THE MESSENGER

EL MENSAJERO

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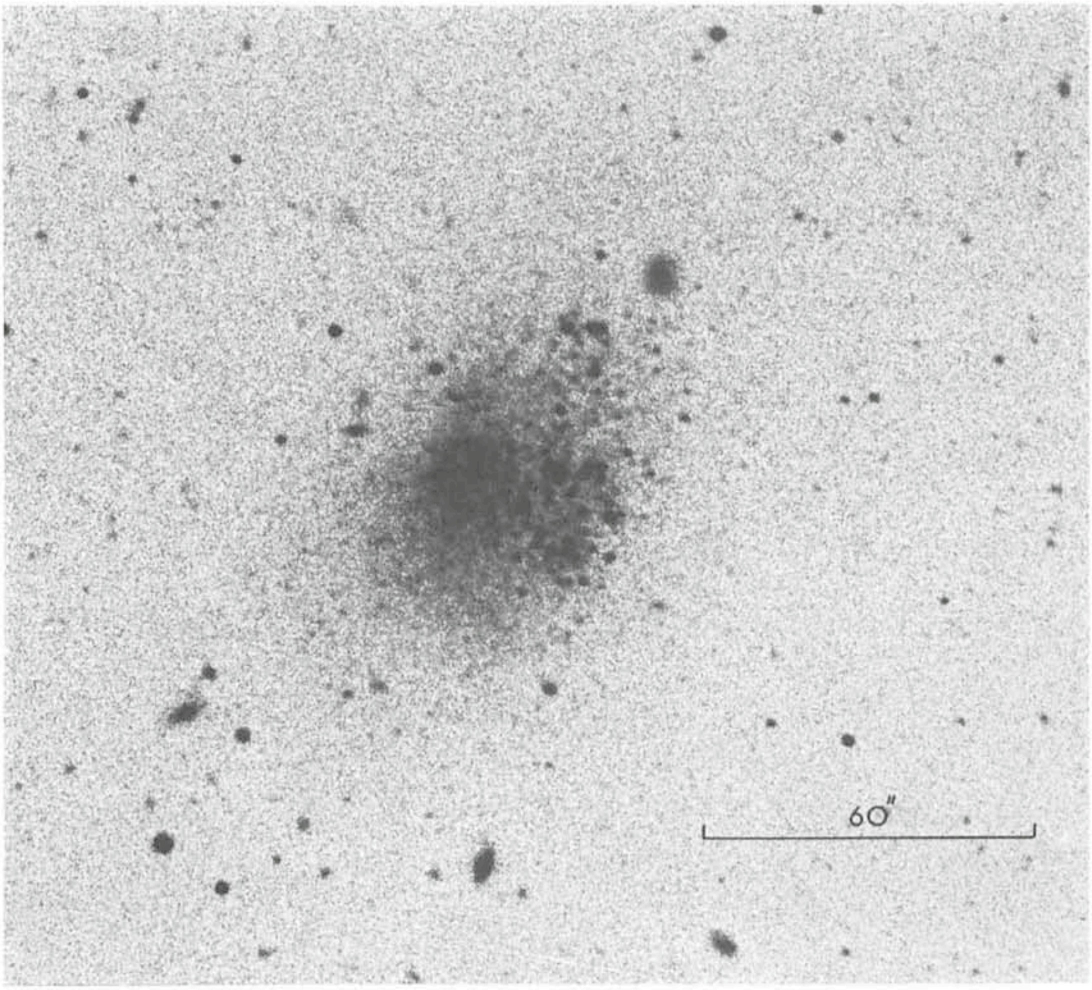
A Giant Leap for European Astronomy

FIRST PHOTOGRAPHS WITH THE ESO 3.6 METRE TELESCOPE



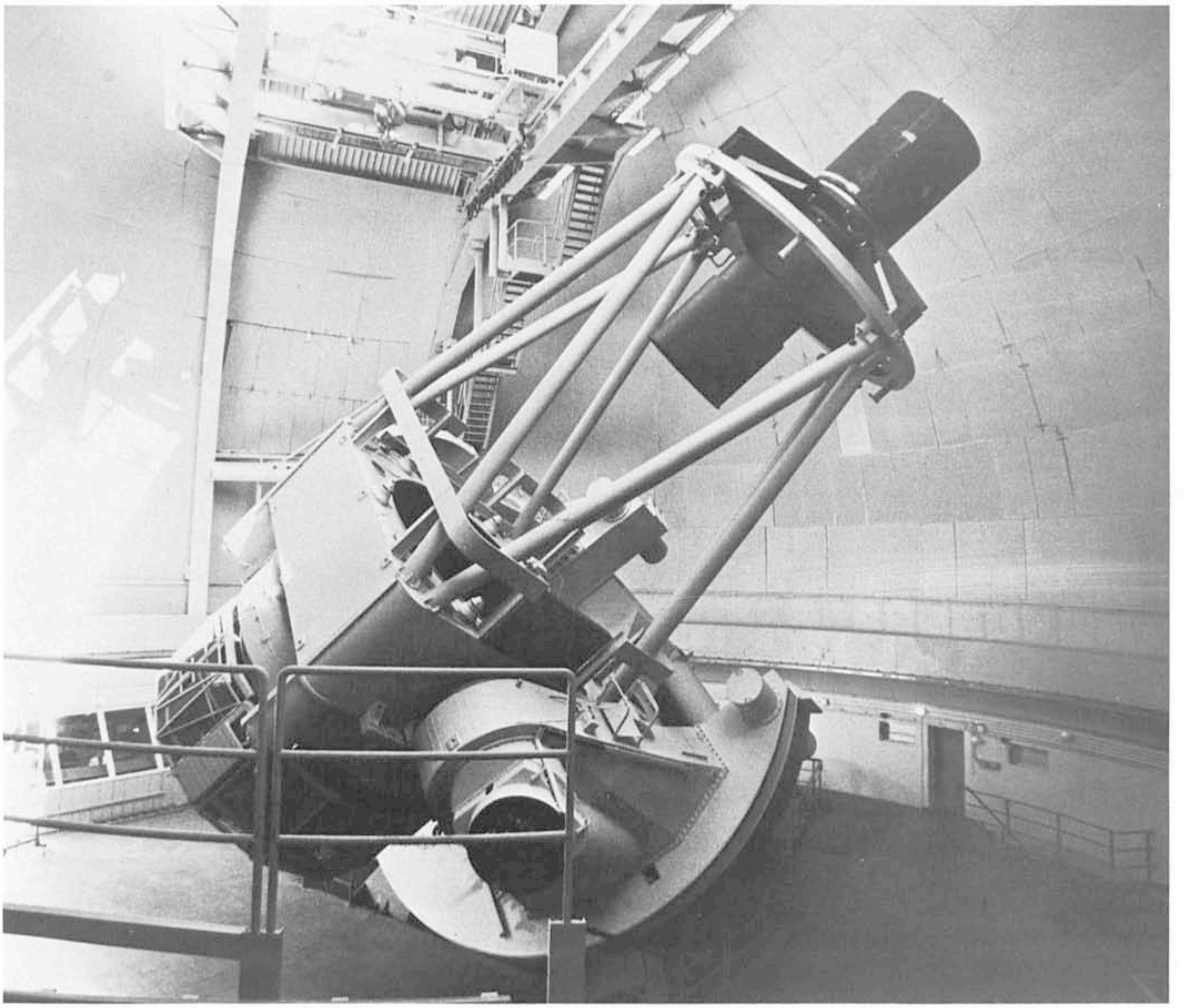
One of the first prime-focus photographic plates taken with the giant ESO telescope on La Silla shows a field with a newly discovered irregular dwarf galaxy in the southern constellation Sculptor (see page 16). Observer: Dr. S. Laustsen, ESO; exposure 120 min on November 11, 1976; emulsion IIIa–J baked in nitrogen; filter GG 385; blue corrector lens; smallest images 70 microns = 1.3 arcsecond.

"First Light" for 3.6 m Telescope

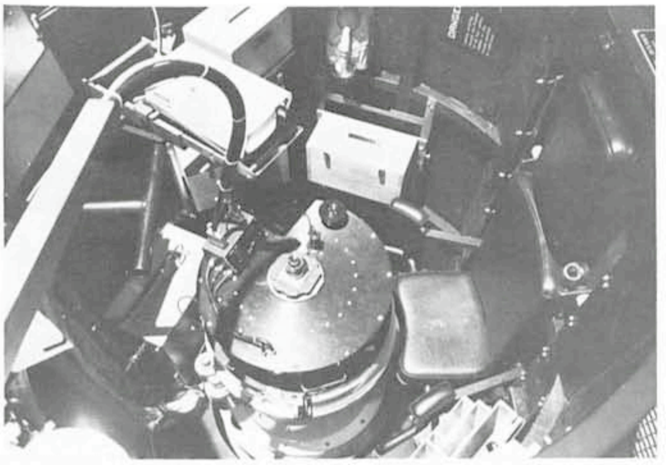
A first look at the sky through the ESO 3.6 m telescope with its mirror aluminized was taken during the night of November 7–8. The "first light" to a telescope is a unique moment, and it was celebrated with a midnight tea. But apart from that, we had many troubles that night. Obviously you cannot expect everything to work at once in an instrument as complex as the 3.6 m telescope; much time must be allowed for debugging the entire system. The people who work with it have to learn how to handle the various procedures, but after a very successful aluminization, we had nearly forgotten that something could go wrong. And so, during the night of first light, the images (what a disaster!) looked like small hearts. Very romantic, although not exactly what astronomers are looking for in the sky. It took us two days to find and cure that fault. The 11-ton main mirror had chosen to rest on two of the back supports only. From the third one it kept a respectful distance of 1 mm.

The third night (November 9–10) was much more successful. The newly-discovered dwarf galaxy in Sculptor (see page 16) was on the programme, and a one-hour exposure revealed its beauty and showed a good number of its brighter stars resolved. This first plate has been followed by others of up to two hours exposure (see the cover photo). During the first five nights we have taken about 30 plates and the image quality looks very good. We still have to determine the limiting magnitude, but it should be at least 24^m, possibly even fainter.

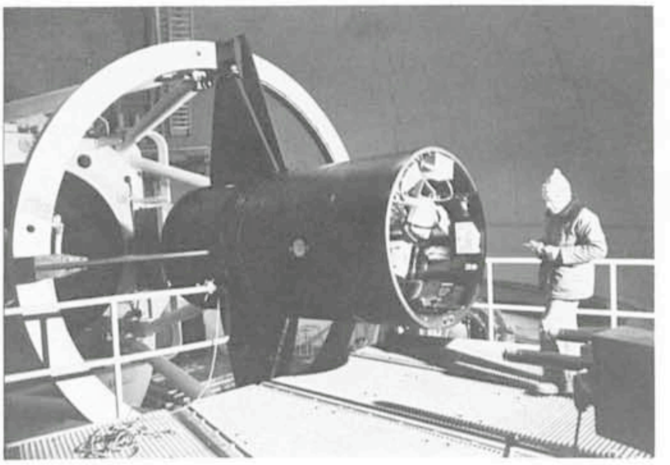
A lot of work has been done to get this far. In the last issue of the *Messenger* we reported that the mechanical assembly of the telescope was completed. Since then, the telescope controls have been put to work by a team from the Electronics Group from Geneva who spent more than a month on La Silla. The optics have been installed and a systematic alignment and test programme has been carried out by a team of three from the Optics Group in Geneva during the last two months. As mentioned above, the mirror has been aluminized. Not a small job either, but it was so well prepared that already the first aluminizing gave an excellent result. On these big jobs as well as on hundreds of smaller ones, the work has been progressing steadily, although not without minor setbacks. On August 26, a light-



The ESO 3.6 metre telescope on La Silla. In the front end the prime-focus cage.



A look down in the prime-focus cage. To the right, the astronomer's chair, from which he guides the telescope during the exposures. In the centre the adaptor with an eyepiece for direct viewing and focussing. Above this the TV-camera (see text).



Preparing observations. The astronomer is about to enter the prime-focus cage, which he rides during the exposure. To facilitate entry, the telescope is brought to horizontal position. The exchange of top-ends, which is a unique feature of the ESO telescope, is also done in this position.

ning struck the dome and caused a lot of damage to the electrical installation and the newly-installed electronics. A few weeks later a part of the building was flooded with oil, and cleaning-up took several days. Never mind, we feel that the photos of the last nights more than compensate the difficulties behind!

Now, however, we should be careful not to give the impression that our work on the telescope is finished. So far, only the prime focus is in operation. A great many improvements and minor jobs still have to be made. But in between, the observations continue. And it is our belief and hope that the percentage of time devoted to astronomy will from now on steadily increase.

S. Laustsen, November 12, 1976

Optical Alignment of 3.6 m Telescope and First Tests

The Optics Group from Geneva has been intensively occupied for the last ten weeks with the alignment and testing of the prime-focus optics for the 3.6 m telescope.

The basic alignment of the optics of the telescope perpendicular to the declination axis was completed about three weeks ago. Since that time, an intensive period of Hartmann testing has fully occupied us.

