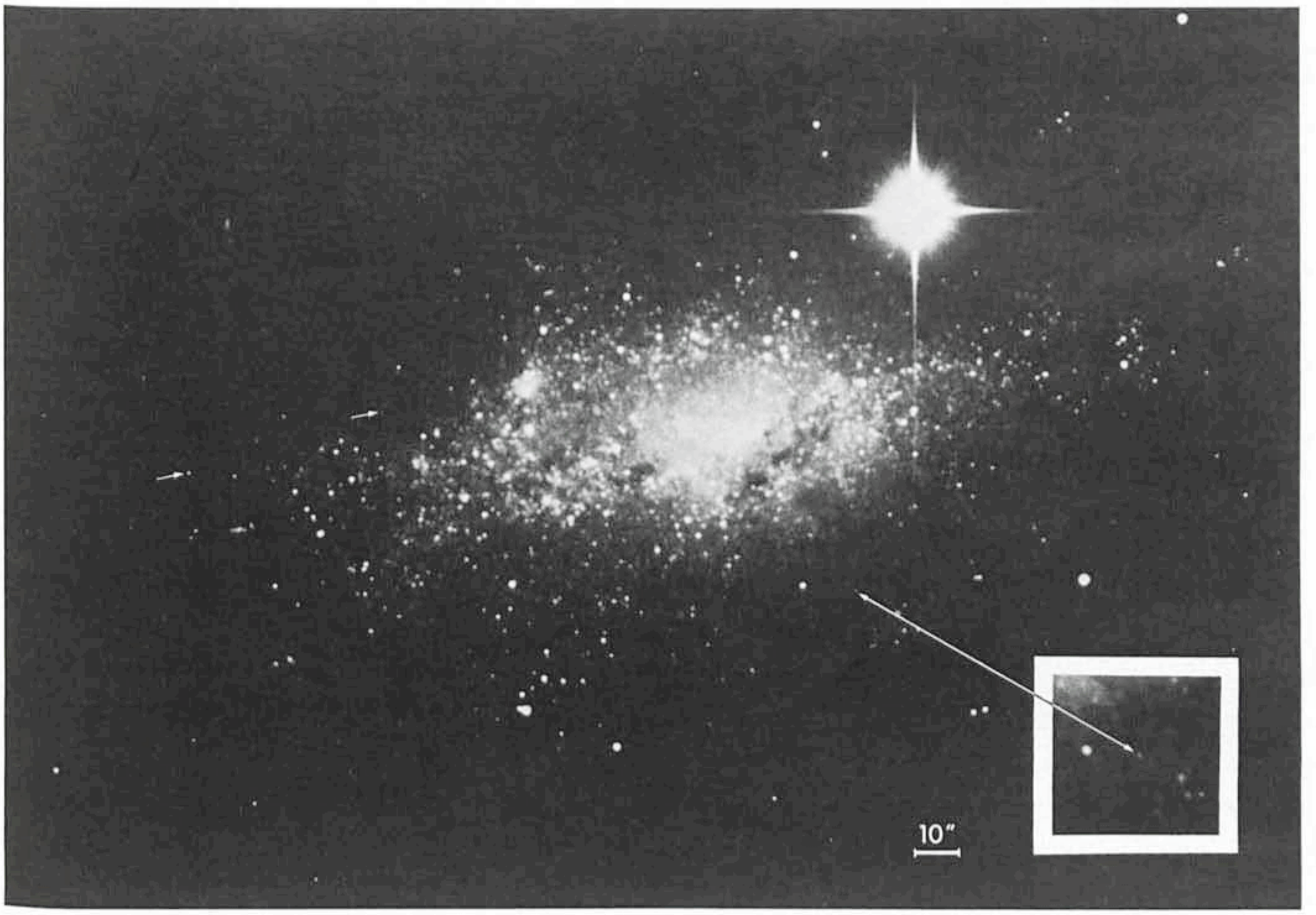
No. 11—December 1977

Variable Stars in IC 5152



This 60-minute exposure on blue-sensitive IIIa-J emulsion of the galaxy IC 5152 was obtained at the prime focus of the ESO 3.6 m telescope under excellent seeing conditions during the early morning of June 12, 1977. The galaxy is highly resolved into stars and a comparison of this plate with several others has revealed three variable stars (indicated with arrows). One of the variables is also shown (in the insert) on a plate from July 8, 1977. Although the seeing on July 8 was clearly inferior to that on June 12, it is quite obvious that the star is brighter on the later date.

The bright star northwest of IC 5152 is HD 209142 of 8th magnitude.

One of the best methods to determine the distance to a (nearby) galaxy is to measure the periods and magnitudes of the so-called cepheids in the galaxy. The cepheids are variable stars and they are found by comparing photographic plates of the galaxy from different nights. Drs. Svend Laustsen and Gustav Tammann from the Scientific Group at ESO/Geneva have just analysed such plates of the IC 5152 galaxy:

The southern dwarf irregular galaxy IC 5152 has so far not drawn much attention, although an excellent photograph by D. S. Evans (Photographic Atlas of Southern Galaxies, 1957) showed it to be highly resolved and therefore relatively nearby. In fact its corrected radial velocity is only $+ 5 \pm 30$ km s^{-1}, and since no field galaxy is known with such a small velocity it was concluded that IC 5152 must be a member of the Local Group (A. Yahil, G.A. Tammann, A. Sandage, 1977, *Ap. J.* **217,** 903).

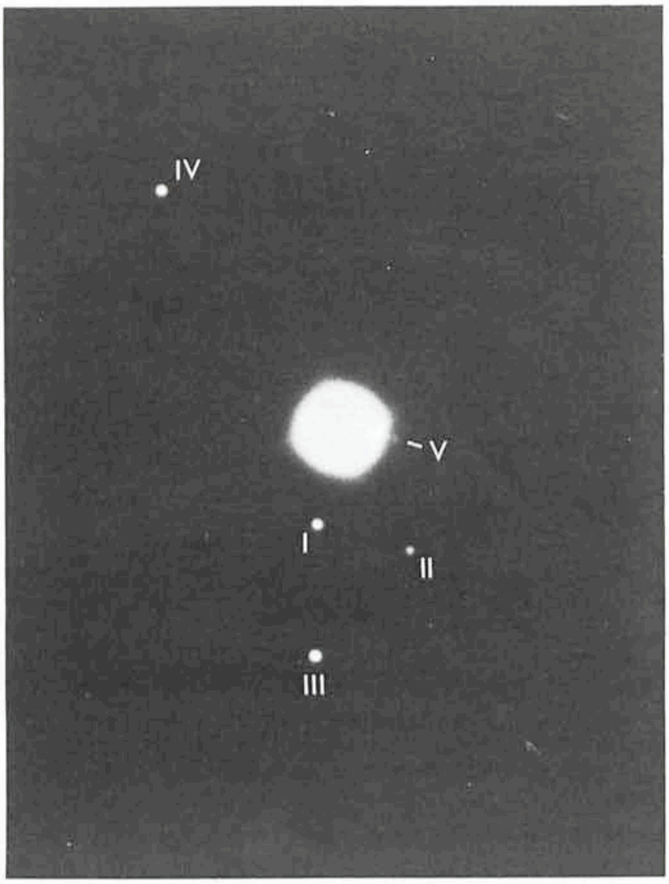
The first plates of IC 5152 taken in different colours with the 3.6 m telescope on La Silla not only show many blue and very red supergiant stars and a few extended H II regions—which were already observed by J.L. Sérsic (Atlas de Galaxias Australes, 1968)—but have also led to the discovery of the first three variable stars in this system. No period is known yet for these variables, but their colour, amplitude and the time scale of their variability make them good candidates for being cepheids.

A very rough estimate of the distance of IC 5152 gives 1.5 Mpc. At this distance its absolute magnitude is about -14^m to -15^m, which makes it comparable in size to the well-known Local Group dwarf IC 1613. The distance of 1.5 Mpc suggests that the Local Group is somewhat larger than the conventionally adopted radius of 1 Mpc.

Further work on IC 5152 is planned. It is hoped that this will lead to a more reliable distance determination, which will not only help to define the size of the Local Group, but also provide an important additional calibrator of the extragalactic distance scale.

The Satellites of Uranus and Neptune: A New Astrometric Programme

Observations are now being obtained at La Silla of the outer planets Neptune and Uranus. In order to determine exact positions of the satellites of these two giant planets, Drs. G. Ratier and O. Calame of the Pic-du-Midi Observatory in the French Pyrenees have recently used the ESO 1.5 m telescope. They give some preliminary information about their important programme:



A 20-sec exposure was recently obtained of Uranus and its five satellites by ESO astronomer W. Wamsteker, at the prime focus of the 3.6 m telescope. All satellites are well visible: I Ariel ($14^m.4$), II Umbriel ($15^m.3$), III Titania ($14^m.0$), IV Oberon ($14^m.2$) and V Miranda ($16^m.5$), the one closest to Uranus. The magnitude of Uranus is $5^m.7$ and the size of the disc 1.9 arcsecond (much larger on the photo because of the light diffusion on the photographic emulsion). The diameters of the satellites are poorly known, but are probably of the order of 1,000–2,000 km for I to IV and 500 km for V.

Since the discovery (on 10 March 1977) of a "ring system" around Uranus, the interest in the satellites of the outer planets has undergone a revival.

Prior to that date, it was well known that astrometric observations of the faintest satellites of these planets were suffering from large inaccuracies which lead to a poor knowledge of their orbits, i. e. the predicted positions were not always in good agreement with those actually observed. Numerical and classical theories were not working satisfactorily on a long-time basis. For this reason a cooperative programme was initiated in 1976 between CERGA (Grasse near Nice) and the Pic-du-Midi Observatory, in France, in order to obtain new observations of these objects. Good seeing conditions are, of course, required for the success of the programme. For Uranus and Neptune, it appeared that the best image quality would be obtained on La Silla, due to the negative declination of these two planets at the present time.

A two-step reduction technique is necessary to determine the coordinates (Right Ascension and Declination) of the satellites, since there is no chance of finding enough stars with accurately-known positions among the faint stars in the small field around the planets. Therefore, ESO Schmidt plates will be used to measure the positions of the faint stars in relation to the brighter, standard stars, and in turn the positions of the satellites can then be measured relative to the faint stars, ensuring the astrometric tie-in to the brighter (standard) stars.

Preliminary observations were made in June 1977 at the ESO 1.5 m telescope in Cassegrain focus with the modified 16 x 16 cm camera and the TV-guiding system. In spite of rather bad weather conditions, some useful plates were obtained. However, as a greater number of stars (i. e. a larger field) would ensure a better accuracy, we hope soon to use the new Danish 1.5 m telescope with its large-field Ritchey-Chretien optics.

Finally, it should be mentioned that great care is also needed in measuring the plates on a two-dimensional coordinate measuring machine. Tests are in progress to determine what kind of machine is the best suited, the PDS-system at CDCA in Nice or perhaps the ESO S-3000 in Geneva.

