte del año 1979, reunirá entonces todas las actividades europeas que actualmente se desempeñan en Ginebra y en Garching.

Un modelo del edificio, presentado en la página 17 de esta edición, dará una idea a nuestros lectores del futuro aspecto de la sede europea de ESO. La vista fue tomada de la parte posterior del edificio y no muestra la entrada principal.

El redescubrimiento de Adonis

Recientemente el telescopio Schmidt de 1 metro de ESO ha desempeñado un papel importante en el exitoso redescubrimiento de un planeta menor largamente perdido.

Hace 41 años el Dr. E. J. Delporte del Observatorio Uccle en Bélgica anunciaba el descubrimiento de un pequeño planeta (1936 CA) de movimientos rápidos poco usuales. Fue bautizado *Adonis*, y, a pesar de que su brillo disminuía rápidamente, fue posible seguirlo durante dos meses con el reflector de 100 pulgadas en el Monte Wilson, justamente encima de Los Angeles.

Como ésto normalmente no es suficiente para establecer órbitas exactas de planetas menores, muy pronto fue ubicado en la lista de "planetas probablemente perdidos".

Dr. Brian Marsden del Observatorio Smithsonian, quien posee uno de los mejores programas de computación para la determinación de órbitas, no estaba tan seguro de ésto. Basándose en las relativamente escasas observaciones computó la órbita del planeta menor—tomando en consideración la influencia de gravitación de los nueve planetas—y fue capaz de predecir que él se acercaría considerablemente a la Tierra a principios de 1977.

En noviembre de 1976, Dr. Marsden dio la alerta a los telescopios Schmidt ubicados alrededor del mundo y les pidió buscar a Adonis. No fue premiada la búsqueda del astrónomo de ESO H.-E. Schuster con el telescopio Schmidt durante dos noches en el mes de enero. Una búsqueda similar efectuada por el astrónomo Charles Kowal del Observatorio Palomar tuvo más éxito. En una placa tomada el 16 de febrero encontró un pequeño planeta que parecía moverse en la dirección esperada para Adonis. Cuando ESO fue informada del posible descubrimiento de Adonis, se tomaron placas con el telescopio Schmidt y el objeto fue rápidamente encontrado. Pudo ser fotografiado durante cinco noches consecutivas, proporcionándose cinco posiciones vitales que probaban definitivamente que Adonis había finalmente sido redescubierto.

Arriendo de las oficinas de ESO en Santiago a Naciones Unidas

Ha sido firmado un contrato de arriendo entre ESO y las Naciones Unidas para arrendar las oficinas desocupadas, el antiguo astro-taller y parte de la bodega en el edificio principal de ESO en Vitacura.

El espacio arrendado por las Naciones Unidas se ha desocupado luego que la mayoría de los servicios de ESO habían sido trasladados desde Santiago a La Silla. El traslado al lugar del observatorio forma parte de la reorganización de ESO en Chile, iniciada en el año 1975 a fin de asegurar un mejor funcionamiento del observatorio. Actualmente ESO sólo ocupa algunas oficinas y parte de la bodega en el sótano del edificio principal en Vitacura.