The measuring facilities at present available on La Silla are not sufficiently accurate to give a final figure for the concentration of geometrical energy in a given diameter. However, there ist clear evidence that the specification of 75 % within a diameter of 0.4 arcsecond should be fulfilled—we think probably by a clear margin. The computer analysis of the plates shows that the basic, lower-order-aberration terms are small; while the workshop tests had already established that the surfaces are very smooth. Turbulence effects in the dome and telescope seem, at present, to be the factors limiting quality and the precision of centring. However, even with the existing plate-measuring facilities, it has been possible to centre the system to within 0.2 arcsecond of tangential coma, in spite of dome turbulence and indifferent external seeing.

External seeing has been mainly poor during the whole test phase, but the first photographs with the telescope have shown very circular images of faint stars on IIIa–J plates with diameters of 1 to $1^1/_2$ arcsecond. With the actual seeing conditions prevailing, the Hartmann tests are at least an order of magnitude more precise than visual or photographic assessments.

As soon as the Hartmann plates have been measured on a more accurate measuring machine in Europe, a complete report of the test results will be published. These results will refer to the naked mirror and to the complete prime-focus system with the Gascoigne plate correctors. The triplet correctors will be available in a few months and will be the subject of a further report.

The Cassegrain-focus alignment and tests should take place about next March.

R. Wilson, October 29, 1976

The Prime-Focus Cage

The first plates have now been taken with the 3.6 m telescope. This was done in the prime-focus cage that allows the astronomer to ride in the front end of the telescope during the observations. In the following we shall explain how the cage was equipped for the first test of the telescope.

In the cage there is room for one astronomer, an adaptor and some auxiliary equipment needed by the astronomer during the observations. The adaptor may be used either as a camera or as a support for other detectors. The adaptor is placed on a pedestal protruding into the cage from the unit underneath the cage through a hole in the floor of the cage. That unit is supported by the structure of the telescope through the main spiders. The cage itself is supported by additional upper spiders. Due to this double-support structure, only a minimum of vibrations are transmitted to the adaptor from the cage motors or the astronomer.

The cage thus supports only the observing astronomer and the auxiliary equipment. The observer sits in a chair, which is adjustable in height by means of a motor-drive. Furthermore, the whole cage may be rotated in order to provide a maximum of comfort for the astronomer in all positions of the telescope. All necessary control-panels are situated on the wall of the adaptor and within the reach of the astronomer. A TV-monitor displaying a guide-probe image from the adaptor and a handset to control the telescope facilitate manual guiding from the cage. The cage is equipped with intercom, telephone, boxes for storage of plate- and filter-holders, safety belt and a rescue device (rope with friction brake) allowing the astronomer to leave the cage at any moment in case of emergency.

The pedestal supporting the adaptor comes through the floor of the cage and is fixed to the prime-focus unit underneath. The pedestal includes a high-precision motor-actuated focussing drive which may move the whole adaptor (or any other instrument) along the telescope axis. The speed is variable by means of a thyristor controller. The position of the focussing drive is measured by an encoder and is shown on a digital display on the wall of the cage.

The adaptor is seen on the photo. For direct prime-focus photography, the adaptor is mounted together with a support carrying a one-element Gascoigne corrector lens (not shown). The obtainable field is approximately 17 arcminutes when using this corrector lens.

The adaptor is equipped with 6 filter-holders and 6 plate-holders for photographic work. An eyepiece may be mounted on one of the plate-holders. The TV-guide probe has a field of 1 arcminute, which may be placed anywhere along the periphery of a circle with a diameter of 27′ and concentric with the plate field. One of four guide-probe filters may be selected. The TV-camera is equipped with an image intensifier to increase sensitivity.

The adaptor has a shutter that may be remotely controlled from the main console. Since also the TV-guide-probe image may be displayed on the console, it is possible to take exposures with the cage unmanned.

T. Andersen, November 2, 1976

Another photo from the ESO 3.6 metre telescope shows the central part of the old stellar cluster NGC 2477 in the southern constellation Puppis. Observer: Dr. S. Laustsen; exposure time 20 min; emulsion 127–04 (baked in nitrogen); filter RG 630.

A Very Near Miss: 1976 UA

Science-fiction authors use the effect ever so often, but in real life it seldom happens. We know, however, that the Earth is being struck by meteorites every day, and that statistically the number of small bodies in the solar system is more than enough for a larger-size celestial boulder—a small asteroid—to hit the Earth at regular intervals. And if it happens in the near future it could be a more or less catastrophic disaster, depending on the size of the asteroid and the location of the impact site.

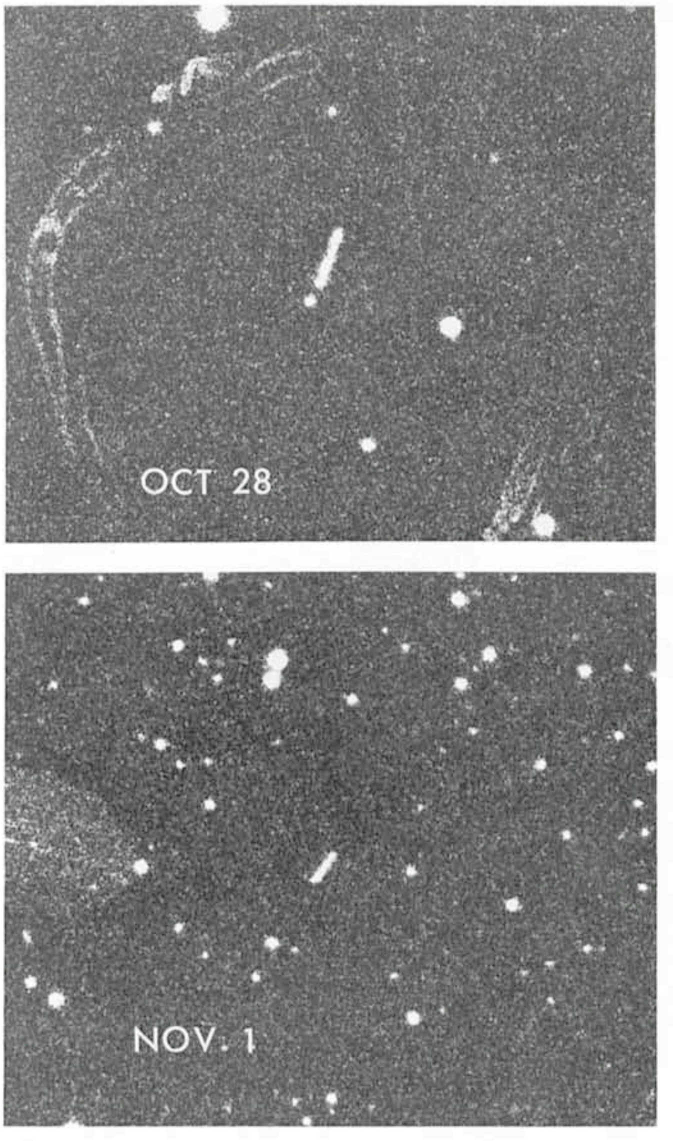
On October 20, 1976, a small asteroid passed within 1.5 million kilometres from the Earth, four times further away than the Moon. Its diameter, probably around 100 metres, would have made a very neat hole, had it actually hit the Earth's surface. Luckily, it went past and it was by pure chance that it was at all detected by astronomers.

It was first seen at the Hale Observatories' Palomar station where by extraordinary coincidence it was recorded on photographic plates taken almost simultaneously with two Schmidt telescopes. W. Sebok was working at the 48-inch Schmidt and E. Helin, T. Lauer and D. Zelinsky at the 46-cm Schmidt on the night of October 24–25, when they independently noticed a long asteroid trail on their plates (cf. *Messenger* No. 6, p. 11). It was soon realised that C. Kowal had seen the same object on an October 21–22 plate taken with the 46-cm Schmidt telescope, but not less than 17° north of the Oct. 24–25 position! That gives an impression of the speed with which it was moving. Further observations on October 26 confirmed the object. The name 1976 UA was given to the asteroid, since it was the first one discovered in the period October 16–31, 1976. (Jan. 1–15 = A, Jan. 16–31 = B, ..., Oct. 16–31 = U).

Dr. B. Marsden at the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts, was informed and on October 27 a general alert went out by telegram to all observatories with telescopes large enough to observe the asteroid, at that time of magnitude about 16 . This telegram was received on La Silla at about 18.00 local time in the evening. It included a rough ephemeris (table of expected positions) for the next-coming days. Unfortunately, the weather that evening was not very promising; there were clouds and cirrus, and the Moon was up during the beginning of the night.

It was therefore with a limited optimism that Guido Pizarro, night-assistant at the ESO Schmidt telescope, and Richard West, ESO staff astronomer (temporarily replacing Hans Schuster), went to the Schmidt dome, put a plate in the telescope and settled down to wait for a hole between the clouds. But nature was kind, and at 23.30 the shutter was opened for 10 minutes. After some anxious moments in the dark-room, followed by a careful search under a microscope, the short trail of 1976 UA was found. The magnitude of the asteroid was difficult to estimate due to the clouds, but it appeared that it was somewhat fainter than expected.

The position was measured and a telegram was sent to Dr. Marsden in the morning of the 28th. On the basis of the Palomar positions and the ESO position, Dr. Marsden computed the orbit. It showed first of all that a very close encounter took place on October 20, but also that 1976 UA is the asteroid with the shortest period known, only 283 days! In its rather elliptic orbit, it comes as close as 70 million kilometres from the Sun and as far as 183 million kilometres. It was during its outward passage across the Earth's orbit that it came so close this time.



The motion of 1976 UA, just after the close encounter with the Earth, is well illustrated by these two photos, obtained with the ESO Schmidt telescope on October 28 and November 1, 1976. Both exposures were 10 minutes on blue-sensitive IIa-O emulsion. The image (trail) of 1976 UA is clearly longer and stronger on the October 28 plate than on the November 1, showing how the small planet quickly recedes from the Earth and becomes fainter with increased distance.

The observations were continued at ESO every night until November 1, when the Moon moved too near to the position of 1976 UA. It appears that these observations will be very important for the computation of the definitive orbit. Since 1976 UA moves so fast, relative to the Earth, its magnitude will rapidly diminish through November and it will be an unobservable object of magnitude 21 in the beginning of December 1976. Therefore, if we shall have any hopes of ever finding 1976 UA again, we must try to get as many and as accurate positions as possible during this short time interval. Presently (November 11), the ESO Schmidt telescope is about to start a new series of observations after the passage of the Moon. From Dr. Marsden's first orbit, it appears that we may see 1976 UA in October 1983 as a faint object of magnitude 18 when it passes within 15 million kilometres from Earth. There is no doubt, however, that the small planet leads a dangerous life in the space between the inner planets, and its orbit is frequently modified when it passes relatively close to the Earth, as it certainly did this time.

This experience is most interesting because it demonstrates that there are many planets yet to be discovered in the inner part of the solar system. Doing some simple statistics about the chance of discovery of a minor planet like 1976 UA, one may well wonder how many have passed unnoticed through the Earth's neighbourhood in recent years? Or what about those that are now on their way?

Some French Stellar Programmes in the Magellanic Clouds

Eric Maurice

Since the very early years of the existence of ESO, French astronomers and technicians have been closely involved in its activity. It is not possible, here, to mention all those who, starting in 1961—and even before for site-testing—have spent a period of their lives in South Africa or in Chile to install and test the instruments and then to observe. Nearly all French observatories are or were involved in these activities but it is appropriate to mention especially the Haute-Provence and Marseille observatories, and the prominent influence of Ch. Fehrenbach.

Eric Maurice, *now at the Marseille Observatory, was ESO staff astronomer in Chile from 1968 to 1973. His review is based on information from many French astronomers and gives a comprehensive, up-to-date summary of observations and results obtained with the ESO telescopes during recent years.*

Fifteen years have passed since the first plates were taken with the objective prism-astrograph (the GPO) at Zeekoegat in South Africa; now applications for observing time regularly exceed the possibilities by a factor of three to one for the 1.5 m and the 1 m telescopes at La Silla. Many French astronomers are regularly travelling to observe in Chile. My present purpose is to present a survey of French stellar programmes in the Magellanic Clouds.

The Large Magellanic Cloud

A large number of objective-prism plates have been taken in this direction; the Fehrenbach "prisme-objectif à champ normal" is essentially devoted to radial-velocity determination. Its diameter is 40 cm, the photographic limiting magnitude is $12^{m}.5$ over a square field of $2° \times 2°$. The plates are measured at the Marseille Observatory under the supervision of Ch. Fehrenbach and Marcelle Duflot.

On each plate, generally more than 500 measurable spectra are present. The radial velocity (approximately 250 km s^{-1} for the LMC, and 0 km s^{-1} for the galactic stars) is used as membership criterion. The plates now cover nearly the whole LMC. In Fig. 1, the area delimited by thick lines corresponds to the radial-velocity results already published (398 LMC supergiants and 1434 galactic stars). The area delimited by thin lines corresponds to the results to be published soon.

Among the high radial-velocity stars found in the direction of the LMC, two groups must be mentioned.