"Optical Telescopes of the Future"

The Organizing Committee informs us that the preparations for this ESO conference are proceeding well. It will take place at CERN, Geneva, on December 12–15, 1977. Prospective participants who have not yet announced their arrival are requested to contact Dr. R. N. Wilson, ESO c/o CERN, CH-1211 Geneva 23, Switzerland, as soon as possible.

The programme will start on Monday 12 December with a general introduction, followed by a review of conventional large telescopes. Tuesday, 13 December, will be devoted to Incoherent Arrays and Multi-mirror Telescopes. Wednesday, 14 December, deals with Special Techniques, Coherent Arrays and Interferometers, and the last day, 15 December, is concerned with Image Processing and Live Optics and a discussion of the Astronomical Implications.

The conference is the first major, international one of its kind and has attracted a large number of well-known astronomers and experts from all continents. It is expected that the Proceedings will be published soon after, following the tradition of earlier ESO conferences.

The X-ray Cluster of Galaxies Klemola 44

On October 17, 1977, three astronomers sat together at lunch on La Silla. One, Dr. Massimo Tarenghi—newcomer to the Scientific Group in Geneva—had just returned from the Interamerican Observatory on Cerro Tololo. Another, Dr. Anthony C. Danks, recently joined ESO/Chile, and the third was the editor of this journal. By chance, Dr. Danks showed some plates of the cluster of galaxies Klemola 44 which he had obtained a few nights before with the 3.6 m telescope. Dr. Tarenghi told that he had observed the same galaxies spectroscopically the night before at Tololo. An intense exchange of information resulted. The editor smiled happily and then made the inevitable suggestion . . .

So here is the essence of that discussion, summarized by Dr. Danks.

The X-ray equipment of the University of Leicester aboard the satellite Ariel V recently detected a new X-ray source A 2344-28. The new source was quickly identified with the galaxy cluster Klemola 44 by Maccacaro et al. (1977). The cluster is shown in figure 1, reproduced from a plate which was taken at the prime focus of the 3.6 m telescope at La Silla by ESO astronomer Anthony Danks.

It is interesting to see that several of the galaxies appear to share common envelopes which are likely areas from which X-rays may be emitted. It is from such photographs that a detailed morphological study of the region can be made.

A large number of X-ray sources are now identified with clusters of galaxies thanks to the satellites Uhuru and Ariel V. But as the number of X-ray clusters of galaxies grows larger, the astronomer grows more curious and asks: "What mechanism produces such X-rays?" Already in 1972, Solinger and Tucker proposed a "thermal-bremsstrahlung" model. They were the first to show that there exists a relationship between X-ray luminosity (L_x) and the cluster velocity dispersion (ΔV).

It was noted that the brightest X-ray galaxy clusters were also the richest (more galaxies per unit area on the plate). They argued that cluster richness must be related to space density which is a measure of the gravitational field and that the gravitational field in turn must manifest itself in the velocity dispersion ΔV.

The "thermal-bremsstrahlung" model predicting that L_x is proportional to $(\Delta V)^4$ was reasonably consistent with the observations. By using this model, the mass of the galaxy cluster can also be calculated from the observed X-ray flux and is generally larger than the sum of the masses of the galaxies in the cluster. This leads to the suggestion that the additional mass is in intra-cluster matter, and that the X-ray flux is due to this radiating matter. Some evidence for such intra-cluster matter can be seen in figure 1.

Since this interpretation was published in 1972 many new X-ray clusters have been discovered. Some of the more recent clusters contain relatively few galaxies, raising the question "Are other X-ray production mechanisms possible?".

It appears that Klemola 44 is such a case. Maccacaro et al. (1977) already noted that the velocity dispersion ΔV was too low to fit the Solinger and Tucker relationship. But their value of ΔV was based on measurements of only 8 galaxies in the cluster. More measurements were needed to be certain of the ΔV value and Chincarini et al. (1977) have now confirmed the low ΔV value with redshift measurements of 24 of the galaxies in Klemola 44. They have convincingly argued that an Inverse-Compton scattering of synchrotron electrons by the microwave background could produce the observed X-ray flux. Of course, a source of relativistic electrons is necessary, but it could easily be supplied by one of the cD galaxies in the field. Confirmation of this

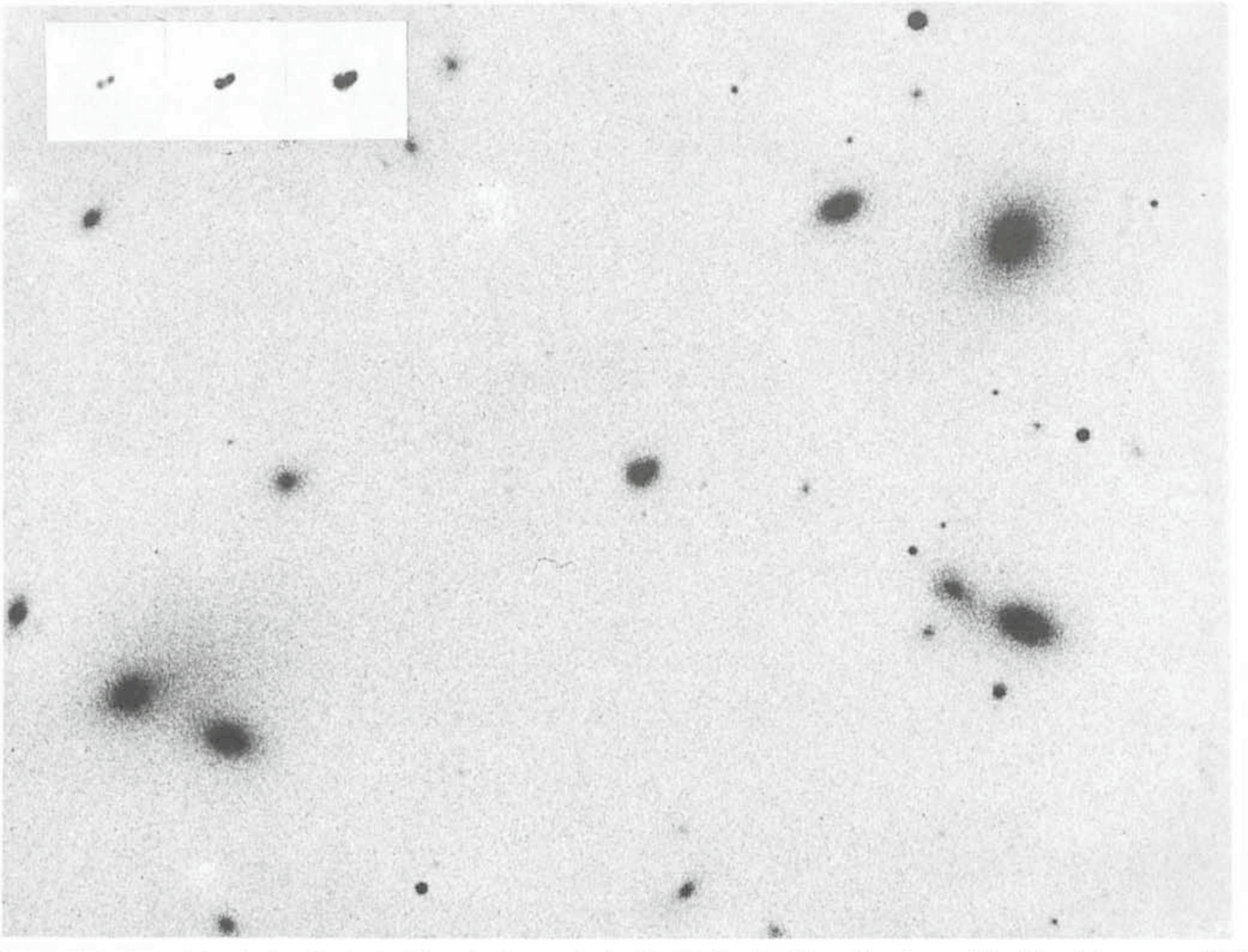


Fig. 1. — *This plate of the cluster of galaxies Klemola 44 was obtained by Dr. Danks at the prime focus of the 3.6 m telescope on IIa-O emulsion behind an ultraviolet-cutting filter GG385. Plate No. 985; exposure time 10 minutes. It is here reproduced in negative, i.e. as the original plate looks like, in order to bring out better the halos around the galaxy pairs. Note that the central object is a very close pair of galaxies, cf. the insert of that object printed at various central densities (from the same original plate).*

must await radio observations of the region. However, this is clearly a very exciting subject that brings together all fields of astronomy.

References:

Chincarini G., Tarenghi M., Bettis C., 1977, *Ap. J.* (to be published).

Maccacaro T., Cooke, B. A., Ward M. J., Penston M. V., Hayes R. F., 1977, M. N. R. A. S. **180,** 465.

Solinger A. B., Tucker W. M., 1972, *Ap. J.* **175,** L107.

Reference Positions of Southern Stars: PERTH70

A new catalogue, *Perth70,* containing one star per square degree has appeared: E. Høg and J. von der Heide, 1976, Abhandl. aus der Hamburger Sternwarte IX, and also available on magnetic tape from the Strasbourg Data Centre. The catalogue was observed about 1970 with a mean error 0.″17 and contains approximate proper motions giving positional accuracy of ± 0.″3 at the epoch 1980. The accuracy of the widely used SAO catalogue is about ± 1″.

Perth70 is part of an international effort to determine positions of a Southern Reference System (SRS). Altogether 12 observatories have taken part in the meridian-circle observations, and all observations are being compiled to a SRS catalogue by the US Naval Observatory in Washington and by the Pulkovo Observatory. Perth70 was observed by the Hamburg Observatory expedition to Perth, West Australia, from 1967 to 1972, directed by J. von der Heide. The meridian circle was equipped with a novel photoelectric slit micrometer developed at Hamburg and it had an automatic data-acquisition system so that reductions could keep up with observations with only a few days delay—quite a new situation for meridian techniques. The instrument has given 180,000 observations during its ten years at the Perth Observatory, where it continues to be used by I. Nikoloff.

The Perth70 catalogue contains 4,800 stars with $m < 8$ and $\delta < +35°$ and 20,100 faint SRS stars about $m = 9$ and $\delta < +5°$. This is 98 per cent of all SRS stars. The coordinate system is a smoothed FK4 system since some local systematic errors of FK4 have been removed.

There are 8,000 bright stars in the catalogue common with Boss' General Catalogue. For these stars improved proper motions are being derived at Copenhagen with errors about ± 0.″004 per year. This is part of a joint effort by Danish astronomers obtaining photometric data and radial velocities of bright stars. The improved space velocities will be used to study galactic structure. Erik Høg

A Search for Beta Cephei Stars in the Southern Hemisphere

C. Sterken, M. Jerzykiewicz

The present article is another illustration of new, exciting work in the southern hemisphere which is still largely unexplored when compared to the northern. Drs. Christiaan Sterken and Mikołaj Jerzykiewicz have during the past years been looking for new, relatively bright variable stars of the β Cephei type south of –20°. The observations were made by Dr. Sterken, who was formerly with ESO in Chile, and who will spend another year at the Landessternwarte Heidelberg-Königstuhl, FRG, before he returns to his native Belgium. Dr. Jerzykiewicz made the reductions with the ODRA 1204 computer of the University of Wroclaw, Poland.

One of the main reasons for studying β Cephei-type variables seems to come from the fact that the causes underlying their oscillations are still unknown. Other unsolved problems are the questions why the spectral range in which the β Cephei stars occur is so narrow, and why some of these stars appear to be periodic while others show complex frequency spectra.

The fact that all formerly known β Cephei stars are apparently bright is probably a selection effect, because it is in general relatively difficult to recognize short-period and small-range light or radial-velocity variations in fainter stars. The interesting discovery of the faint β Cephei variable HD 80383 by Haug (*The Messenger* No. 9, June 1977, p. 14), is a nice illustration that β Cephei stars do indeed occur among the apparently less luminous stars.

How to Find More β Cephei Stars?

The possible lines of attack the observers can follow in an attempt to help to solve the above-mentioned problems could either be to observe systematically the individual objects during long observing runs, or to try to increase the number of known β Cephei stars. About 25 β Cephei stars are presently known, and adding even a few ones would significantly increase the statistics of this type of stellar variability. Since the pioneer work of Walker (1952, *Astron. J.* **57**, 227), several programmes aimed at discovering β Cephei stars north of declination –20° have been carried out. However, south of this limit somewhat less effort was directed towards discovering β Cephei stars, and no systematic search of the Walker type has ever been carried out on the southern sky.

In order to fill in this gap, the authors started an observing programme with the purpose of detecting new β Cephei stars among the bright southern stars.

We first compiled a list of all stars south of declination –20°, which appear in the Catalogue of Bright Stars, and whose position in the HR diagram is the same or nearly the same as that of the presently known β Cephei stars. The boundaries of the region considered are shown in Fig. 1. The number of β Cephei stars for each MK type is indicated. Exactly 131 stars with declination south of –20° are situated in the area indicated. Twenty-six of these stars were dropped, either because they are well-known variables, or they were too bright for photometric observation (in this case it was impossible to find suitable comparison stars). For each programme star two nearby comparison stars with similar spectral type and brightness were chosen. Because telescope time was the limiting factor, a number of programme stars were purposely selected as comparison stars.

Observations on La Silla

During the first observing run in the period between November 24 and December 31, 1975 (32 nights) nearly one thousand photoelectric observations of 68 programme stars were obtained with the four-channel uvby photometer attached to the Danish 50 cm telescope at La Silla. The differential observations were programmed in such a way, as to make most likely the discovery of light variation with time scales of about three to seven hours. At least four measurements for the same triplet: "first comparison star – programme star – second comparison star" was obtained during a night, and care was taken that these observations were spaced not closer than about one hour. After some 20 measurements of the same triplet were secured, the star was dropped, and another triplet was selected for observing. In this way all observations of the same triplet were spread over a time span of several days.

Since the relatively large number of observations were obtained on photometric nights only, without changing the equipment, in a fraction of a single season, and by one person (C. S.), one may expect that the errors of observation are normally (Gaussian) distributed. We therefore calculated all standard deviations corresponding to the different series of magnitude differences between programme star and comparison star, and between the comparison stars themselves.

Fig. 2 shows the frequency histogram of the standard deviations of all "b" measurements taken at airmasses not exceeding 1.3, i. e. within 40° from zenith. The distribution shows a fast increase from nearly zero to a quite well-defined maximum, followed by a much slower and rather

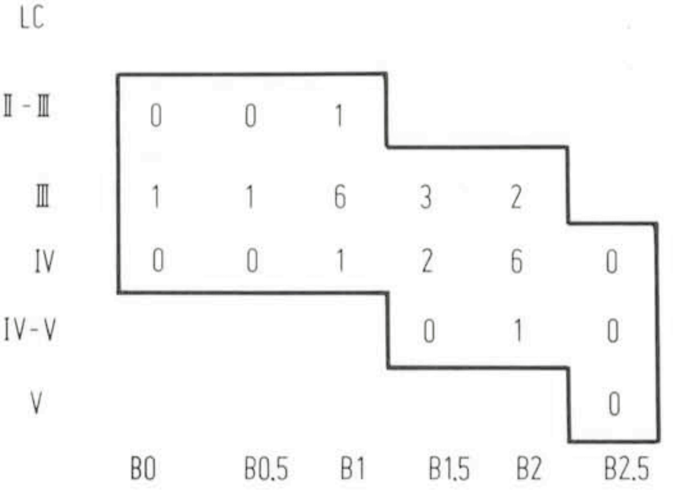


Fig. 1. — *The distribution of known β Cephei stars in the spectral type luminosity class diagram. Numbers of β Cephei stars for each MK type are indicated.*

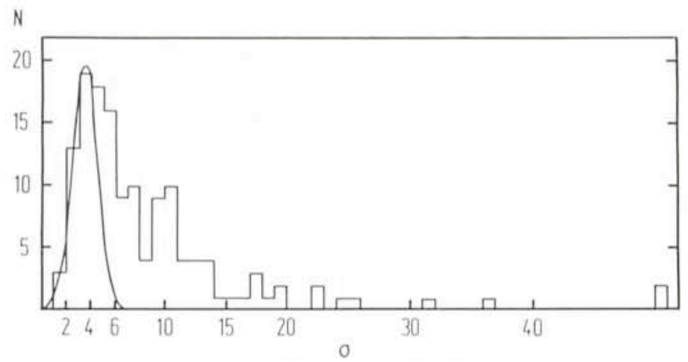


Fig. 2. — *Frequency histogram of standard deviations of the magnitude differences in the "b" filter obtained from observations taken at airmasses smaller than 1.3 (the unit of σ is 0.001 mag).*

irregular descent. The diagram can be regarded as a combination of a normal frequency curve, with its centre located at the observational average mean error, and a flatter, somewhat irregular one, generated by the observed distribution of intrinsic variability. Assuming that the portion of the frequency histogram to the left of maximum gives a reasonably good approximation of the observed error distribution, we estimate that the average mean error of a single magnitude difference is equal to $0^m_{\cdot}0035$.

Sorting Out the Variables

Once the average mean error of a single measurement was known, we were able to classify the magnitude differences into three categories, viz. *constant*, *doubtful* and *variable*, according to the size of the largest deviation from the mean. We considered as constant such series of magnitude differences in which the deviation never exceeded two average mean errors. If in a series of magnitude differences there occurred deviations equal to or greater than three average mean errors, we classified the magnitude difference as variable. The intermediate cases were labeled as doubtful.

Next we identified as constant all stars which occur in magnitude differences classified "constant". Many of these constant stars were also included in the "variable" magnitude differences, so we could in some cases unambiguously identify the stars causing the variations. However, an unambiguous assessment of the degree of variability was not always possible, and we have to wait for more information from future observing runs. It must be stressed that only measurements obtained at airmasses smaller than 1.3 were used for deciding about the variable or non-variable character of a star. Measurements taken at high airmasses (but not exceeding 2.0) were only used to complete the light-curves and to get a better idea about the character of variability present.

Table 1 gives the distribution of light variability obtained so far. The doubtful cases also contain the 20 cases for which the magnitude differences show that at least one or two stars from the triplet are variable, but where we could not decide *which* of the three stars cause the variability.

The amplitudes and the time scales of the variations present in the 13 variable programme stars indicate that probably no more than four stars are serious candidates for β Cephei membership. One of them (HD 64722; B1.5 IV) shows typical β Cephei-type light variation with a very short period of $0^d_{\cdot}1160$. The observations of HD 64722 are shown in Fig. 3 as a function of phase in the $0^d_{\cdot}1160$ period. Zero phase corresponds to Julian Date (JD) 2442742.

The 37 remaining programme stars were observed in a similar way during 18 nights between June 15 and July 3, 1977. Unfortunately the weather conditions were rather poor during the run, and we could not obtain a similar amount of measurements as earlier. However, the material is also homogeneous (for every programme star about eight to ten measurements were obtained), and we expect to derive preliminary conclusions very soon.

Table 1. — *Distribution of light variability from the first sequence of measurements obtained in 1975*

	constant	variable	doubtful
68 programme stars	21	13	34
42 non β Cep box stars	23	11	8

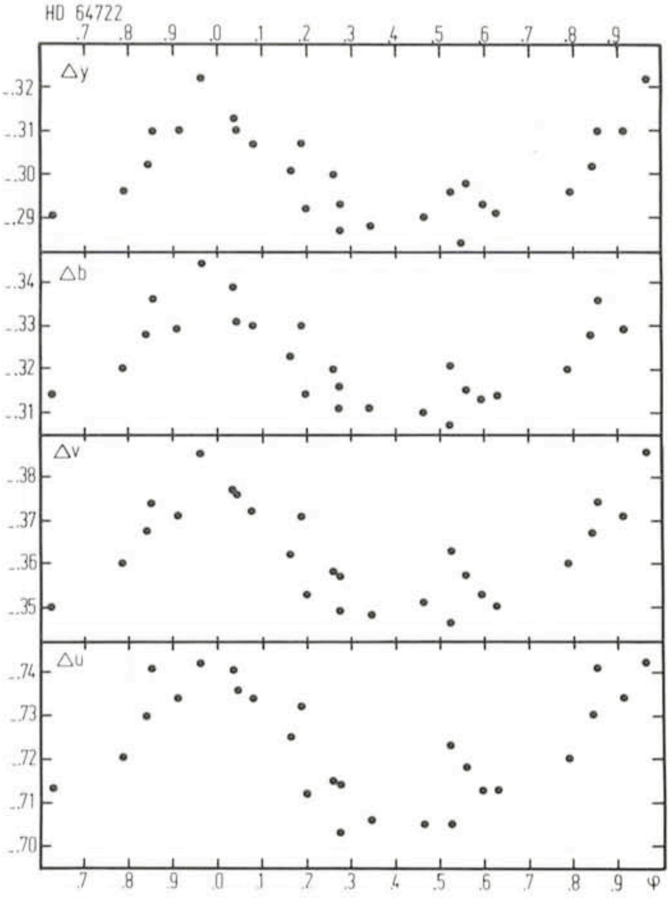


Fig. 3. — *y, b, v and u differential observations of HD 64722 plotted as a function of phase in the $0^d_{\cdot}1160$ period. Zero phase corresponds to JD 2442742.*

Future Plans

So far the first goal of the project has been reached: the variable and non-variable objects in the β Cephei box were singled out. The second part of the programme consists of a systematic follow-up of the candidates which we found during the first runs, in order to get a complete description of the light-curves (eventual beat periods). A first attempt will be undertaken during an observing run at La Silla between November 27 and December 17, 1977. We hope to be able to confirm the β Cephei membership of some of the candidates by means of simultaneous spectrographic and photometric observations.

Besides valuable information about β Cephei stars, our programme has yielded an enormous amount of data concerning other types of new variables. Until now at least 30 new bright, variable stars have been discovered, and we hope to be able to get complete light-curves in the near future. Further observation runs are planned for April 1978, December 1978 and April 1979.