In the first group (approximately 30 stars of spectral types ranging from A0 to F0), the spectra present very strong hydrogen lines and a large Balmer discontinuity. These stars have been thoroughly studied and their membership in the LMC now seems certain. No equivalent class of stars is, at present, known in our Galaxy. The second group contains at present 34 high-velocity galactic stars; their radial velocity is larger than 100 km s^{-1}. The study of these stars is in progress.

Ch. Fehrenbach and M. Duflot are also listing the objects presenting emission spectra observed from objective-prism plates. They have recently published a list of 80 Wolf-Rayet stars for which they give precise classifications. For 30 of them, the C or N character was not previously known. They are now preparing a list of planetary nebulae, emission-line stars (H, Fe II, forbidden [Fe II], etc.). Most of these objects have already been mentioned but a more accurate description of their spectra will be given.

Among the stars selected by the Fehrenbach-Duflot group are some that were studied at 74 Å mm^{-1} with the Marseille Cassegrain spectrograph (RV Cass) and photometrically by A. Ardeberg (Lund Observatory), J.P. Brunet, E. Maurice, G. Muratorio and L. Prévot. The method of selection of these LMC stars did not permit obtaining a complete list of O-type stars: their spectra do not present a sufficient number (if any) of absorption lines to permit radial-velocity determination. A systematic search of the O-type stars has consequently been undertaken by the "PLM group"; (L. Divan and M.L. Burnichon-Prévot from Paris; J. Rousseau and A. Mianes from Lyon; N. Martin, L. Prévot and E. Rebeirot from Marseille) for two reasons; firstly, to make possible a statistical study of this type of star; and secondly, because of the intrinsic interest of these very young stars which are still very near their place of formation.

For this purpose the objective-prism astrograph has been equipped with an interference filter; consequently the exposure time may be considerably longer (fainter objects are reached) and spectral overlapping on objective-prism plates are not so frequent. A list of 272 new OB2 stars, detected by this method, has been published.

Using all the known members of the LMC, the same group undertook a study of the structure of the Large Cloud, particularly to compare the spatial distribution of supergiants and of ionized and neutral gas.

Three-colour (blue, visible and red) photographic photometry has also been undertaken; for this the prism was removed from the astrograph. From these observations, colour indices will be determined and colour-colour diagrams (U-B/B-V) will be drawn.

BCD (Barbier, Chalonge, Divan) spectral classification is done at the IAP (Institut d'Astrophysique de Paris) by Lucienne Divan. An advantage of this method is that it permits the determination of the distance of the Large Magellanic Cloud independently of previous determinations (from RR Lyrae variable stars, cepheids, etc.).

In this method the parameters λ_1, D (characteristic of the Balmer discontinuity) and the blue gradient of the continuum Φ_b, are determined for the LMC supergiant stars and compared to the corresponding values of galactic stars. Each star is represented by a point in the (λ_1; D) diagram; this diagram is calibrated in absolute magnitude and in intrinsic colour. From the position of the point in this diagram the absolute magnitude M_V and the interstellar absorption correction A_V are determined, and the distance

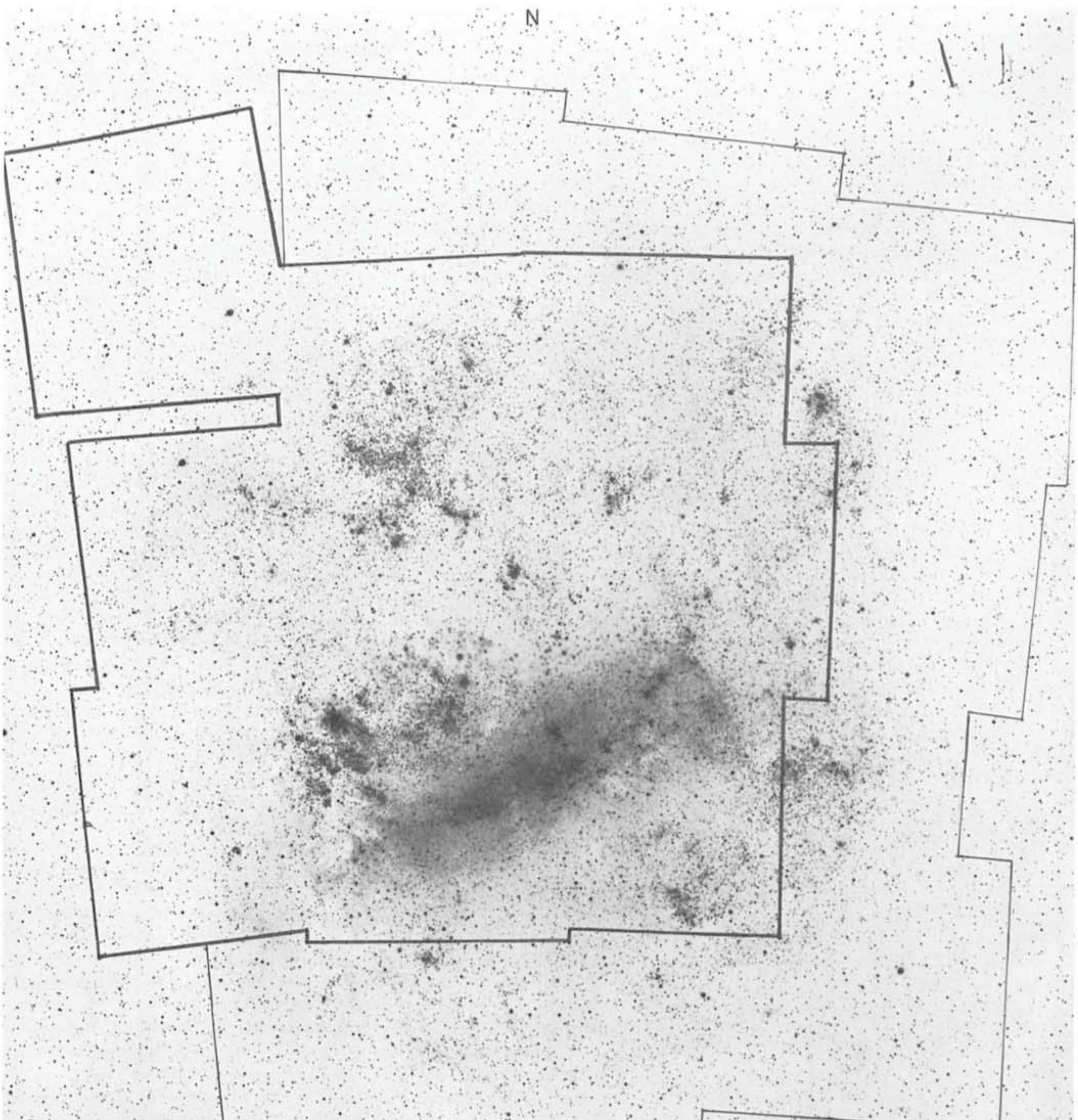


Fig. 1. — The Large Magellanic Cloud. Radial velocities have been published for 398 LMC supergiants and 1434 galactic foreground stars in the area within the heavy lines. The adjacent area (thin lines) will soon be published.

modulus is calculated. (The apparent magnitude is determined from UBV photoelectric photometry.)

The internal agreement obtained for the determination of the distance from stars with spectral types ranging from B5 to A0 is good. The mean value is m-M = 18.1. This is lower than the more generally admitted value (m-M = 18.5), but is in excellent agreement with the determination made by M. Walker from very faint (probably main-sequence) stars of the LMC cluster NGC 1866.

This determination of the distance modulus is independent of the hypothesis made concerning intrinsic colours of the stars. The only assumption is that these stars have the same intrinsic colours as the galactic stars having the same (λ_1; D) values.

Some of the observed stars are brighter than the brightest known in our Galaxy ($M_V < -8$); they have made it possible to extend the calibration in absolute magnitude of the (λ_1; D) diagram up to $M_V = -9.5$. This calibration will be used to determine the distance modulus of the Small Magellanic Cloud.

Muratorio (Marseille) is studying some peculiar supergiants in the Magellanic Clouds (mainly in the LMC) with bright emission lines of hydrogen, Fe II and forbidden [Fe II]. Some of these spectra barely show hydrogen-absorption lines in their continuum while others exhibit a rich mixture of absorption and emission lines. Although some of these spectra present characteristic P-Cygni-type profiles for the hydrogen lines, these stars show similarities with η Carinae or VV-Cephei-type objects.

The spectra were obtained at La Silla with the RV Cass at 74 Å mm^{-1} and with the coudé spectrograph at 20 Å mm^{-1}. They were scanned on the Grant machine in Santiago; the magnetic tapes obtained are processed on the T 1600 computer in Marseille to identify the lines and determine their radial velocities and equivalent widths.

These data will make it possible to study the variations of physical parameters (such as temperature, velocity field, electron density) as a function of the depth in the atmosphere of these stars.

E. Maurice (Marseille) has undertaken to search for possible optical counterparts to the LMC X-ray sources. A few spectra had already been taken with the RV Cass (74 Å mm^{-1}) for the above-mentioned Marseille survey of the brightest LMC supergiants. The observations are now made at 125 Å mm^{-1} (and 60 Å mm^{-1}) with the Echelec spectrograph; the spectrograph is used in the single dispersion mode and equipped with the Lallemand electronic camera. The resolution permits good spectral classification and radial-velocity determination; the electronic camera makes it possible to improve considerably the time resolution (for a 12th B magnitude star the exposure time is of the order of 20 minutes).

Optical candidates for these X-ray sources are selected from two criteria: firstly, from the periodic apparition of emission lines (essentially He II at λ 4686, and C III – N III – O II at λλ 4634–4650); and secondly, from the periodic variation of the radial velocity of the supergiant in absorption and also, when possible, of the hot spot responsible for the emission lines.

Observations have been made for three sources: For LMC X-2 the supergiant HDE 271213 (Radcliffe R 96) seems to be the proven counterpart with a period of 23 days from photoelectric measurements. Its spectral type seems to be variable; the star is classified by the Marseille group as B1 Ia, and as B3 I (and possibly as late as B5) by the Radcliffe observers. For LMC X-1 three stars are surveyed. From the present observations the O9 f supergiant CPD–69°476 (Radcliffe R 149) seems the most probable candidate although the B5 I star CPD–69°474 (Radcliffe R 148) is better situated with respect to the various error boxes determined by the satellites. Another B2 Ia supergiant (HDE 269992) has also been surveyed, as it presents radial-velocity variations. For LMC X-5 the star HDE 269445 (R 99) has been surveyed. Its spectrum, containing only bright hydrogen, He I, He II, C III, etc. emission lines, some of which are variable with a period of a few days, makes this star a possible candidate for this source.

The Small Magellanic Cloud

A. Florsch (Strasbourg) is continuing his work on the SMC supergiants using the objective-prism technique. He has already published several lists of radial velocities and photographic magnitudes for proven or probable member stars of the SMC.

The analysis of the radial velocities shows the existence of two groups of stars; these velocities are in good agreement with the values published by Hindman for neutral hydrogen. The stars in the northern part of the SMC are brighter than those in the southern part. The analysis of the data from SMC cepheids by Payne-Gaposchkin and Gaposchkin indicates that the "dm" term follows the same rule. The pattern suggests that the two effects of absorption and variable distance are mixed.

Also in progress is the detection and measurement of high-velocity stars in the vicinity of the SMC.

Agnès Acker (Strasbourg) who had collaborated with Ch. Fehrenbach and M. Duflot in the identification of Wolf-Rayet stars and planetary nebulae in the Large Magellanic Cloud, is now planning the same kind of research in the Small Cloud.

From RV Cass spectra, P. Dubois (Strasbourg) has measured radial velocities, determined MK spectral types, and discussed peculiar features of some SMC supergiants. This is the first step of a study of certain line intensities, in order to obtain quantitative spectral classifications, absolute magnitudes and chemical compositions of these supergiants. Also planned is the study of some cluster stars in the SMC.

In collaboration with A. Ardeberg (Lund), E. Maurice (Marseille) has made spectrographic and photoelectric UBV observations of a set of the brighter stars from the SMC and its wing. A list of 85 supergiants has been prepared. The data include MK spectral types, radial velocities, and results of UBV photometry for 51 supergiants, whereas photometric data only are given for the rest of the stars. When possible, radial velocities for interstellar Ca II und [O II] are given. These results will be discussed in a forthcoming publication.

Using these results and previous radial-velocity data, E. Maurice, L. Prévot and A. Pourcelot establish a list of (weighted) radial velocities for 81 stars in the SMC and its wing. Attempts are made to derive a rotation law for the SMC from these data.

An objective-prism survey and UBV photoelectric measurements were made by M. Azzopardi and J. Vigneau (Toulouse) in the direction of the SMC. It made it possible to detect 506 stars that show high-luminosity spectral characteristics; 193 of them had been considered as SMC members by other authors. 1975 coordinates and MK spectral types for all stars, V magnitudes, (B–V), (U–B) colour indices and remarks for most of them are presented. A master set and 16 identification astrograph charts are provided.