At the time when this long-range programme will be accomplished, almost all northern and southern B0 – B2 stars brighter than magnitude 6.5 will have been checked for β Cephei membership, and a more homogeneous sample will then be available for statistical investigation.

Vertical Extinction on La Silla

H. Tüg

Among the many factors that determine the quality of an observatory site, two are crucial. These are the seeing *(how much the light from a celestial object is spread out during the passage through the Earth's atmosphere) and the* extinction *(how much the light is weakened during the passage). It has long been known that La Silla is among the best sites in the world what concerns seeing but it is only recently that a major study has revealed that the La Silla extinction is very small on good nights. Dr. H. Tüg from the Astronomical Institute of the Ruhr University in Bochum, FRG, spent several months on La Silla in 1974–76 with his "black-body" platinum oven which will still be remembered as the "new star" next to the water tanks, where the Swiss telescope is now situated. As a result of his work, we can now give quantitative figures for the extinction at ESO.*

"Bad data are better than no data!", says the desperate visiting astronomer attempting photometric work through clouds. Scheduled only for a few nights, weather always becomes important. The measurements of vertical extinction are the best indicator for the quality of a night. From this point of view we try to give an answer to the questions "What is a good night on La Silla?" and "How good is good?".

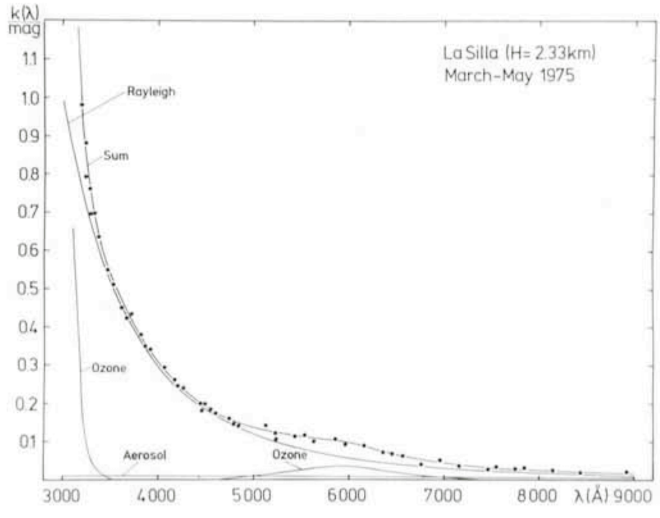
For the last decade, ESO meteorological reports show a mean of 225 photometric nights per year, which is 62 % of the total number of nights. A photometric night is characterized by ESO as "six or more hours of uninterrupted clear sky". For La Silla extinction coefficients were only known from measurements in common filter bandpasses (e. g. C. Sterken, M. Jerzykiewicz, *Astron. Astrophys. Suppl.* **29,** 319, 1977) but not over the whole optical region.

During calibration work from 1974 to 1976, when the spectral energy distribution of southern standard stars was measured by comparison with black bodies, extended extinction measurements were undertaken with the 61 cm Bochum telescope using a photoelectric rapid spectrum scanner. The high accuracy of the experiment demanded excellent nights. Normally three extinction stars of early type were observed between airmasses 1 to about 2.5, one star rising, one star setting, and a third star, close to $\delta = -60°$, observable almost the whole night and which passed the meridian at about midnight. The wavelength region was 3000–9000 Å with a bandpass of 10 Å in the blue und 20 Å in the red region. The extinction coefficients were calculated in steps of 50 Å using the Bouguer method. Regions with strong lines were omitted.

Neglecting also the absorption bands of atmospheric oxygen and water vapour, the total extinction of even a clear, cloudless sky consists of three components: Rayleigh scattering, ozone absorption and aerosol scattering. Each component has its own wavelength characteristic. The amount of Rayleigh scattering depends only on air pressure and therefore on the altitude of the observatory. The ozone is concentrated in the stratosphere between 10 and 35 km, so that its contribution is independent of the observatory point, but the concentration varies with latitude and season, sometimes over time scales of hours. The aerosol scattering is due to solid particles and liquid droplets of any size which remain suspended in the air. Most of these particles are small liquid droplets resulting from condensation of water on very small hygroscopic nuclei. Others are the solid or liquid products of combustion not acting as nuclei. The size of aerosol particles cover the range from 10^{-3} to 10 μ, which indicates that their behaviour in incident light cannot be described by a simple theory.

The extinction due to Rayleigh scattering and ozone can be calculated quite accurately for any observatory location. So the aerosol scattering is determined by subtracting these two amounts from the total observed extinction. This procedure, which is described in more detail by Hayes and Latham (*Astrophys. J.* **197,** 593, 1975) was applied for calculating the aerosol extinction for La Silla. The figure shows the extinction coefficient in mag/airmass for all three components separately against wavelength. The sum is given by a least square fit of the measured values. While the aerosol extinction changes slowly by wavelength, ozone shows a sharp cut-off at 3200 Å and an additional bump at 6000 Å. This bump deforms the resultant curve in a manner which cannot be seen in extinction curves resulting from filter measurements.

Extinction measurements were made during three observing periods with a total number of 41 photometric



nights. No clouds were detected during these nights, except low sea-level clouds above the Pacific, which do not affect the sky above La Silla.

Year	Period	Photometric nights
1974	August 15–September 2	4
1975	March 20–May 12	19
1976	November 1–December 10	18
	Total:	41

But the determination of nightly extinction coefficients revealed that only 27 of them ($\sim$ 65 %) were of the required quality. The extinction for these so-called "good nights" did not differ by more than 2 % (at 5000 Å) from the curve given in the figure. This was determined from the mean of 19 "good nights" during the period March 20 to May 12. The mean of the other two observing runs agreed with this result to $\pm$ 0.005 mag/airmass (at 5000 Å). The points are measured values to illustrate the typical fluctuations for only one star in a "good night". Fourteen nights showed higer values of extinction and were not useful. Because Rayleigh scattering could not have changed (constant air pressure) and the ozone is limited to fixed wavelength regions from the shape of the total extinction curve, it was obvious that this was definitely due to aerosol scattering.

The most surprising result is that the contribution of aerosol in "good nights" is only 0.01–0.02 mag/airmass, although the soil on La Silla is dry and the wind is sometimes rather strong. No observatory is known in the northern hemisphere with a comparably low extinction. The best observing sites in California and Arizona show 0.05–0.10 mag/airmass aerosol extinction. Considering the number of photometric nights and the observed transparency of the sky, La Silla is one of the best observing places in the world.

We can summarize our experience with extinction measurements by the following statements:

1. If a cloud was visible during the daytime, either before or after a clear night, this night had to be omitted.
2. Condensation trails from aircraft visible on a blue sky, even for seconds, indicated unstable layers in the higher atmosphere and gave rise to uncertain nights.
3. No correlation was found between the extinction coefficients and the direction of observation.
4. Sometimes cloudless nights showed higher extinction but good stability. In this case the aerosol must be spread out uniformly around the sky.

The author wishes to express his gratitude to Dr. W.A. Sherwood, Dr. A.F.J. Moffat and Prof. J. Hardorp, who were helpful in collecting the extinction data during the calibration work.

High-dispersion Investigation of the Nucleus of NGC 253

M.-H. Ulrich

Dr. Marie-Hélène Ulrich is a well-known authority on emission-line galaxies and comes originally from the Observatoire de Paris, France. She has worked for a long period in the USA, at the University of Texas, Austin, and recently came back to Europe to join the ESO Scientific Group in Geneva. She here discusses the nearby galaxy NGC 253 and shows how optical, infrared and radio observations come together in a model of this very interesting object.

The nearby galaxies are particularly interesting because they are the ones which can be studied with the best linear resolution. Among the galaxies which are at distances less than $\sim$ 5 Mpc, there are a few galaxies which are truly exceptional such as M82 = NGC 3034 and NGC 5128 = Centaurus A. Other galaxies show mild cases of activity which may represent normal but short stages of the evolution of galaxies. For example, M81 has a very compact, flat-spectrum central radio source of low absolute luminosity; in M31 the ionized gas shows non-rotational motions of small amplitudes. Another very informative case of activity in a galactic nucleus is provided by the Sc galaxy NGC 253 (fig. 1). The main signs of activity are (i) motions of the gas indicating that gas is escaping from the central region and (ii) extremely intense infrared radiation emitted by the nucleus. The results of recent spectrographic observations of NGC 253 (M.-H. Ulrich, 1978, in press) are briefly outlined below.

NGC 253 is at 3 Mpc and its heliocentric systemic velocity is 250 km s^{-1}.

Spectrograms of the central region of NGC 253 were obtained with the RC spectrograph of the 4 m telescope at Kitt Peak National Observatory, Arizona, USA. One of the spectrograms is shown in figure 2. On the original plate the dispersion is 54 Å/mm^{-1} and the scale perpendicular to the dispersion is 25 arcsec/mm^{-1}. The set of spectrograms reveals departures from rotational motions in the south-east quadrant with apex at the nucleus. In particular on spectra taken along the minor axis, the velocity of the gas is definitely smaller than the systemic velocity indicating that gas is flowing out of the nucleus and towards us. The velocity field observed from measurements along the emission lines of the ionized gas is in excellent agreement with the velocity field mapped by interferometry of H I 21 cm observed in absorption in front of the continuum source (S. Gottesman et al., 1976, *Ap. J.* **204,** 699). No velocity larger than the systemic velocity is observed in the atomic gas, ionized or neutral. In contrast, the molecular lines of H_2CO and OH show both higher and smaller velocities than the systemic velocity. This suggests a model for the gas in the nuclear region where the gas in its densest form, i. e. molecular gas, is expanding but is still in the region emitting the radio continuum whereas the atomic gas is outside the continuum source. In this model, the part of the atomic gas flowing out of the nucleus and away from us is behind the continuum source and therefore cannot be seen in H I 21 cm absorption, nor can it be seen in the optical emission lines because of the absorption by dust in the equatorial plane.

Fig. 1.—*Photograph of NGC 253 with the ESO Schmidt telescope (IIa-O + GG385, 60 min).*

It would be particularly interesting to conduct a spectrophotometric study of the ionized gas flowing out of the nucleus. Relative line intensities can provide the reddening—which is probably small since the gas is outside the equatorial plane—and the density of the gas. This information combined with a measure of the absolute intensity of one of the lines would allow to calculate the mass of the ionized gas escaping the nucleus. The temperature cannot be determined because [O III] 4363 is very weak; however, the mass of the emitting gas is only a slow function of the effective temperature T_e. Such an investigation is planned for the autumn of 1978 using the IDS scanner of the ESO 3.6 m telescope.

In an exploratory step towards such an investigation, the absolute intensity of Hα in the nucleus of NGC 253 has been estimated by comparison with M82 for which absolute spectrophotometry exists. Using this estimate, the rate of mass loss from the nucleus of NGC 253 is approximately 10^{-2} $M_{\odot}$/year. It can be shown that 1,000 O6 stars in the central region can provide the ionizing flux necessary to keep this outflowing gas ionized and also provide the mechanical energy to accelerate it above the velocity of escape. The presence of this large number of young stars is consistent with the infrared luminosity observed by G. Rieke and F. Low (*Ap. J.* **202,** 197, 1975) between 2 and 30 μm. It can also be argued that the present rate of star formation cannot last for the entire life of the galaxy; otherwise the nucleus would lose most of its mass and it is tentatively concluded that there is now an outburst of star formation. Clearly, this very informative galaxy deserves further study which should enable one to reach definitive conclusions regarding the above important points.