Using this catalogue, it is possible to define a structure of the SMC shown by the supergiants. The comparison with de Vaucouleurs' counts of stars brighter than $m_{pg} = 14.3$ shows that 80 % of the supergiants have been detected. The apparent distribution centroid for the extreme Population I of the bar is found to be located at $\alpha = 0^h57^m3$, $\delta = -72°45'$ (1975.0). The mean colour excess is $E_{B-V} = 0.04 \pm 0.03$ for foreground stars, and $E_{B-V} = 0.07 \pm 0.04$ for SMC members. The gas-to-dust ratio is discussed, and its value is found to be $R = 7.5 \times 10^{22}$ atom cm^{-2} mag^{-1}.

The chemical compositon of the Magellanic Clouds is poorly known. In "Conference on Research Programmes for the New Large Telescopes" (ESO/SRC/CERN, Geneva, 1974), Graham has emphasized the great need of accurate metal abundance determinations in the Magellanic Clouds. The interest of this study is twofold; it will lead to a better knowledge of the Magellanic Clouds and, in the same time, it will be a key to our understanding of the properties of our local group of galaxies.

Almost all the abundance determinations in the Magellanic Clouds rest upon very delicate calibrations: the large spread of the results given in the literature proves how highly difficult it is to carry out such calibrations.

R. Foy has undertaken a direct determination of the stellar abundances in the SMC through high-dispersion spectral analysis. During his recent observing run, he obtained two good-quality spectrograms of a solar-type supergiant (B = 11.8). These spectrograms have been taken with the Lallemand electronic camera and the echelle spectrograph at the 1.52 m telescope in La Silla. The dispersion is 8 Å mm^{-1}. The detailed analysis of these spectra will lead to a determination of the chemical composition of the SMC star with the same accuracy than that obtained for a star in the solar neighbourhood.

Obviously, similar observations of other stars are still required for the above-cited purposes: knowledge of the global chemical composition of the Magellanic Clouds, and its interpretation with respect to the other dwarf local galaxies.

High-velocity stars have been systematically searched for with the objective-prism technique by Nicole Carozzi-Meyssonnier (Marseille) between the two Magellanic Clouds and between the LMC and the Galaxy, in order to detect possible links between these objects.

124 stars have been found; they can be classed into two groups. Forty-nine of them are B and A-type supergiants belonging to the SMC wing. The remaining 75 stars, which are essentially of late type (G–K) and of luminosity classes III to V, are galactic; they are found between the two Clouds and between the LMC and the Galaxy. These results have already been published.

* * *

In this résumé I have presented only the stellar work and not any of the nebular investigations in the direction of the Magellanic Clouds, undertaken primarily by the Marseille interferometry group.

I wish to express my gratitude to all those who so kindly sent me their contribution and thus made this review possible.

The Bochum Telescope Explores the Southern Sky

Three nations have national telescopes on La Silla, Denmark (50 cm and 1.5 m), the Federal Republic of Germany (61 cm) and Switzerland (40 cm). In the last issue of the Messenger, *we heard obout the Swiss telescope which has recently started observations in the rich southern sky. The Bochum telescope is an oldtimer on La Silla and has produced an incredible amount of valuable observations. Professors* J. Dachs *and* Th. Schmidt-Kaler *of the Bochum University explain how the 61 cm telescope has contributed to the advance of astronomy in the southern sky:*

Recently, the Bochum 61 cm photometric reflector at La Silla celebrated its eighth anniversary. Following a trilateral agreement between the Director of the European Southern Observatory, the Deutsche Forschungsgemeinschaft (German Research Council) and the University of Bochum, a Boller & Chivens 24-inch Cassegrain telescope was installed at La Silla in September 1968, next to the former dome of the ESO 1 m telescope. The Bochum telescope is housed in the only aluminium dome at La Silla glistening in the sun on the western slope of the hill, overlooking the ESO hostel and a large part of the Pacific Ocean.

An account of the instrument, of its installation and of the stellar photometer attached to it has already been given in the ESO Bulletin No. 5 at page 15 ff. (1968). Meanwhile, work done at the 61 cm reflector by Bochum astronomers has led to not fewer than 80 printed contributions in scientific astronomical journals!

The main objects for photometric studies by Bochum observers have been luminous OB stars and supergiants in southern open clusters, in selected Milky Way fields and in the Magellanic Clouds. Investigation of the brighter stars of more than 120 open clusters with the 61 cm telescope by Drs. Moffat and Vogt (at present staff member of the European Southern Observatory) has resulted in a much better definition of distant spiral structure in the southern hemisphere of our Galaxy. Photometry of about 400 supergiants in the Large Magellanic Cloud by Dr. Isserstedt (now with the University of Würzburg) has approximately doubled the number of members of this neighbouring stellar system for which photometric classification and the amount of interstellar absorption are known. The distribution of the early-type supergiants revealed spiral features of the Large Magellanic Cloud. Light curves of small-amplitude magnetic variables and their spectral variations are another topic being investigated at the 61 cm telescope by Dr. Maitzen (now at Vienna Observatory) who is also a frequent guest at ESO telescopes.

Data acquisition with the Bochum telescope has been improved very much by a computer control of the photometer installed in 1971 using a Hewlett-Packard type 2114 B computer with 8K memory. In order to provide sufficient space for the bulky electronic equipment needed for computerization, ESO has been kind enough to enlarge the Bochum building by a third room in the ground floor serving

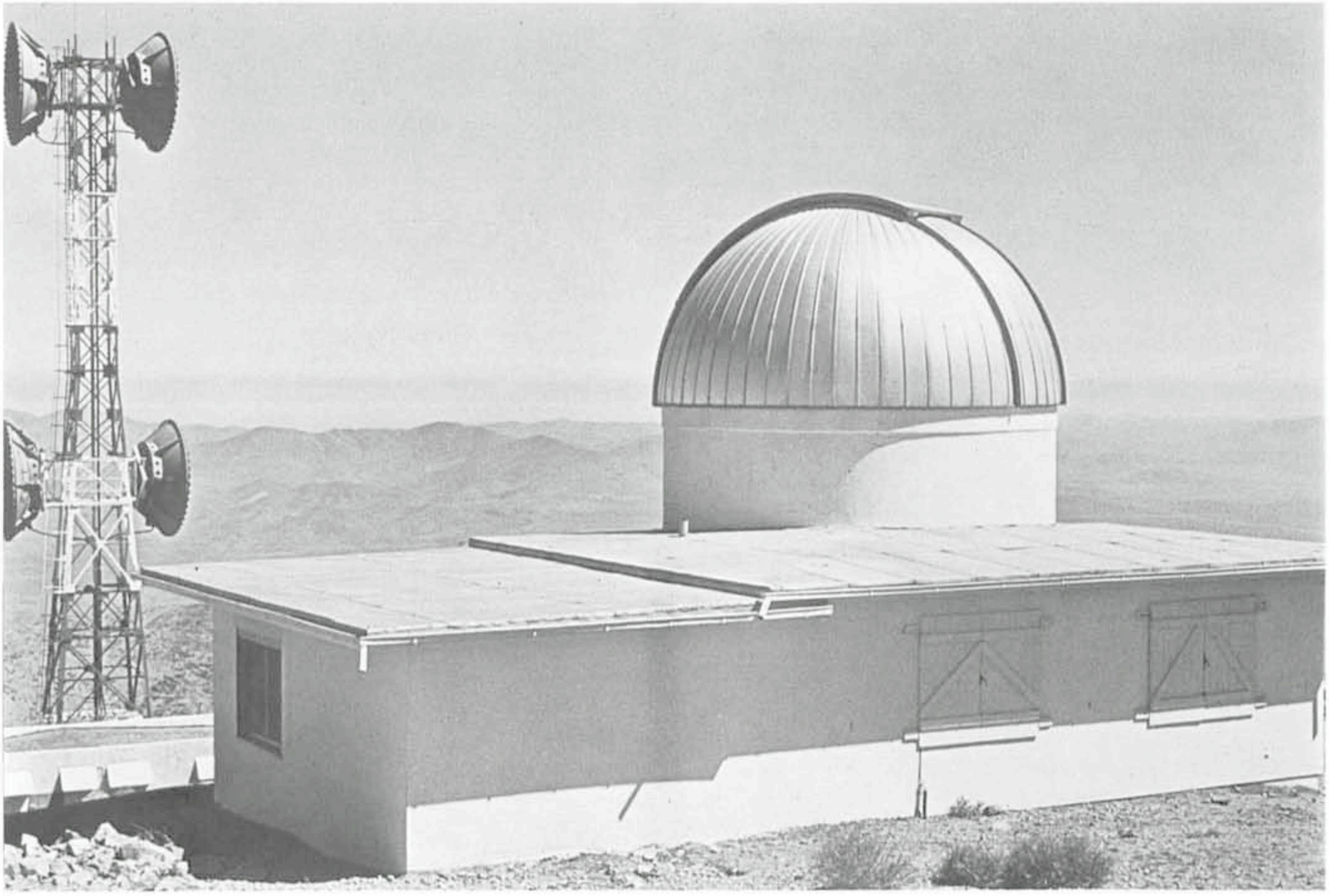


Fig. 1. — The Bochum University station at La Silla.

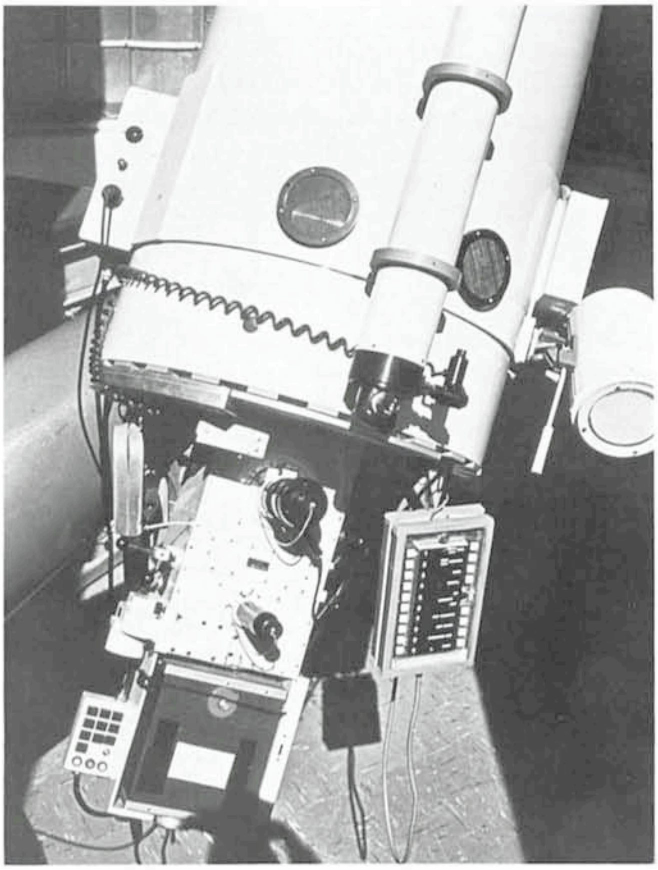


Fig. 2. — The 61 cm Cassegrain telescope of the University of Bochum with the photoelectric photometer attached.

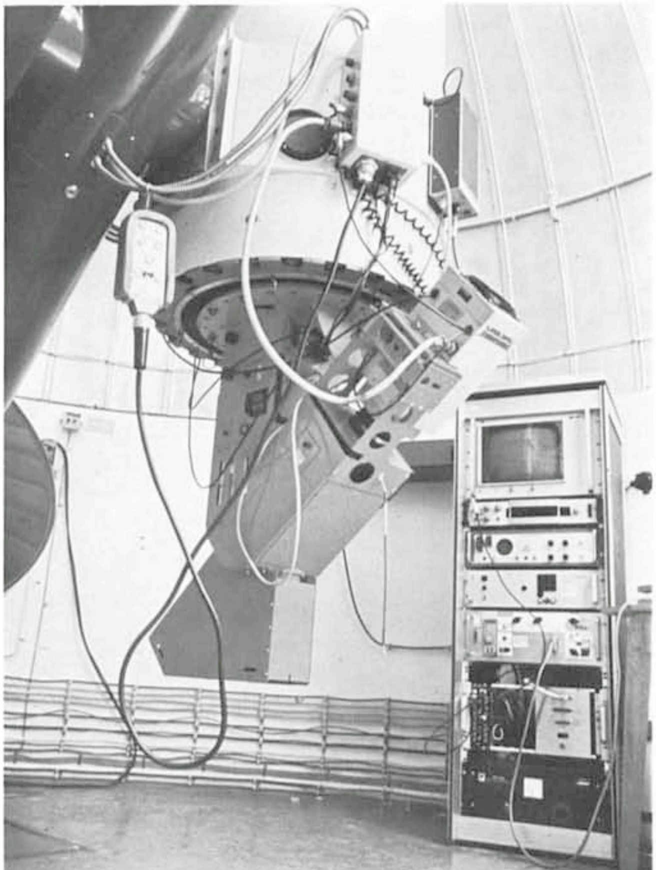


Fig. 3. — The spectrum scanner at the 61 cm telescope.

as the new dormitory for the Bochum observers, while the first two rooms are housing the data-acquisition system and spare instruments.

Numerous European guest observers and ESO staff astronomers have also used the 61 cm telescope with its photometric equipment and computer control which are at ESO's disposal during 30 per cent of every year's observing time.

A more complex addition to the equipment—so far used only by Bochum observers—is a photoelectric rapid spectrum scanner installed in 1973. It is a single-channel instrument containing a blazed grating in a crossed Czerny-Turner mounting which is driven by a computer-controlled step motor. The spectrum scanner has been extensively used in order to establish a sequence of southern standard stars with photoelectrically measured spectral energy distribution calibrated by comparison with northern standard stars and with copper and platinum black bodies. Besides, spectral energy distributions of different types of stars, e.g. supergiants and peculiar stars are being studied with the scanner as well as emission-line profiles of stars with extended envelopes like Be, Wolf-Rayet and Y-ray stars.

Temporarily, a super-wide-angle camera of 140° field developed at Bochum was installed at the site to obtain photographic surface photometry of the southern Milky Way in four colours. As a by-product an Atlas of the Milky Way was assembled and has now been published.

The Bochum observers are grateful to ESO for the opportunity to participate in the investigation of the southern skies, and look forward to another many years of generous and fruitful cooperation at La Silla.

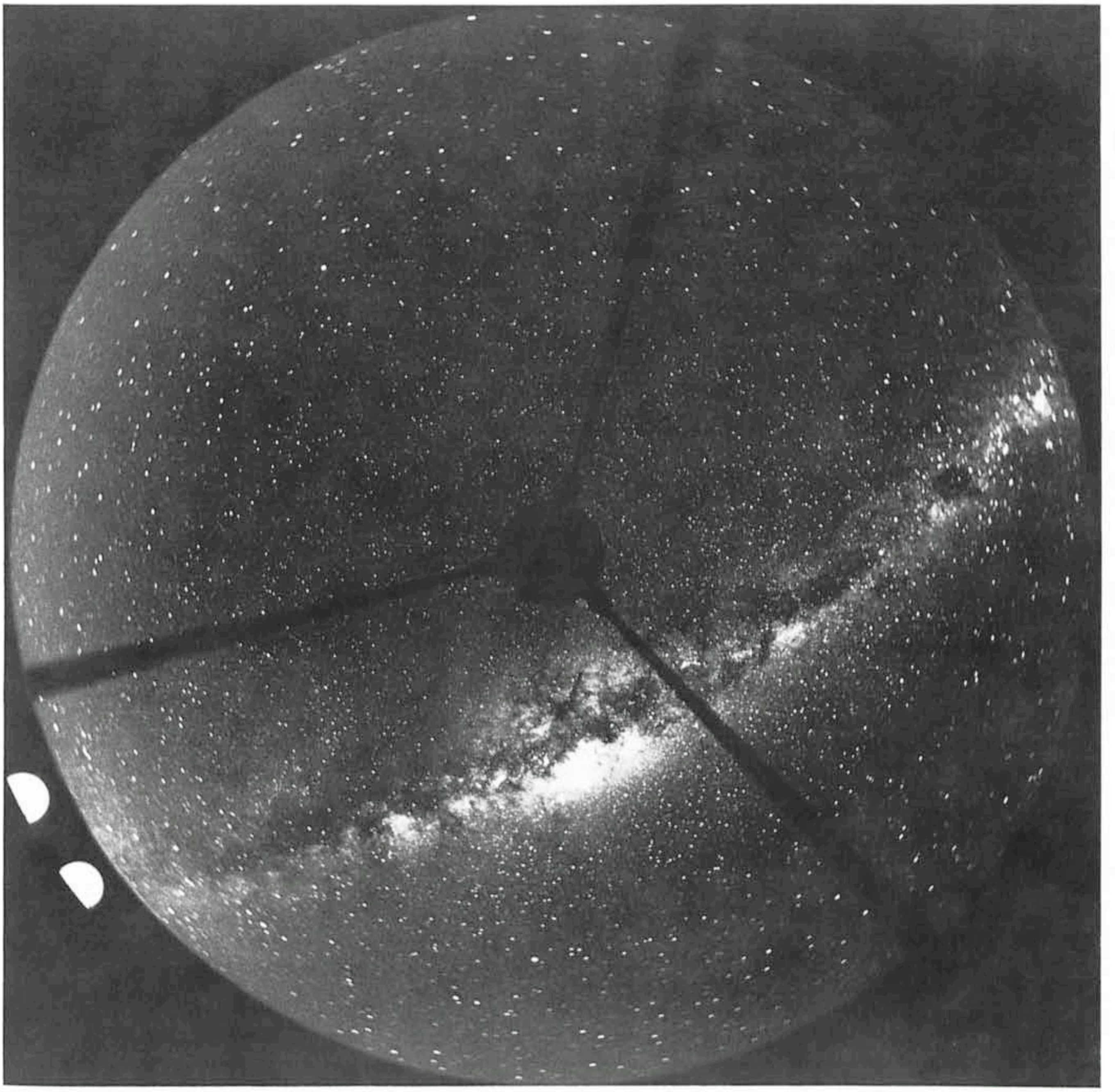


Fig. 4. — The central region of the Galaxy photographed in red light with the 140° wide-angle camera of the University of Bochum.

A Search for F Stars of Intermediate Population II Within 100 Parsecs

Bengt Strömgren

The class of stars of intermediate population II is defined through the chemical composition of the stars. A star belongs to this class if its relative heavy-element content Z is between one-fourth and one-tenth of the Z-value for Hyades stars. This means that the range in question is from Z = 0.008 to Z = 0.003, so that Z = 0.005 is a typical value.

For the great majority of population I stars the relative heavy-element contents Z lie between 0.015 and 0.035. The Z-value for the Sun is fairly close the lower limit. On the other hand, halo stars and members of most globular clusters—i.e. extreme population II stars—have Z-values that are down from the Hyades value by factors greater than 10, generally between 10 and 200. It may be noted, however, that some globular clusters, e.g. 47 Tucanae, have member star Z-values that place them in intermediate population II.

Professor Bengt Strömgren, *President of the ESO Council, needs little introduction to the readers of the* Messenger. *There are few astronomical fields to which he has not contributed and his name is attached to subjects as different as envelopes of ionized hydrogen around hot stars and high-precision photometry. The Strömgren four-colour photometric system allows an accurate determination of luminosities and ages of many types of stars. The system is particularly well suited for the large-scale investigation of the evolution of our galaxy, the Milky Way. The massive observational programme of Professor Strömgren and his collaborators in Copenhagen is a rarely seen combination of quantity and quality, already leading towards a much better understanding of the solar neighbourhood and the continued interaction between the interstellar matter and the stars.*

The limits for the Z-range defining intermediate population II have been chosen according to practical considerations. On the one hand, samples of intermediate population II stars obtained through observations should contain at most a very small fraction of stars that really belong to population I or extreme population II, and are "scattered" into the sample through observational error, and furthermore it is desirable that intermediate population II stars as defined form a fairly homogeneous group. These considerations tend to force the choice of a fairly narrow Z-range. On the other hand, it is undesirable to reduce the size of the sample so much that stars are excluded which are actually fairly similar to the typical sample star. The chosen limits seem to be adequate, and in particular a widening of the Z-range from 0.008–0.003 to, for example, 0.010–0.002 would not increase the size of the sample very much.

The task of picking out metal-poor stars with relative heavy-element contents falling in the range characteristic of intermediate population II is not a very simple one. True, through quantitative spectral analysis based on high-dispersion spectra it can be determined whether a star belongs to this class or not. However, such analysis requires much telescope time per star and it has not proved feasible to investigate large numbers of stars in this way. On the other hand, there is a good deal of experience showing that stars of intermediate population II cannot be reliably picked out through routine spectral classification based on objective-prism spectra, even when such fine spectra are used as are obtainable with the Curtis Schmidt telescope on Cerro Tololo.

Pioneer work in 1954 by Nancy Roman showed that F stars of extreme population II can be identified on the basis of their ultraviolet excess determined through photoelectric UBV photometry. This method lends itself to survey work as the required telescope time per star examined is relatively short. It was subsequently found that the same is true for *unevolved* F stars of intermediate population II, but not for the equally important type of *evolved* intermediate population II F stars, which lie $0^{m}.5$–$1^{m}.5$ above the zero-age main-sequence (ZAMS). The reason is that the chemical-composition effect on the U-magnitude is partly compensated by an evolutionary effect, connected with the fact that the evolved stars have lower atmospheric gravity.

However, some years later it was shown that F stars of intermediate population II can be reliably picked out through photoelectric four-colour observations in the uvby system (B. Strömgren, *Astrophys. Norveg.* **9**, 333, 1964). In this system, intensities of intermediate-width bands at 3500 Å, 4110 Å, 4670 Å and 5470 Å are observed.

The three intensity ratios measured permit determination, for F stars, of three parameters, namely effective temperature, absolute magnitude (or atmospheric gravity), and relative metal content. In other words, it is here possible to separate the effects of chemical composition and evolutionary change. This works for unreddened stars. For reddened stars yet another index, the β-index which indicates the strength of the Balmer-line Hβ, must be measured. Then the degree of reddening can be determined, and the method works again.

Recently B. Grønbech and E.H. Olsen have published a catalogue of photoelectric uvby photometry for 2,771 bright O- to G0-type stars south of declination +10° (*Astron. Astrophys. Suppl.*, Vol. **25**, No. 2, 1976). The observations were made with a four-channel spectrograph-photometer attached to the Danish 50 cm reflector on Cerro La Silla. The instrumental equipment, the observational procedure and the transformation of the observed quantities to the standard uvby system of Crawford and Barnes have been described in a publication by Grønbech *et al.* (*Astron. Astrophys. Suppl.*, Vol. **26**, No. 2, 1976). Altogether 13,958 photoelectric uvby observations of standard stars and programme stars were made during the two investigations referred to.

Together with a number of catalogues of uvby photometry, largely by D. L. Crawford and his collaborators of AURA, this new catalogue covers the entire sky, and uvby photometry is available for altogether about 5,000 O-G0-type stars brighter than V = $6^{m}.5$, the magnitude limit of the Bright Star Catalogue.

Analysis shows that about three dozen of the 5,000 stars in question are F stars of intermediate population II, i.e. a very small fraction. However, it must be remembered in this connection that among the stars brighter than V = $6^{m}.5$ there is not a single F star of extreme population II. Also, if the comparison is made with main-sequence F stars of the same colour range it turns out that the intermediate population II stars form about 7 per cent of the stars.

Although the sample of F stars of intermediate population II brighter than $V = 6^m.5$ is small, it has proved large enough for a preliminary analysis of the space velocities of the sample stars to show that the population in question is intermediate between population I and extreme population II with regard to kinematics, also. In particular, the average value taken without regard to the sign of the space velocity component at right angles to the galactic plane is larger than for population I stars, but a good deal smaller than for extreme population II stars. This suggests that stars of intermediate population II were formed during an epoch range when the Galaxy had developed a flattened disc.

Analysis of material for stars brighter than $V = 6^m.5$ has shown that the stars of intermediate population II have a distribution in the Hertzsprung-Russell diagram that is sharply limited on the high-temperature side, at a colour index b–y just under $0^m.30$, corresponding to spectral class F5. This indicates that the stars of intermediate population II all have ages not very much smaller than the age of our galaxy.

The small sample of F stars of intermediate population II brighter than $V = 6^m.5$ has proved useful for calibrations of the metal-content index m_1 derived from uvby photometry. Such calibrations, which make possible the derivation of the relative iron content and the Z-value from measured values of m, have recently been carried out with improved accuracy by D.L. Crawford and C. Perry who utilized the available material based on quantitative spectral analysis using high-dispersion spectra, and by P.E. Nissen who determined relative iron contents trough narrow-band photoelectric photometry.

It is clear from the results just referred to that more extensive investigations of F stars of intermediate population II can yield material that will be valuable in studies of the early phases of evolution of our galaxy, in particular for investigations pertaining to the epoch when stars first began to be formed in large numbers in the galactic disc.

With this in view, plans were developed for a search for F stars of intermediate population II brighter than $V = 8^m.3$. E. H. Olsen worked out a list of programme stars for which photoelectric uvby photometry was to be carried out with the Danish 50 cm reflector on Cerro La Silla. The list included all stars in the Henry Draper catalogue brighter than $V = 8^m.3$, in the spectral range A5-G0, and south of declination $+6^\circ$. Stars in the Catalogue of Bright Stars that had already been observed were excluded, and there remained altogether about 7,000 stars.

It is intended to extend the work to the northern hemisphere, once the southern-hemisphere programme has been completed. E. H. Olsen has set up a corresponding list of programme stars, and the total number of stars to be observed in both hemispheres is 13,307.

During 20 nights in August and September 1976, E. H. Olsen has obtained photoelectric uvby photometry with the Danish 50 cm reflector on Cerro La Silla for 3,600 programme stars. This covers about one-fourth of the programme for the entire sky. It is hoped that the remaining half of the southern-hemisphere observations can be completed in March and April 1977.