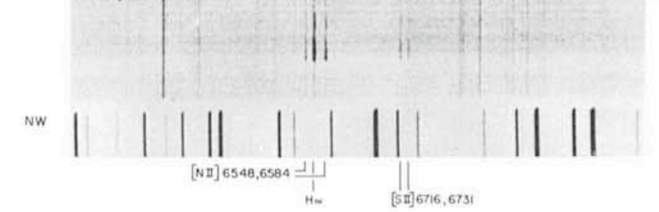


Fig. 2.—*Spectrogram of NGC 253 taken along the minor axis and crossing the major axis at 15 arcsec north-east of the nucleus.*

OH/IR Sources as an Example of a Successful Simultaneous Radio and Infrared Programme

Drs. E. Kreysa, G.V. Schultz, W.A. Sherwood and A. Winnberg from the Max-Planck-Institut für Radioastronomie (MPIfR) in Bonn have during the last two years simultaneously observed OH/IR sources at the 100 m Effelsberg and the 1 m ESO telescopes. G.V. Schultz reports about the results which open the door to further exciting investigations:

In the *Messenger* No. 6, September 1976, W.A. Sherwood reported on the successful discovery of infrared counterparts of type II OH/IR sources previously found in the Onsala OH survey by A. Winnberg et al. The frequency of discovering the IR counterparts was about 50 % at that time. In the meantime our detector has been improved in sensitivity by E. Kreysa and our frequency of detection with the new photometer has risen to 80 % of a sample of 40 OH sources without having to use a larger telescope.

However, we are now limited at 3.7 μm (by background radiation) to 9^m with a signal-to-noise ratio of one in one-second integration time and only a larger telescope can increase the discovery rate. On the other hand at 2.2 μm we improved the sensitivity in August 1977 to $11^m.7$ and still we are not at the background limit, i. e. we can improve the sensitivity between 1.2 μm and 2.2 μm without using a larger telescope. This value of $11^m.7$ allows us to estimate the limiting magnitude for a 15-min integration time to be $15^m.4$ or with the 3.6 m telescope to be $18^m.2$ between 1.2 and 2.2 μm in the absence of source confusion.

Having discovered an infrared source near the position of an OH source, one cannot be certain that it is really the IR counterpart of the OH source due to the positional errors of the radio and optical telescopes. Hence, we began to observe 15 out of these type II OH/IR sources two years ago simultaneously or quasi-simultaneously at the 100 m telescope in Effelsberg and the 1 m ESO telescope, approximately every 6 months. What we found is not only interesting but, in one point, extremely exciting. First, there is a general correlation between flux changes in the OH lines and in the IR band. This confirms our identifications of the IR sources as the counterparts of the OH sources. Second, we can determine different phase lags between the 1612 MHz line, the 1667 MHz lines and the IR radiation and third, we have found that there is also a phase lag between the high and the low velocity components of the 1612 MHz line of about twenty days.

The simplest model is a long period variable M star which is surrounded by expanding dust and molecule shells. All changes in flux of the star caused, for example, by variations of the surface temperature arrive at the same time at the shell, if the shell has spherical symmetry (not required in a more detailed study) with the M star at the centre. The excited OH radiation, however, has different travel times to reach the observer depending on whether it comes from the front or the back sides of the shell. A phase lag of 20 days means that the radiation from the backside requires 20 days to cross to the near side and that the diameter of the OH-molecule shell has a value of $6 \cdot 10^{16}$ cm which is the first direct observational support for the value used in the calculations of Goldreich and Scoville (*Ap.J.* **205,** 144 and 384, 1976).

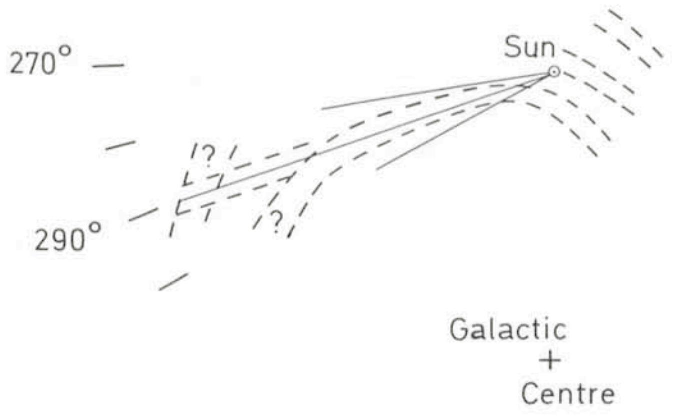
To determine the radius (or radii) of the shell, one has to measure the relative intensities of the two components carefully and many times during one cycle. This method also opens up the possibility of determining the distances of the sources if one combines the determination of the shell radii with interferometric determinations of the exact positions of maser points around the star. On the other hand, measurements of the energy distribution in the infrared wavelength region allow the temperature of the dust to be determined as well as the radius of the dust shell if the distance is known. By comparison of the radii of OH and dust shell, one may be able to see how the molecules and dust are distributed with respect to the star.

This example should show how valuable the combination of radio and IR measurements is.

Photometry of OB Stars in Carina

The spiral structure of our Galaxy has for many years been mapped by radio observations of the hydrogen 21-cm line. Similar optical observations are severely influenced by the absorbing interstellar matter in the plane of the Milky Way and we know comparatively little about the distribution of stars beyond some kiloparsecs. However, investigations of faint (and therefore mainly distant) hot OB stars in the direction of the Carina spiral arm now give a more accurate picture of this feature. Dr. Stig Wramdemark of the Lund Observatory in Sweden last year published the results of earlier observations at La Silla. He here gives an up-to-date summary of his latest observations:

The study of the spiral structure in our own galaxy is a very difficult task, primarily because of our position near its plane. From studies of other spiral galaxies it is found that good spiral tracers (i. e. objects that outline the spiral arms) are OB stars, H II regions, long-period Cepheids, late-type supergiants and Wolf-Rayet stars. A study of these young stars in our own galaxy shows that we are situated on the inner side of a spiral arm, the Local arm. The most conspicuous arm in the northern hemisphere is the Perseus arm, situated 2–3 kpc outside the Local arm. In the southern hemisphere the Sagittarius arm is probably connected with the Carina arm. A thorough study of more than 400 OB stars brighter than $V \approx 11.5$ in Carina was made by Dr. John Graham (*Astron. J.* **75,** 703). The stars have distances between



Geometry of the Carina spiral feature. The three directions in which observations were obtained are indicated on the figure.

1 and 8 kpc from the Sun. He also found that we are looking along the Carina arm at galactic longitude l ≈ 290°.

During three observing runs at La Silla (1974, 1976 and 1977) I studied some fields in the Carina direction. One area at l = 280° is situated just outside the Carina arm, another (l = 290°) contains objects belonging to the arm, and a third area (l = 298°) cuts through the arm.

Only OB stars were studied, since they are by far the most numerous ones and consequently the best for statistical treatment. Furthermore, their luminosities and intrinsic colours are fairly well known. The OB stars were measured in UBVβ. To discover fainter stars than those investigated by Graham, three-colour photographic survey plates were used for detection (U, B and V exposures were made on the same plate with slight displacements between the exposures).

Two fields along the arm, one in the plane and the other one degree below it, were examined. The results (*Astron. and Astrophys. Suppl.* **23,** 231) show that there are OB stars in both areas with distances from 1.5 to 15 kpc. About 40 of them are situated between 10 and 15 kpc. One may ask if these stars are members of the Carina arm, or if the arm bends inwards at a distance of about 6–9 kpc, as suggested by some investigators. Another possibility is that these stars are members of an outer arm as found from 21-cm radio data. This arm could be an extension of the Local arm or of the Perseus arm. It seems clear that the interstellar extinction does not increase very much from 2 to 6 kpc. Thus, in spite of the large number of young stars, practically no absorbing matter is found. An increase of the matter density occurs suddenly at 6 kpc. The increase is more pronounced in the plane than below it. This could partly explain why several investigators suggest a bending down of the Carina arm at larger distances.

A maximum of OB stars between 2 and 4 kpc displays the position of the Carina arm in the direction l = 298°. Very few stars have distances less than 1.5 kpc, which means that no connection is found between the Local arm and the Carina arm in this direction.

At l = 280°, on the other hand, a large number of OB stars were found within 1 kpc from the Sun, and the density of absorbing matter is comparatively high. This region is probably a part of the Local arm.

To get more information about the positions of spiral arms in our galaxy, the measurements of OB stars should continue. Furthermore, the spectra of some stars should be examined. In each of the studied areas there are stars with extremely high colour excesses. There may be a reason that cannot be explained from UBVβ photometry. There is another group of stars warranting a more careful examination. These come out with distances larger than 10 kpc, and since their galactic latitudes are higher than 2°, I derive distances from the galactic plane larger than 350 pc. Implicit in the reasoning is the assumption that the stars have luminosities of normal OB stars. That assumption cannot be refuted from UBVβ studies alone.

Three New Comets

The ESO 1 m Schmidt telescope has been involved in the discovery of three new comets since the last issue of the *Messenger*. One, P/Comet Schuster (1977o) is a "real" ESO comet; the two others, P/Comet Chernykh (1977l) and P/Comet Sanguin (1977p) were confirmed with this telescope, after they first had been sighted in USSR and Argentina, respectively.

Periodic comet Chernykh was found by soviet astronomer Dr. N. S. Chernykh at the Crimean Astrophysical Observatory on August 19, 1977. It was some time before the news reached La Silla, via the Bureau of the International Astronomical Union in Cambridge, Mass., USA. At that time the Moon had moved very close to the comet's expected position, but Dr. H.-E. Schuster still managed to get a 7-minute exposure on August 31, 1977, when the Moon was only 15° away. This was done on red-sensitive emulsion (098-04) behind a red filter (RG630) to reduce the influence of the moonlight. The plate confirmed the existence of the comet and helped Dr. Brian Marsden to compute the orbit, an ellipse with an orbital period of 16 years.

The discovery of periodic comet Schuster on October 9, 1977 brought the total of comet discoveries at ESO to four over a period of less than three years. Dr. Schuster noted the fuzzy trail on a plate, obtained under bad seeing condi-

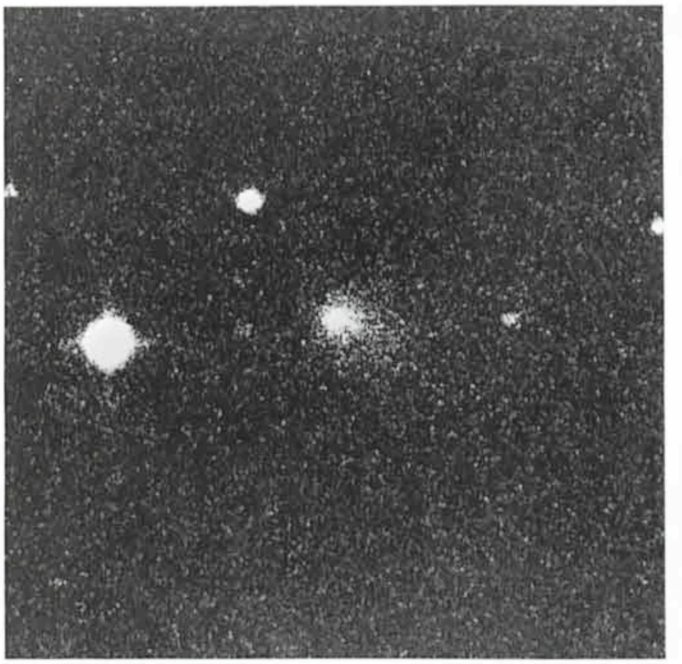


Figure 1. — *Comet Chernykh (1977l) photographed with the ESO Schmidt telescope on August 31, 1977. Red-sensitive 098-04 emulsion behind RG630 filter. Exposure time 7 minutes.*

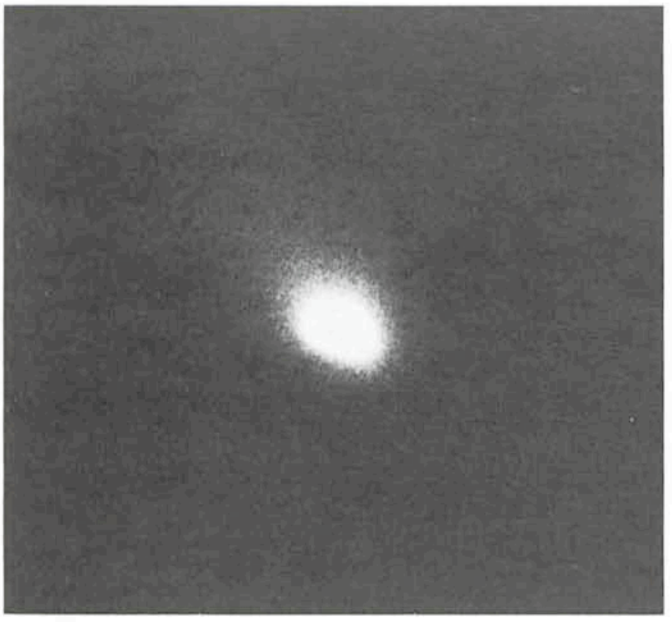


Figure 2. — *Comet Schuster (1977o) on a one-hour exposure with the 3.6 m telescope. October 15, 1977. IIIa-J + GG385. Observers: Drs. S. van Agt and P. O. Lindblad. (With their permission we reveal that the telescope was set to follow automatically the expected motion of the comet and that they spent most of the 60 minutes in the 3.6 m kitchen for a midnight snack! O tempora, o mores . . .)*

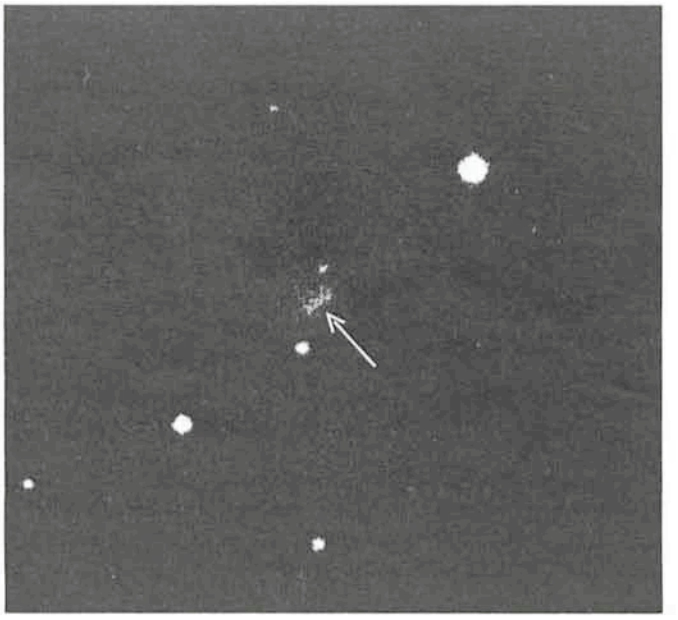


Figure 3. — *Comet Sanguin was confirmed on this 15-min Schmidt plate on October 20, 1977. 098-04 + RG630.*

tions for Drs. L. Schmadel and J. Schubart in Heidelberg, FRG. At first there was some doubt about the nature of the object (due to the bad seeing most of the trails—i.e. the minor planets—were equally fuzzy) but more plates on the following nights soon removed the doubts. It also turned out that the comet had been photographed on six plates in the beginning of September 1977, but at that date it was indistinguishable from a minor planet. Dr. Marsden finds an elliptical orbit from the observations September 3–October 17, 1977 with a period of only 7.48 years. The comet is intrinsically comparatively faint and will not become brighter than 16 mag this time. A deep 3.6 m plate was obtained on October 15 and is reproduced here.

Comet Sanguin was discovered at El Leoncito (Argentina) on October 15, 1977 by J. G. Sanguin. It was confirmed with the ESO Schmidt on October 20 (IAU Circular 3124) at magnitude 15–16, although the Moon again was troublesome. The preliminary orbit was computed by Dr. Marsden, who favours an elliptical solution; period about 13 years.

These are just three examples of the many contributions to solar-system astronomy that have come from the ESO Schmidt telescope during the past few years.

Those Troublesome Wolf-Rayet Stars

The Wolf-Rayet stars are among the more spectacular in our Galaxy. Not only are they some of the hottest and most massive stars known, but they also stand out as strong emission-line objects. With the aim of improving their usefulness for the study of the structure of the Galaxy, two Swedish astronomers, Drs. Ingemar Lundström and Björn Stenholm from the Lund Observatory, have initiated a study of the absolute magnitudes of Wolf-Rayet stars. Dr. Stenholm writes about the observations at ESO and how it now appears that most (if not all) Wolf-Rayet stars are in fact double stars:

During two observing runs at the 1 m reflector on La Silla, Ingemar Lundström and Björn Stenholm from Lund Observatory have obtained photoelectric observations of galactic Wolf-Rayet (WR) stars. Our fundamental idea is that WR stars, although evolved from the main sequence, are young stars, due to their high masses. They should then be useful as tracers of the spiral arms of the Galaxy (see also the article by S. Wramdemark, p. 10). If so, they might be the most powerful ones among optical spiral tracers, as a consequence of their high luminosity and easy detectability (emission lines!) on objective-prism plates. However, earlier investigations of the relation between WR stars and spiral structure have not been fully convincing. There are two reasons: the number of galactic WR stars is small, just about 150 are known today, and precise knowledge of their absolute magnitudes is lacking, although several attempts to determine them have been made. The most reliable calibration of the absolute magnitudes was made by L. F. Smith in 1973 and implies a variation in luminosity with spectral subtype. In order to use the newly discovered and faint WR stars for studies of galactic structure, it is thus necessary to make at least an approximate spectral classification.

When the observational programme at ESO was started, photometric and spectroscopic data were missing for about one-third of the WR star population.

The aim of our programme was thus twofold:

(1) Increase the number of WR stars with reliable magnitudes and colours suitable for distance determinations.

(2) Improve our knowledge of the absolute magnitudes of WR stars.

Due to the broad emission bands in WR spectra, ordinary UBV photometry is impossible for these stars. A narrow-band, five-colour system, originally invented by L. F. Smith and in which the majority of the WR stars were observed by her, was also used by us. This photometric system makes it possible, besides magnitude and colour measurements, to determine approximate spectral classes for faint stars, which are too faint for regular spectroscopy. We measured 32 stars not previously observed in this system and for most of them we have now obtained spectral classes. Four stars among them appear to be Of stars, a class of stars resembling the WR stars, and a few may be ordinary absorption-line stars.

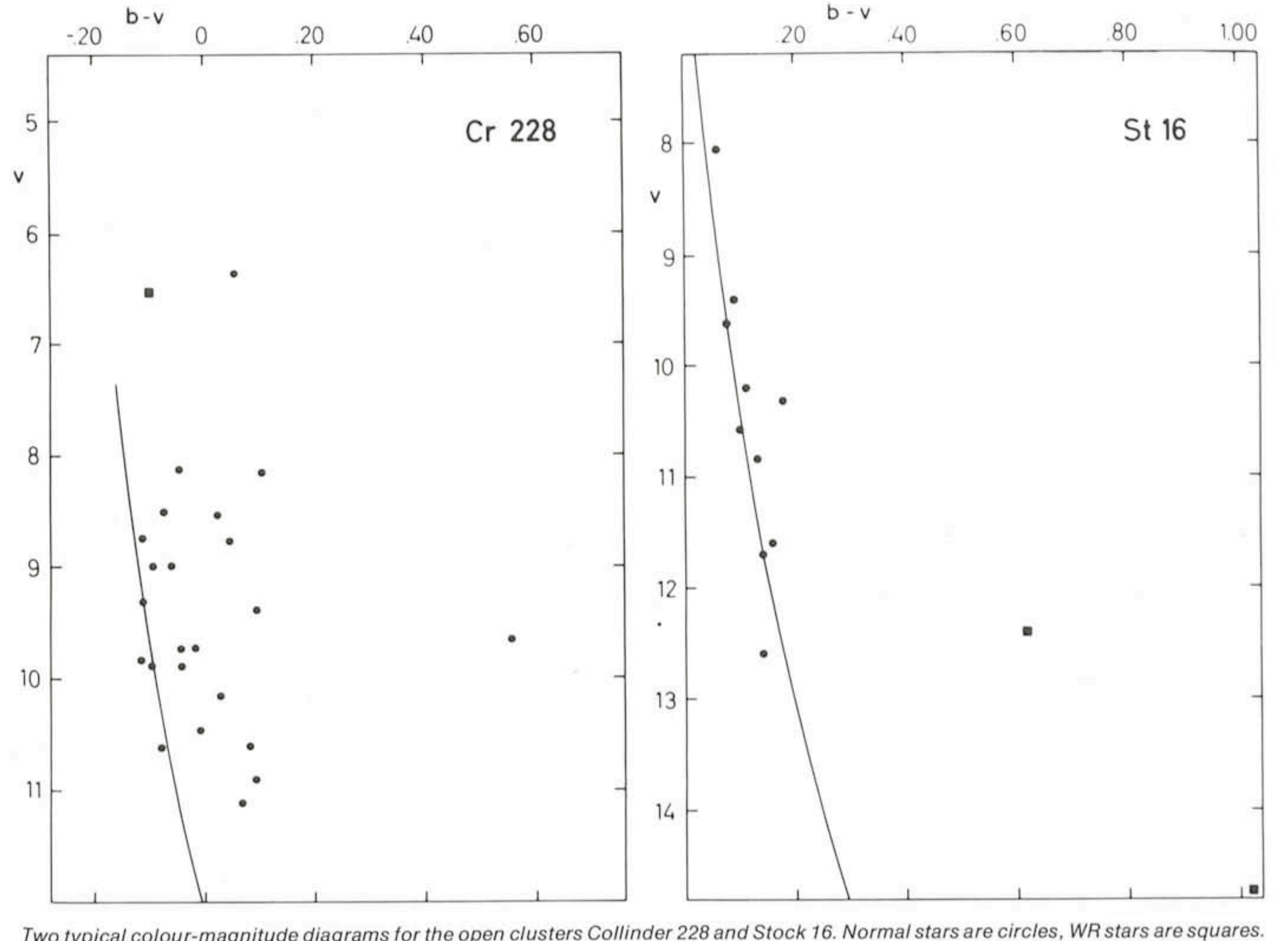
Absolute Magnitudes

Before we use these measurements to improve the map of WR stars in the Galaxy, we also want to investigate the existing absolute magnitude and intrinsic colour determinations. This question has always been somewhat controversial. The fundamental assumption in absolute magnitude investigations is that there exists a standard correlation between the spectral appearance and the luminosity, but this is not necessarily so. WR stars might be highly individual objects.