It should be noted that the great majority of the programme stars have only been observed once. However, the mean error of 1 observation of a programme star is $\pm 0^m.005$, $\pm 0^m.007$ and $\pm 0^m.008$ for b–y, m_1, and c_1, respectively, and the accuracy obtained with these observations is therefore sufficient for the establishment of an intermediate population II "candidate list" consisting of, for this one-quarter of the whole programme, a few hundred stars. Two additional observations will be obtained for stars of the "candidate list". Observations of the index β will also be obtained for the stars of the "candidate list" in order that corrections for interstellar reddening can be made, although it is expected that these will generally be small, since the great majority of the stars in this list are located within 100 parsecs. In this way a final list of intermediate population II stars will be set up as a result of the search.

The August and September 1976 observations have been reduced by the observer, and he has derived a catalogue of b–y, m_1 and c_1 in the Crawford-Barnes standard system for 3,600 stars. E. H. Olsen and the author of this article have found it worthwhile to carry out a preliminary analysis of the data even at this early stage in order to extract information pertaining to intermediate population II stars.

There appear to be somewhat over one hundred intermediate population II stars in the relevant one-fourth of the sky. We have made a somewhat restricted list of such stars, limiting ourselves to the Δm_1 range (measuring metal deficiency relative to the Hyades) $0^m.050$ to $0^m.069$, corresponding to Z between 0.007 and 0.004. Furthermore, we excluded stars with distances larger than 80 parsecs. This was done to counteract the effect of having at this stage only one uvby observation at disposal, and no β-index observations. There resulted a sample of 71 stars, for which the distribution of the b–y colour-index values is shown in the following table:

b–y	Number of stars
$0^m.25$–$0^m.27$	0
0 . 27–0 . 29	1
0 . 29–0 . 31	9
0 . 31–0 . 33	22
0 . 33–0 . 35	14
0 . 35–0 . 37	12
0 . 37–0 . 39	11
$>$ 0 . 39	2

It is seen that the phenomenon of the sudden appearance of the intermediate population II stars near b–y = $0^m.30$ is confirmed. The distribution of the stars in the (b–y)–c_1 diagram, which corresponds quite closely to the distribution in the Hertzsprung-Russell diagram, shows a well-defined ZAMS distribution and a "turn-up" near b–y = $0^m.30$, and also a subgiant branch of evolved stars with absolute magnitudes between 3^m and 4^m. A preliminary analysis of these data, based on as yet unpublished model-atmosphere results by R. Bell and B. Gustafsson, and computed isochrones for stars with $Z = 0.004$ and $Z = 0.01$, respectively, by P.M. Hejlesen lead to the result that the stars in question have ages not far from 10 billion years. However, a determination of the age range has to wait until the expected much more complete material is at hand.

There is some hope that the entire search can be completed before the end of 1978. Plans for determinations of proper motions and radial velocities for the stars of the finally established intermediate population II list are now being considered. The aim is to obtain location in the Hertzsprung-Russell diagram, individual values of relative heavy-element content Z, mass, age, as well as space velocities for an unbiased sample of several hundred stars of intermediate population II.

Finally it should be mentioned that the photometric material obtained for large numbers of population I stars will also be of value, and that this material, too, should be supplemented with material on proper motions and radial velocities.

Investigation of F stars of intermediate population II within 100 parsecs is clearly only a first step. Studies pertaining to greater distances in the direction of the galactic poles form a logical further step, and such studies are under way. Reference is made in this connection to the article by Adriaan Blaauw in number 5 (June 1976) of the *Messenger*. A goal for the future is the exploration of the region of the central bulge of our galaxy.

Those Tumbling Asteroids

Once a small planet has been discovered (see f. inst. Messenger *No. 6, Sept. 1976) and its orbit determined, we can keep track of it and find it again in the sky at any time as a faint speck of light, moving along between the fixed stars. Then we can study it further by spectroscopy and photometry (measurement of its magnitude and colours). Whereas its spectrum is normally very similar to that of the Sun (reflected sunlight from the asteroid's surface), its light-curve may tell us its rotation period, and possibly, after a long series of precise measurements, the shape and direction of the rotation axis. These quantities are not trivial; f. inst. the behaviour of minor planets of the same family (similar orbits) is of importance for our understanding of their origin.*

Drs. Anna *and* Jean Surdej *recently joined the ESO astronomical staff in Chile. The sympathetic couple has different backgrounds: specialized in solid-state physics, Anna has now become interested in astronomy and Jean, who was formerly at the Institut d'Astrophysique in Liège (Belgium), has a keen eye on the physics in comet tails. Soon after their arrival on La Silla, they started photometric observations of asteroids and this is their report on (599) Luisa:*

The light-curves of an asteroid are mainly observed to obtain information about its period of rotation, its shape and the orientation of its rotation axis in space. The relation found between the different spectral magnitudes, mainly U, B, V, and the varying phase angle are important in the study of surface textures of asteroids. Furthermore, the absolute magnitude V (1.0) of an asteroid, i.e. its V magnitude extrapolated at heliocentric and geocentric distances both 1 A.U. (150 million km) for a zero phase angle (angle Sun–asteroid–Earth = 0°), can be determined and so, a rough value for its albedo (ability to reflect light), its mean radius and mass.

Observations for such studies have been performed with the pulse-counting photometer at the ESO 50 cm telescope for a few, so far physically unknown, asteroids. We reproduce in Figure 1 one of the light-curves obtained for the minor planet 599 Luisa on September 9 during its 1976 opposition. In that figure are plotted the magnitudes of the asteroid, obtained by comparison with a constant-light star, against the observing time in Universal Time (U.T.).

When observing the photoelectric light-curves of 599 Luisa, we measured regularly two comparison stars chosen close to the asteroid and of similar coulours and magnitude. This allows to remove the extinction effects (i.e. dimming of the light from any celestial object during the passage through the Earth's atmosphere) from the light-curve of the minor planet as well as judging the quality of the night and sometimes finding variability of one or both comparison stars. The scatter of the comparison readings helps in evaluating the quality of the night at any moment. Figure 2 shows the count-rate in the V filter of one of the comparison stars (V = 0.9.35) against observing time in U. T. The maximum scatter for the night is found to be ± 0.006 magnitude. The general observing routine includes frequent observations of the sky, asteroid, comparison stars and of some standard stars in the U, B, V system (Johnson and Morgan) to determine the magnitudes of the asteroid.

The large amplitude of the light-curve reproduced in Figure 1 is mostly due to the changing shape of the asteroid during its rotation as seen from the Earth. The short time-scale feature appearing in the light-curve around 6 h U.T. corresponds very probably to topographic accidents (craters?, dark spots? . . .). A more complete study of this and other asteroids will be reported soon in the literature

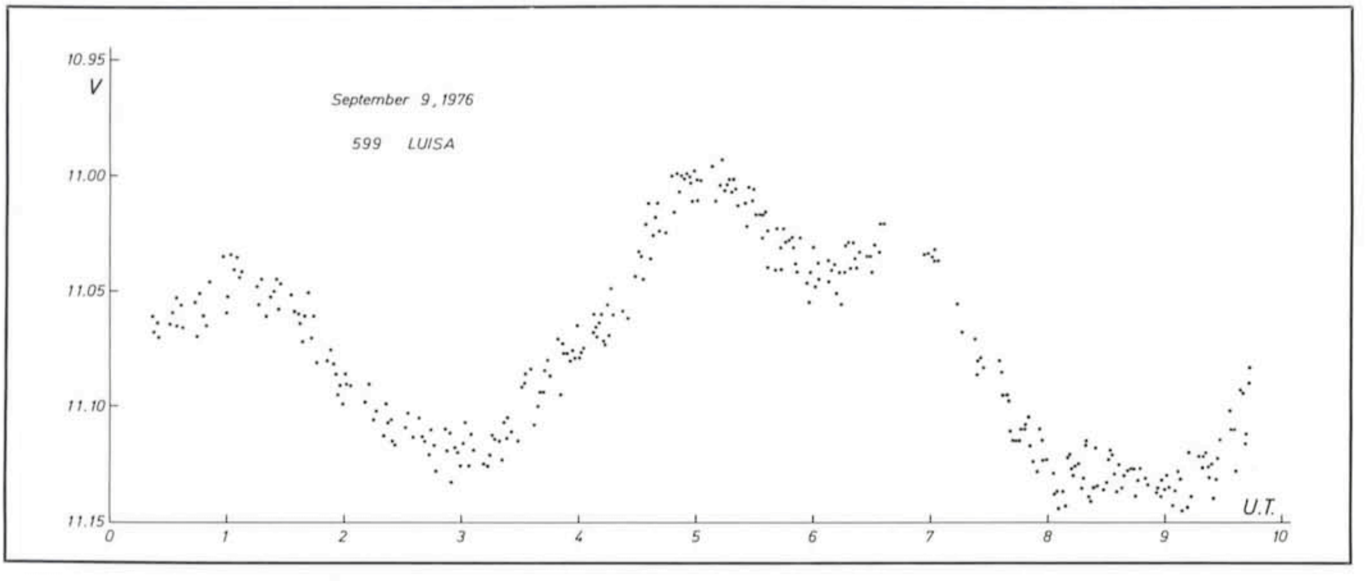


Fig. 1. — Light-curve of the minor planet 599 Luisa.

by the authors in collaboration with H. Debehogne (Royal Observatory, Uccle, Belgium). Asteroids are in the greatest number among the small planetary bodies which can provide valuable information concerning the early evolution of our solar system. It is the wish of a lot of us to observe more of them in the near future.

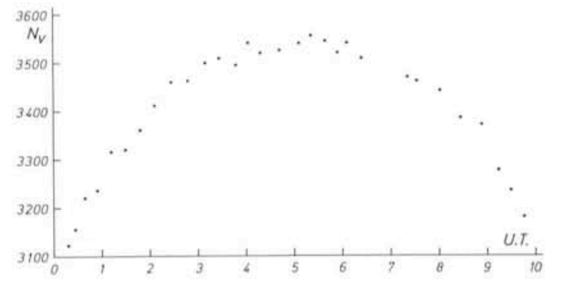


Fig. 2. — Numbers of pulse-counts per second for the comparison star. Note how there are first relatively few counts (the star is in east at low altitude and the atmospheric extinction is large). As the star rises higher and higher, the number increases and it reaches a maximum when the star culminates (passes the meridian). Then, as it descends on the western sky, the extinction again increases and the count number becomes smaller. This extinction effect has been removed from the light-curve in Figure 1. ▶

Why are Binary Stars so Important for the Theory of Stellar Evolution?

A good theory needs a good observational basis.

The truth of this statement is accepted by both theoretical and observational astronomers, but the history of astronomy nevertheless shows many theoretical studies which have been founded on insufficient or even inaccurate observations. Our present knowledge of stellar evolution is best visualized as the movements, as time passes by, of stars with different masses and chemical compositions in the Hertzsprung-Russell (temperature versus luminosity) diagram. This theory is very complicated and rests heavily on observations of luminosities, colours and sizes of amazingly few, well-studied stars. Dr. Henning E. Jørgensen *of the Copenhagen University Observatory has studied the problems of stellar evolution with fast computers and is well aware of the necessity of extremely accurate observations in support of the theoretical studies. He explains why eclipsing binary stars are particularly suited for this purpose and informs about some of the recent observations of southern binaries from La Silla.*

New, Improved Observations Needed

In 1971 it was decided to start an observing programme on eclipsing binaries with the 50 cm reflecting telescope at La Silla belonging to the Copenhagen Observatory. Further there was the possibility of obtaining accurate spectroscopic elements from 12 Å/mm plates using the ESO 1.5 m telescope.

Extremely many observations of eclipsing binaries of all sorts are published in the literature, but still we know accurate masses, radii and luminosities for very few stars, certainly fewer than ten. Several accurate light-curves have been published but in most cases for systems with complications like strong deformation of the components or surrounding gas, for which no acceptable model is developed. Published masses and radii cannot be trusted. Moreover, the light-curves were usually obtained with broad-band filters far from being monochromatic; often the instrumental systems are badly defined. Those of us who do stellar-evolution calculations are left with the feeling that the hundred thousands of observations of eclipsing binaries scattered through the literature are of very little value to us.

How to Check Stellar Models

The stellar-evolution people are left with a bad problem: how to check the stellar models? There are several parameters to play around with in the models, and uncertainties in opacity tables and nuclear cross sections are not easy to evaluate. The only check we have is the neutrino flux from the Sun and we all know of the difficulties this experiment has given to us. However, we think that the models are not *too* bad, without knowing *how* bad. The checking of stellar models is important in several respects. Let me only mention the age determination, and that we use ages of stars when studying the chemical and dynamical evolution of our galaxy. The accuracy of ages ist hard to estimate.

To get a real check of a stellar model we must determine *mass, radius, luminosity, age* and *abundances* (Y, Z) of stars by observation. This is obviously very difficult to do and our check cannot be a very accurate one. Using binaries, however, we may check if the two components lie on an isochrone (have the same age) and if the mass ratio is right. This tells us if the evolutionary speed through the HR diagram is calculated correctly. Knowing from observation the parameters, mass, radius, temperature (or luminosity) and abundance of heavier elements Z, we derive a helium content Y adopting the stellar models. The helium content is an important quantity in cosmological problems.

Accuracy...!

Which are the requirements on the observationally determined parameters? Let us consider an example. We wish to derive the helium content Y of an unevolved binary with a mass of around two solar masses with an accuracy of $\varepsilon(Y) = 0.03$. From homogeneous stellar models we find immediately that the mass must be known to 2 %, the heavier elements to 25 % and luminosity to 10 % as a typical combination of uncertainties. The situation is a bit more complicated when we consider evolved stars.

This high precision can be obtained only if we carefully select the most simple photometric and spectroscopic systems. The components must be well separated with small deformations. The eclipses must be deep, if possible a total eclipse. The luminosity of the two components should be nearly the same and not differ more than half a magnitude, since radial velocities of both components cannot be derived with sufficient accuracy if the luminosity difference is too large.

Several systems on the southern sky are observed in the Strömgren four-colour uvby system with a simultaneous four-channel photometer on the 50 cm telescope, giving four essentially monochromatic light-curves. The metal index m_1 gives the content of heavier elements Z to an accuracy better than 25 % for F stars, while we have little check on Z for the earlier-type stars. Radial-velocity measurements are done in parallel to the photometric work.

SZ Centauri

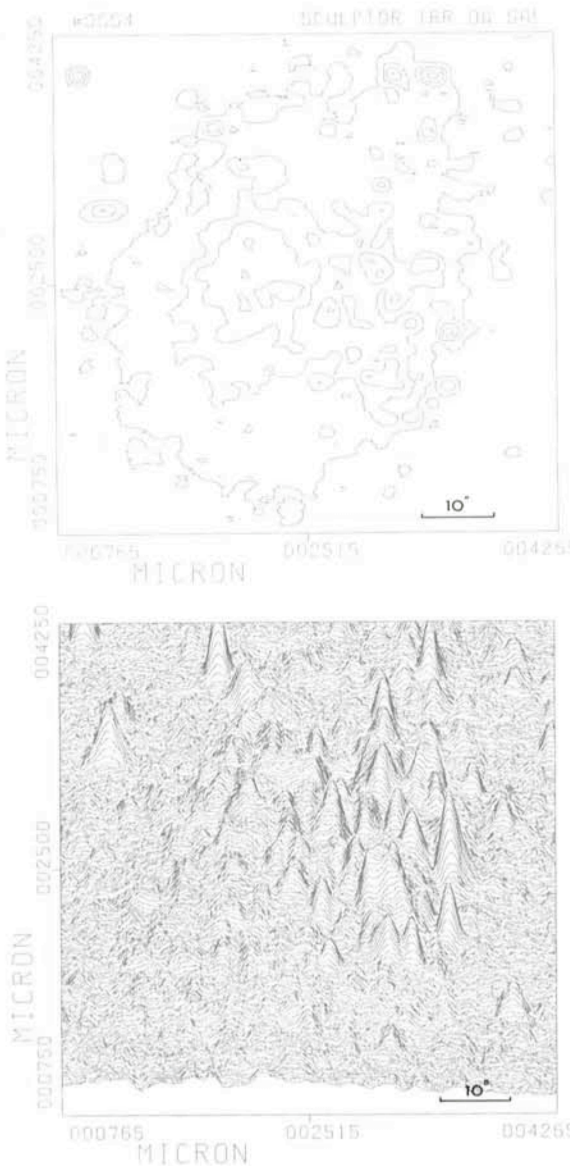
The details of the individual systems shall not be given here, but SZ Centauri is worth mentioning as it poses some interesting problems to theoreticians. The spectrum is A7 III and the masses ($\cong 2.30\ M_{\odot}$) are very nearly equal and known to an accuracy of 1 %. The primary minimum is a total eclipse and the luminosity ratio of the components is known very precisely. The photometric elements are derived by the classical Russell-Merrill method and by the modern model-simulation method by Wood. The two independent methods give consistent results and the radii of the two components are determined better than 1 %. The surface gravities are then also known very precisely (2 %). The temperature difference is small and well defined. Both of the components have left the central hydrogen burning phase, when comparing with standard evolutionary tracks. The tracks and isochrones are nearly horizontal in this phase and the stars move to the left at constant luminosity in the HR diagram. It is simply impossible to account for the observed luminosity (or gravity difference) of the components and the evolutionary tracks may perhaps be very wrong. However, the properties of SZ Cen are understood if there is mixing in a region much larger than the classical convective core. If this explanation is correct, we are forced to a considerable revision upwards of stellar ages. We are presently not very happy about this situation.

AI Hydrae

Finally another interesting system should be mentioned. At least one of the components of the eclipsing binary AI Hydrae is a δ Scuti star with a period of 0.138 day. For the first time we derive observationally a pulsation constant Q to an accuracy of 1 %. The Q value corresponds very precisely to a radial first overtone pulsation, showing that a least one δ Scuti star pulsates in a radial mode and not in a non-radial mode as preferred for δ Scuti stars by many authors during the last few years. The discussion of this system together with B. Grønbech is not yet finished.

TWO NEW IRREGULAR DWARF GALAXIES

During the past year, two new southern dwarf galaxies were discovered on ESO Schmidt plates. The first object, in the constellation Phoenix, was first believed to be a distant globular cluster (cf. *Messenger* No. 4, March 1976), but recent observations by American astronomers at the Cerro Tololo Interamerican Observatory now show the Phoenix

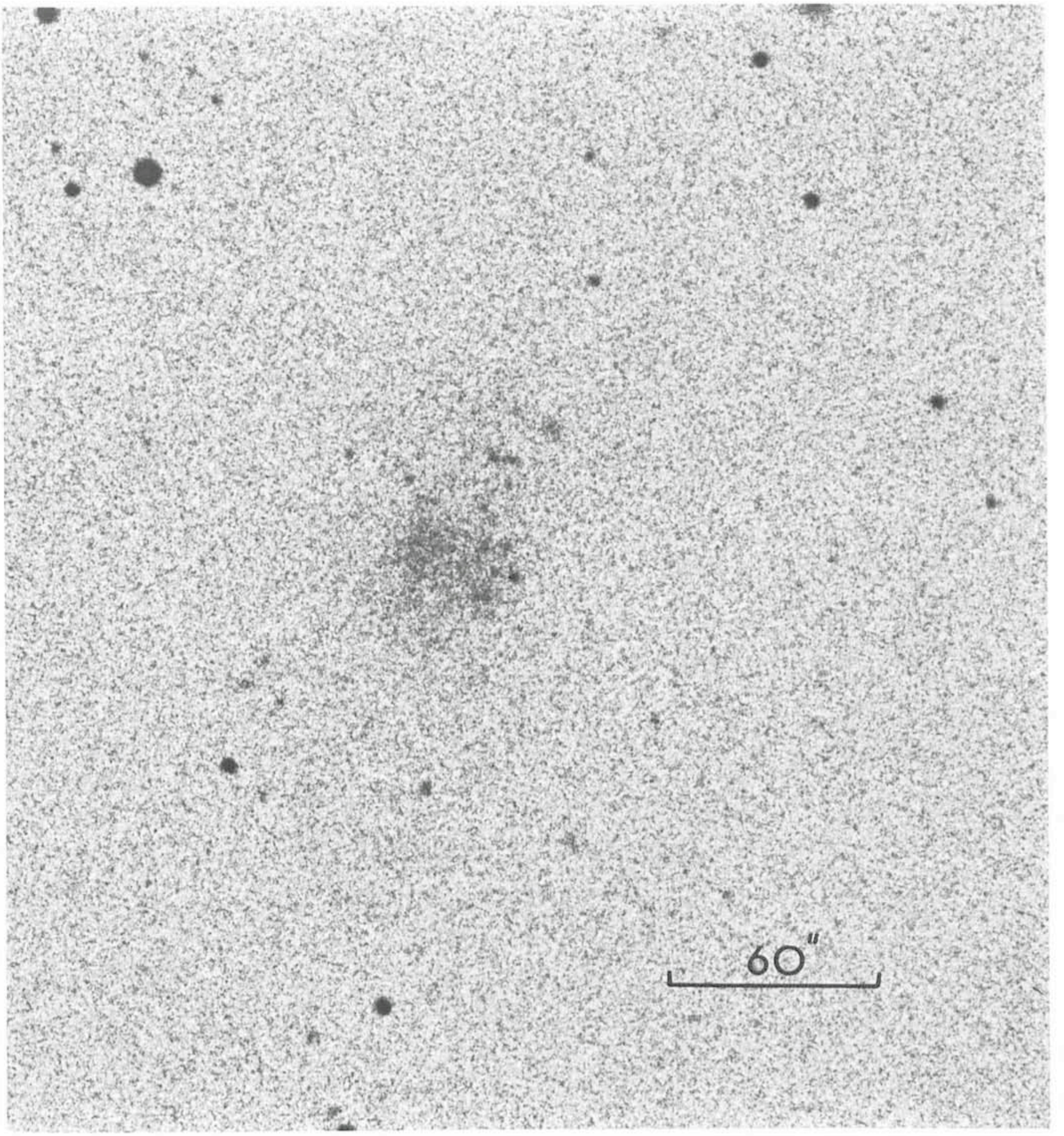


The analysis of astronomical photos involves much more than just looking at the objects on the plates. As an example, we show here a computer-drawn contour map of the Sculptor Irregular Dwarf galaxy, made from the photo on the frontpage of this issue of the *Messenger*. The upper part shows a smoothed isophote that corresponds approximately to the outer boundary of the galaxy. In the lower figure, the intensity across the galaxy is visualized by a three-dimensional (X, Y, density) plot. The higher the "mountains", the stronger the intensity. It is fairly easy to compare directly the photo and the drawing. The positions on the original 3.6 m plate are given in microns at the abscissa and ordinate axes. The plate was scanned by the S-3000 measuring machine at the ESO Sky Atlas Laboratory in Geneva (aperture 100 x 100 microns) and the measured densities were computer-processed in the ESO HP computer system by means of an interactive programme developed by Frank Middelburg. Such scans serve for many purposes: to determine the extent of the galaxy, to integrate the intensity over the whole surface, and to determine the magnitude of individual member stars are just some of these.

object to be an irregular dwarf galaxy at a distance of about 1.8 Megaparsec. The second object, in the constellation Sculptor, has just been observed with the ESO 3.6 m telescope and a preliminary analysis places it at 3 Mpc distance in the Sculptor group of galaxies.

THE SCULPTOR IRREGULAR DWARF GALAXY

This object was first found on a Schmidt plate, taken for the ESO (B) Survey on October 22, 1976 (see photo on this page). Although rather faint, it was partially resolved in stars and it was decided to use it as a test object for the 3.6 m telescope as soon as it was ready to take the first pictures. Three plates were obtained on November 9–11; the result may be seen on the front page of this issue. It is instructive to compare the Schmidt photo with that from the large telescope. The Schmidt plate reaches about $21^{m}.5$, but the 3.6 m plate goes at least $2^{m}.5$ fainter. Look how many of the diffuse spots on the Schmidt plate turn out to be galaxies. See the increased resolution in the galaxy into stars. No



An enlargement from the discovery plate for the new irregular dwarf galaxy in Sculptor. On the original Schmidt plate, 60 arcseconds correspond to 1 mm. Try to compare this picture with that from the 3.6 m telescope on the front page! The limiting magnitude of the Schmidt plate shown here is about $21^{m}.5$.

wonder that the astronomers are satisfied with the new giant telescope!

A preliminary analysis reveals that the brightest stars in the Sculptor Irregular Dwarf galaxy are blue, but that there are also several red stars that could be members. Assuming similarity to the irregular galaxy IC 1613 in the Local Group, ESO astronomers S. Laustsen and R. West deduce a distance modulus of about 27^m, in a report submitted to *Astronomy & Astrophysics* on November 24. The integrated magnitude has been measured as $V = 16^m.0$ with the ESO 1 m photometric telescope. It appears that the galaxy is a very small one, only about 1,000 pc (3,200 light-years) across, and with an absolute magnitude of only -11^m. This would make it one of the smallest and faintest irregular dwarf galaxies known to date, but further research, now being undertaken, is necessary in order to confirm this result. In particular, a search has been started for variable stars, that could possibly show up on the 3.6 m plates, just above the plate limit.

THE PHOENIX IRREGULAR DWARF GALAXY

Astronomers R. Canterna and P.J. Flowers from the Washington State University in Seattle obtained plates of this object with the 4 m Tololo telescope in August 1976. The first analysis indicated a distance of only 300 kpc, making the Phoenix galaxy a new member of the Local Group of galaxies. However, Canterna und Flowers find a great similarity between Phoenix and IC 1613 and obtain a distance of 1.85 Mpc (6 million light-years). It is significantly larger than the Sculptor Irregular Dwarf galaxy, 4,800 x 3,800 pc, and considerably brighter.

Like IC 1613, the Phoenix and Sculptor galaxies may become important stepping-stones towards the outer Universe. It is expected that both objects will be useful for the calibration of the distance scale, once they have been investigated in detail and their stellar content is better known.