Our way to calculate absolute magnitudes for some stars was to investigate the eventual membership of WR stars in open clusters. It is well known that some open clusters have WR stars nearby, and in some cases investigations for membership have been made, but with UBV photometry, which is not reliable in this case. A proven membership, evaluated from colour-magnitude and evolutionary diagrams, gives a good absolute magnitude, and other, independent investigations of cluster distances can easily be taken into account. Our results for four stars are shown in this table:

Star	M_V	Spectral type
MR 28	—6.5	WN7
MR 29	—6.5	WN7+O7
MR 64	—6.4	WN7
MR 65	—5.9	WC7+O5

By chance we have got three stars out of four of spectral type WN7, and one of them is considered a binary, which is also the case for the fourth. Although the magnitudes of the three WN7 stars are very similar, we now have to ask whether these individually-determined absolute magnitudes for the spectral types in question can indeed also be used for other stars in the same spectral class? We hope so but we are not sure. And this leads us into the question about duplicity among WR stars.



Two typical colour-magnitude diagrams for the open clusters Collinder 228 and Stock 16. Normal stars are circles, WR stars are squares. In Cr 228 the WR star, MR 28, falls close to and at the top of the main sequence; it is considered a member. The width of the main sequence depends largely on variable extinction within the cluster, which is a part of the Carina Nebula complex. In Stock 16 the two WR stars fall far from the very well defined main sequence. These stars are obviously not members of the cluster, although they are situated only a few minutes of arc from the cluster centre.

Are All WR Stars Binaries?

From spectroscopic observations of bright WR stars it is obvious that the great majority are binaries; one of the components a WR star, the other a normal early-type star. Recently, there has appeared some theoretical work on close binaries which shows that such a pair can undergo a so-called WR stage once or twice during the evolution of the binary. It is seen that the non-WR component can have a wide range in luminosity, from a faint neutron star to a bright O star. This may imply that a binary system always is responsible for the WR phenomenon, and it is only when the secondary component is bright enough that we have been able to detect its binary nature. Thus, all WR stars might actually be binaries, and in each individual case we have to estimate the influence in luminosity from the companion. This is the main difficulty in the work with WR star absolute magnitudes, and to solve it requires a considerable amount of spectroscopy.

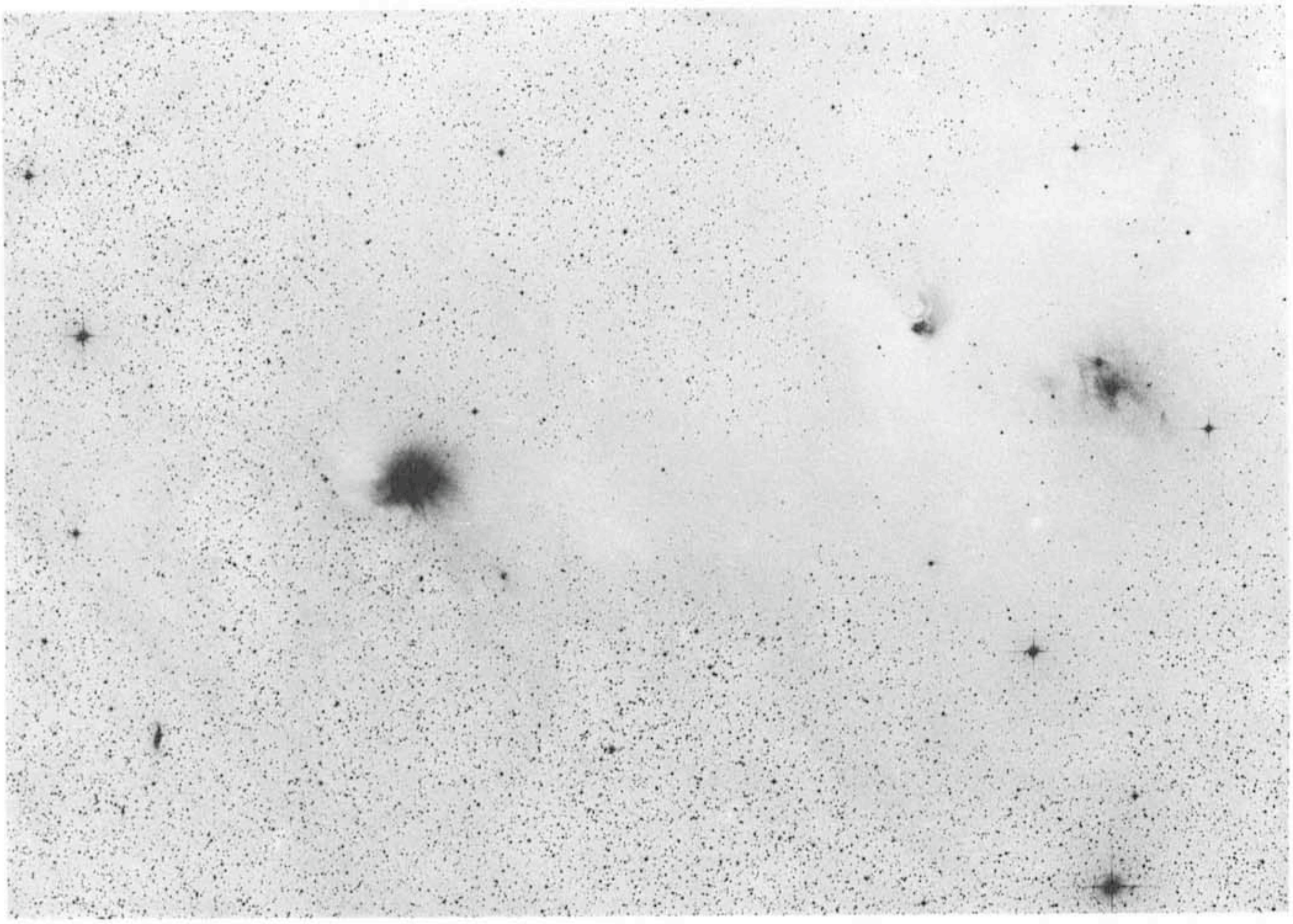
We expect to begin to publish the results of our observations at ESO early in 1978. They were carried out in February 1975 and August 1977.

Where Stars are Born

Dr. Claes Bernes of the Stockholm Observatory has compiled a new catalogue of bright nebulosities in dense dust clouds. He found 160 such objects when searching on the Palomar and ESO (B) atlases. Many of these objects are stellar birth-centres and they will soon be studied by radio and infrared observations. Dr. Bernes reports:

If you consult the Palomar Sky Survey or another sky atlas to check the optical appearance of some celestial region that infrared and radio observations have shown to contain newly-formed stars or even stars being formed now (like NGC 1333 or R CrA complex), you often find a nebulous patch situated in a dark cloud. Contrarily, the existence of a bright nebula in a dark cloud has in many cases attracted the attention of radio and infrared astronomers. It is also clear, after more systematic investigations, that regions with these optical characteristics form a quite well-defined class of objects. Evidently, they may serve as useful indicators of recent and/or still-active star formation.

With this in mind I decided to survey available photographic sky atlases and compile a catalogue of bright nebulo-



The cloud region at $\alpha = 11^h 08^m$, $\delta = -77°$, reproduced from field No. 038 of the ESO/SRC atlas. It contains three reflection nebulae (catalogue entries 142-144).

sities in opaque dust clouds. The Palomar Sky Survey and the Whiteoak extension cover the sky north of declination –46°. When I worked on this task during the summer of 1976, the ESO (B) "quick blue" survey of the southern sky was near completion and enabled me to extend the search to more southernly areas. Most of the ESO plates were available at the Uppsala Observatory, where the ESO/Uppsala galaxy survey was well under way, and I checked many of the remaining plates during a short visit to ESO/Geneva. At this time, only a small area around the celestial south pole was not yet covered by the ESO survey, which meant that I was able to examine about 99 per cent of the whole sky.

In all, I found 160 bright nebulosities in 80 different dark clouds and cloud regions with a Lynds opacity class of at least 4. Most of these bright objects are reflection nebulae, but the catalogue also contains quite a few Herbig-Haro objects (stars being born by contraction in interstellar dust) and emission nebulae that are clearly embedded in or otherwise physically connected to a dark cloud.

Since most of these regions are relatively nearby and at least to some extent optically resolved, it should in general not be too difficult to get an idea of their structure. Moreover, since many of them are seen well away from the galactic equator (galactic latitudes in excess of 15° are quite common), confusion with more distant galactic infrared or radio sources should not be a major problem.

The part of the sky south of declination –46° contains few spectacular regions with bright nebulae in cloud complexes of the kind that can be found farther north (like the Orion and Taurus clouds). However, there are certainly some southern regions that deserve further study, like the one centred at $\alpha = 11^h08^m$, $\delta = -77°$ (1950.0); see the figure.

My future plans include a search for very red and/or reddened objects around a number of nebulosities in the catalogue by means of near-infrared photography. I also expect to map in different formaldehyde lines a few regions with particularly simple geometries.

The catalogue has been published in *Astron. & Astrophys. Suppl. Series* **29,** 65 (1977).

Accurate Spectrophotometry of Early-type Spectrum Variable Stars

A Danish astronomer, Dr. Holger Pedersen from the Astronomical Institute of the Århus University, has recently used a novel instrument, ELIS, to measure the intensity (equivalent width) of the He I 4026 line in early-type stars. The accuracy is impressive and Dr. Pedersen has found several new spectrum variable stars. The observations were carried out at the ESO and CARSO observatories and are here summarized by Dr. Pedersen:

The spectrum line variations of the Ap and Bp stars have so far mostly been studied by ordinary photographic spectroscopy. With photoelectric spectroscopy it is now possible to get better equivalent-width data for individual spectral lines ("area" of a spectral line). During three observing sessions on La Silla I have used the Danish Echelle Line Intensity Spectrometer (called ELIS, see Fig. 1) to observe the strength of the He I 4026 line. The candidates for the first two sessions were B-type He-strong and He-weak stars while still hotter CNO stars were observed during the last run.