How to Keep Hungry Heroes Healthy and Happy

Gastronomy on La Silla

When Captain James Cook served vegetable soup to his crew in 1770 it was not just because of philanthropy or his name. And although likening Cerro La Silla to an old-fashioned warship with its high stern (3.6 m) and low foredeck, may not stand up in all details, some basic problems are still shared with the great navigator. The isolation of La Silla (nearest port Coquimbo over 150 km away), the physical and mental strain from day- and nightwork during long (observing) runs, and the deserted, undulating surroundings could well be expected to have adverse effects on the morale of visiting astronomers and mountain staff. But happily, ESO is in a much better position than most other observatories to fight these natural evils, in particular because of its unique kitchen. "Good and healthy food need not be expensive" and "Food tastes as it looks like" are two of the axioms of German-born ESO Chef-cuisinier Erich Schumann, *who is also the* maître d'hôtel *"ESO La Silla" and a frequent contributor to international gastronomical journals. It is a proven and curious (but not necessarily disturbing) fact that many American astronomers react to the name of ESO by turning their eyes towards the heavens with an "Oh yes, that is where those Europeans have that real* cuisine française*!".*

With 25 years' experience, also from several major European restaurants, Mr. Schumann and his competent Chilean staff daily live up to their internationally established reputation and—with great care and insight—they prepare our stomachs and spirits for the hardships of a mountain observatory. These are Mr. Schumann's own words about some of the secrets of how to keep the ESO people happy and in good shape:

How to Start the Day .....

The day for the La Silla kitchen starts shortly before 7.00 when the first cooks arrive to prepare breakfast under the direction of Juan Fernández. Two kinds of juice (one is fresh orange juice, when oranges are in season), yoghurt, butter, cheese, different hams and sausages and two different marmelades complete the layout on the self-service counter. We also serve three kinds of bread; two are a German-type brown bread, flown in from Santiago twice a week with our daily air-service. Real good Brazilian coffee is prepared in the automatic coffee-machine, and we have tea, herb tea, milo *(para campeones!)* and fresh milk. Fried eggs with ham and bacon, scrambled eggs, omelette with ham, cheese, tomatoes, onions or whatever you like can be ordered to the waiter.

Many astronomers prefer a kind of heavy sandwich called *completo*. This is really something to restore lost energy after a busy cold night at the telescopes or when they wake up in the afternoon: two pieces of toast, topped with slices of baked ham, tomatoes and two fried "fresh farm" eggs.

For lunch and dinner, we serve dishes which must satisfy Chilean as well as European employees and astronomers from all over the world. That is not always easy:

Dinner begins at 18.00 in summertime and at 17.30 in wintertime. You may start with a little appetizer such as stuffed avocado with tuna fish, or diced chicken, ham or *langostinos* (jumbo shrimps).

Chilean Seafood!

Seafood is served very often on La Silla and is much appreciated by our guests. We buy fresh fish and seafood twice a week. It is always amazing to go to the markets in La Serena and Coquimbo and see the wide variety, just out of the Pacific Ocean: *congrio, corvina, cojinova, merluza, cabinza, sardinas, lenguados, atún* (conger-eel, seabass, cajinova, sardines, soles, tunafish). *Mariscos* are different kinds of mussels and shells which can be eaten raw with lemon or prepared in different ways. *Locos* (abalones) are delicious, either cold with different kinds of dressing, or warm with grated cheese and gratinated. *Erizos* (sea-urchins) are liked by people who prefer something fancy; they have a strong taste of iodine.

Ostiones (coquilles St-Jacques) are originally from the beaches of Tongoy and Guanaqueros. Only once a year can they be taken out of the ocean. That is in the wintertime when heavy waves loosen them from the sandy or rocky grounds, lift them up to the surface and throw them to the beach. This year we have had ostiones quite often, but until recently, it was prohibited to collect them commercially during almost 15 years, because the Fishing Department feared that the ostiones families might die out.

Of course, not everything will be on the market every day. Some fish are only in season when they come near the surface or near the coast. Fishing in the La Serena/Coquimbo area is done mostly by small boats, and when the weather conditions at sea are bad, there will be no fish on the market.

For La Silla we buy only the freshest merchandise.

What They Like to Eat

Here are some menu items and recipes of the favorite dishes we serve on La Silla:

Mariscos surtidos: choice of seafood either raw or cooked and served as salads, cocktails or together with tomatoes or avocados. Langostinos with a hot tomato, onion and pepperoni sauce.

Cordero de lechón (lamb) is very good when served from the grill (charcoal) with herb butter and baked potatoes and the delicious fresh green beans. When the summertime comes and the days are longer we serve a *parillada* outside in the patio. Mixed grill on hot charcoal is the summit of every Sunday night.

Caldillo de mariscos: a thick soup-bowl with all the variety of fish and seafood we can lay our "knives" on. I must admit that fish and seafood served or prepared without the famous Chilean wines are not the same. (A good fish-chowder without a glass of white wine is only half the pleasure, but on La Silla no alcoholic beverages are allowed.)

Pizzas: In winter we often serve a dozen varieties. Most ordered is the pizza "Portenno" with seafood, or pizza "El Padrino" with tomatoes, sausage, ham, sweet pickles, olives and two kinds of cheese. "El Padrino" (The Godfather) is the "undercover" name of a well-known ESO astronomer on La Silla who claims that he has seen Etna only on postcards!)

Congrio frito: deep fried conger-eel is one of the favorite dishes served in the dining-room. The fish is seasoned with salt, pepper, lemon juice, a little bit of crushed fresh garlic, turned over in flour, passed through beaten-up eggs and fried in deep oil.

Cazuela de vacuno, ave or *cordero:* A heavy, hearty meat, chicken or lamb soup-bowl with all kinds of fresh vegetables, noodles/rice or corn flour. A real dish for a cold winter day. On the side you may serve a fresh tomato salad with some chopped onions. (A good *vino tinto* would complete that luncheon.)

Seviche de corvina: a cold, hot-spiced, raw entrée of small diced seabass. You must take very fresh raw seabass, cut in small cubes, seasoned with lots of lemon juice, salt, pepper, hot Chilean peppersauce (called *salsa de ají*), some drops of good oil and put in the refrigerator for a couple of hours. Shortly before serving, mix with egg-yolk, garnish with chopped parsley and cilantro or chives. Serve cold.

Empanadas, also called stuffed turnovers with either minced meat, fish seafood or with chese. These empanadas are a must every Sunday or holiday in Chile. Minced meat and onions are cooked together with spices such as *orégano*. Once the meat is cooled off the turnovers are stuffed with that mixture. They are baked in the oven, or when you want them small, they are deep-fried.

Desserts

Cakes, pies and small pastry are served very often for dinner as a dessert, especially apple pie, lemon pie and sweet cheese cake.

A special Chilean fruit ist the *papaya*. It is small, of yellow colour and must be cooked in syrup. You cannot eat it raw. It comes mostly from the La Serena and Elqui valley area. The *chirimoyas* (sugarfruit) are in season from September to January. White fruit meat with small black stones inside. Very tasty and sweet. Served with orange juice or icecream.

Last but not least, a small variety of good cheese is always at choice in the self-service. In particular, the Chilean Camembert is very tasty.

We have of course many other dishes on the programme but I think that this gives the reader some idea obout our menus. We like to serve good and healthy food and are of course always happy to meet special diet requirements, whenever this is possible. Our level may not be compared to that of "Tour d'Argent" neither by the price, nor the selection, but considering our limitations because of our geographical position and our budget, I believe that we do help people to survive the Atacama desert and the visiting astronomers to return to Europe with a pleasant memory of the gastronomical life on La Silla.

Bon appétit!!!

Staff Movements

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

ARRIVALS

Munich

Christa Euler, German, administrative assistant
(transferred from Chile)

Geneva

Martinus Wensveen, Dutch, optical technician
George Contopoulos, Greek, astronomer (paid associate)
Daniel Kunth, French, astronomer (fellow)
Jean Manfroid, Belgian, astronomer (fellow)
Philippe Veron, French, astronomer (paid associate)
Dan Constantinescu, astronomer (fellow)

Chile

Gerhard Schnur, German, observing spectroscopist

DEPARTURES

Munich

None

Geneva

Leon Lucy, British, astronomer (paid associate)
Bob Sanders, American, astronomer (paid associate)
Gonzales Alcaino, Chilean, astronomer (paid associate)
Hernan Quintana, Chilean, astronomer (fellow)

Chile

Wolfgang Müller, German, construction engineer
Christa Euler (transferred to Munich)

(Editor's note: Applications for observing time on La Silla are received by ESO/Munich for period 20 (1.10.1977—31.3.1978) until April 15, 1977. Be sure to make a good case for your proposed programme since exceptionally many requests are expected this time.)

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. Seven telescopes with apertures up to 1.5 m are in operation; a 3.6 m telescope will become operational in 1976. 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) has recently moved from Hamburg to 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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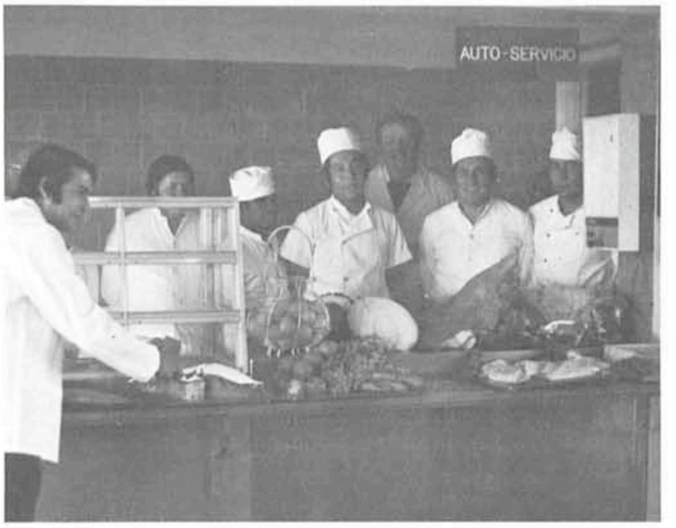

The kitchen staff on La Silla—ready for the battle.

El personal de la cocina — preparado para el combate.

ALGUNOS RESUMENES

Primera fotografía tomada con el telescopio de 3,6 m

Durante la noche del 7 al 8 de noviembre se tomó la primera fotografía con el telescopio ESO de 3,6 m.

El telescopio de Bochum explora el cielo austral

Tres naciones poseen telescopios nacionales en La Silla: Dinamarca (50 y 150 cm), la República Federal de Alemania (61 cm) y Suiza (40 cm).

El telescopio de Bochum, instalado en septiembre de 1968, es el más antiguo de ellos dando lugar a numerosas observaciones publicadas en no menos de 80 artículos aparecidos en periódicos de astronomía.

El telescopio se encuentra equipado con un fotómetro y otros equipos muy modernos. El control se realiza a través de un computador Hewlett-Packard del tipo 1224 B.

Los astrónomos de Bochum han observado principalmente estrellas luminosas en cúmulos abiertos, tanto en la Vía Láctea como también en las Nubes Magallánicas. Estas observaciones han contribuido considerablemente a ampliar nuestros conocimientos sobre la estructura espiral distante en el hemisferio austral de nuestra galaxia.

Un 30 % del tiempo de observación de cada año se encuentra a disposición de ESO y durante este período el telescopio y su equipo han sido utilizados por numerosos observadores de los países miembros de la ESO.

Gastronomía en La Silla

La Silla no tan sólo es famosa por sus excelentes condiciones de observación, sino también ha adquirido una reputación internacional por la excepcional calidad y variedad de su cocina. El señor Erich Schumann, cocinero jefe en ESO, y su competente personal chileno, ofrecen una variedad de comidas que pocas veces se encuentran en otros observatorios.

Algunos minutos antes de las siete de la mañana abre la cocina en La Silla, y entonces uno encuentra todo aquello con lo cual se desea comenzar el día: jugos, yogurt, mantequilla, queso, jamón y fiambres, diferentes variedades de pan, auténtico café brasileiro de la máquina, té y leche fresca. A pedido hay huevos fritos con jamón y tocino, huevos revueltos, tortillas con jamón, queso, tomates, cebollas y tantas especialidades más.

Los almuerzos y las comidas deben satisfacer tanto los gustos del personal chileno como también del europeo y astrónomos de todas partes del mundo. Esto no siempre es fácil conseguir! Frecuentemente se sirven mariscos en La Silla, muy apreciados por todos. Sólo se trae la mercadería más fresca — directamente desde el Océano Pacífico.

He aquí algunos de los platos favoritos que se sirven en La Silla: *Mariscos surtidos* — mariscos a elección, tanto cocidos como al natural, servidos como ensaladas, cócteles o junto a tomates y paltas; langostinos con tomate caliente, cebolla y salsa de pimentón. *Cordero de lechón* — servido a la parrilla con mantequilla y papas asadas acompañado de deliciosos porotos verdes frescos. *Caldillo de mariscos* — una contundente sopa con una gran variedad de pescados y mariscos. *Congrio frito.* Distintas variedades de *pizzas. Cazuela de vacuno, ave o cordero. Seviche de corvina* y *empanadas* de pino, mariscos o queso.

Para completar estos menús a menudo se sirven varios postres, y siempre cuando ésto es posible, el personal de cocina se encuentra pronto a dar cumplimiento con solicitudes de dietas especiales.