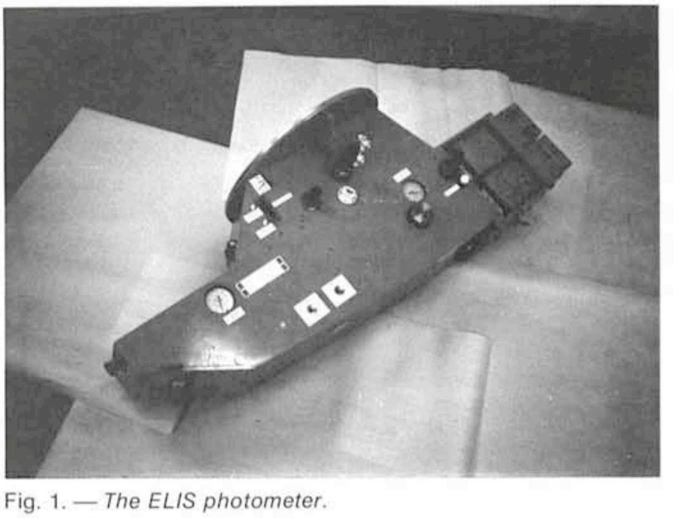


Fig. 1. — *The ELIS photometer.*

The Photometer

The measured quantity R is the ratio of flux through a 9 Å wide slit centred on the spectral line and a 2 x 7.5 Å wide, double continuum slit. The precise relation between the index and the equivalent width of He I λ 4026 has yet to be established. A provisional relation from the definition of the index is

$$W = 9 - 15\,R$$

but this function does not take into account scattered light, the instrumental profile or a possible dependence on the rotational velocity of the star.

The bandpasses are defined by two out of twelve exit slots mounted on a wheel which may be rotated by computer command. The wheel itself may be displaced along the direction of dispersion to correct for radial velocities, slit offsets and bending. By means of observations of spectral lamps the wavelength zeropoint is kept constant to an accuracy of about $\Delta\lambda/\lambda = 10^{-5}$. A small fraction of the light which passes through the entrance slit and the order separating interference filter is directed to a reference photomultiplier instead of the grating. Measuring the ratio of the signals from these two channels, a very efficient correction for scintillation and variable cloud cover is obtained.

Optically ELIS is identical to the prototype used by Dr. P. E. Nissen and described by him in *Messenger* No. 9. The present instrument, however, is computer-controlled so that only a few operations must be done manually. ELIS has also been used successfully as a medium-resolution scanner but its main advantage is in the field of absorption-line measurements. The design of a fully-automated echelle photometer with several optical and mechanical improvements is presently being studied. With such an instrument one can measure in quick succession the strength of several spectral lines and thereby obtain more data for the analysis of the spectrum variable Ap and Bp stars.

The Observations

During the first observing run seven out of 26 stars were found to be spectrum variables. One of the most interesting

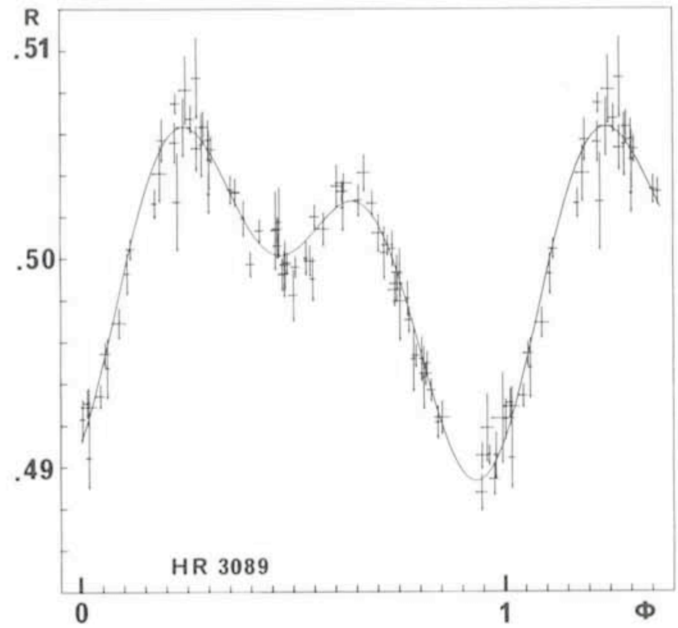


Fig. 2. — *The He I λ 4026 variability of the He-strong star HR 3089. The total range of the index, ΔR = 0.017 corresponds to an equivalent-width change of 225 mÅ. The average mean error is ΔR = 0.00094 or 14 mÅ. A five-term trigonometric function is fitted to the data which are folded modulo 1.33016 day.*

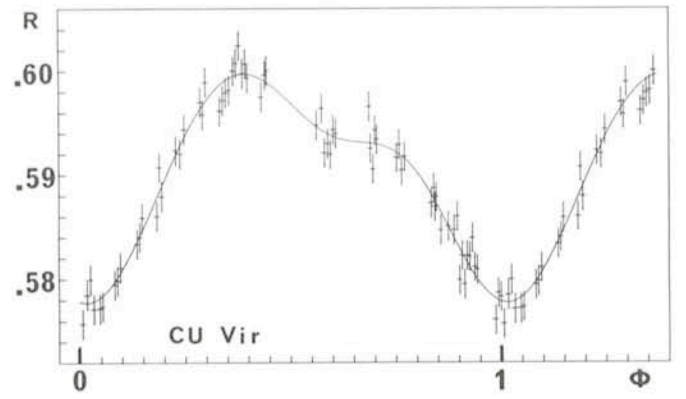


Fig. 3. — *The He I λ 4026 variability of the Ap star CU Vir. Since the observations were taken under nearly equal conditions, the individual mean errors have been replaced by the average mean error, ΔR = 0.00137. The curve is a seven-term trigonometric polynomium with a period of 0.52067688 day. Note the much smaller He line strength in this star as compared to HR 3089.*

among these is the He-strong star HR 3089 for which a period of 1.33 day was found. A total of 82 observations of this star were collected during January, February, October and December 1976, with the Danish 50 cm at La Silla, the ESO 1 m and the CARSO 1 m telescope at Las Campanas. They are shown phase-resolved in Fig. 2 together with a five-term trigonometric function which fits the observations nearly as well as predicted by photon statistics.

At the end of my second visit to La Silla, Dr. Hardorp from Stony Brook, USA, encouraged me to make some measurements of the fast-rotating Ap star, CU Vir. Since the programme for the next observing run was already fixed, only a few hours could be spent on this star but the results nevertheless show a gain compared to conventional equivalent-width determinations. Each of the observations is the result of only 100 seconds integration time on the line band and 100 seconds on the continuum bands. Among other things, the phase-resolved data in Fig. 3 show that the index curve is asymmetric and possibly even has a secondary minimum.

At present, a graduate student, Mr. B. Prinds, is analysing the results for several of the He-weak and He-strong stars in order to find the surface distributions of Helium equivalent width. He "moves around" with imaginary circular spots of enriched He content and tries to make the computed index curve fit the observations when the star rotates. The number of free parameters, however, is so large, that a lot of very different but reasonable solutions seem to exist. This situation can only be changed when high-quality line profiles become available.

Optical Radiation Found in the Radio Lobes of Double Radio Galaxies

Philippe Crane and William C. Saslaw

Pushing the largest telescopes to their faintest limits is certainly not easy, but often extremely rewarding. The discovery of optical objects associated with powerful double radio sources (for which only the central galaxy was known before) will undoubtedly have a great impact on the study of the physics of radio galaxies. Two of the codiscoverers, Dr. Philippe C. Crane of the ESO Scientific Group in Geneva (formerly Princeton University) and Dr. William C. Saslaw, Institute of Astronomy, Cambridge, U.K., and University of Virginia, Charlottesville, USA, here review the new, fascinating discoveries—for the first time outside the professional journals.

When radio galaxies were first discovered in the 1950s, their most surprising property was that the radio and optical emission often came from different places. The most dramatic examples have a giant elliptical galaxy in the centre and two giant lobes of radio radiation on either side. A hundred kiloparsecs (1 pc = 3.26 light-years) is a typical distance between the galaxy and a radio lobe, although some sources spread over several megaparsecs. The radio lobes radiate about 10^{40}–10^{45} erg s^{-1}, and often surpass the optical radiation of the central galaxy in intensity. For comparison, the Sun radiates 3.8 x 10^{33} erg s^{-1}.

At first these radio sources were thought to be colliding galaxies. Now many more sources are known than can be produced by random collisions. Most astronomers believe that the central galaxy has emitted vast clouds of relativistic particles, or continuous beams of particles, or compact massive objects which generate the relativistic electrons in the radio lobes. To help constraining these theories, we

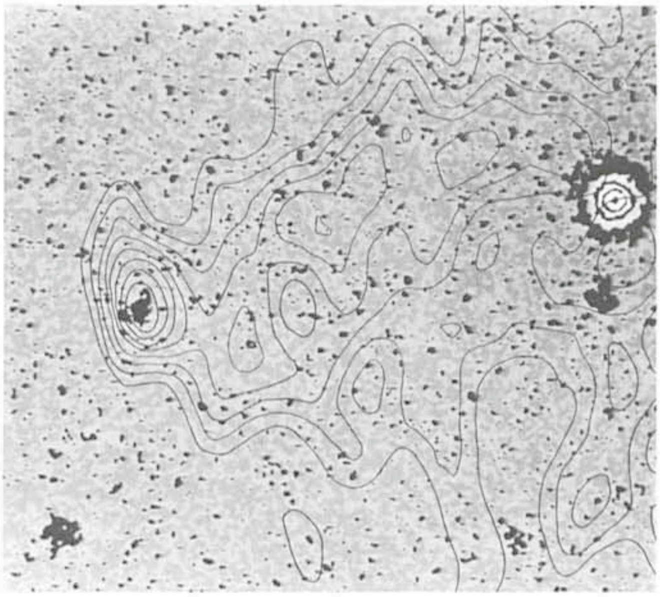


Fig. 1. — *This is a digitally-summed picture made from four 4-metre plates of the eastern radio lobe of the galaxy associated with the radio source 3C285. The radio contours from the Cambridge radio map have been overlaid. The bright object on the right has $V = 20.6$. The faint object centred on the radio hot spot has $B = 23.6$. The picture is 45" across. Both objects are discussed in the text.*

have been looking, in collaboration with J.A. Tyson of Bell Laboratories, for optical radiation in these radio lobes.

If there is optical radiation in radio lobes, it may have several causes. It could come from *free-free emission* or from *line emission* by thermal gas. However, we find that these causes would require an electron density $N_e \gtrsim 10^{-3} cm^{-3}$ which would depolarize the radio emission through Faraday rotation. Since most radio lobes are significantly polarized, this is an unlikely possibility. A second cause of optical radiation could be the same *synchrotron mechanism* that produces the radio emission. This would have the feature that it would be more highly polarized than the radio radiation, since there is much less Faraday depolarization at the high optical frequencies. A third cause of optical radiation could be *inverse compton scattering* of the universal 3°K microwave background by the relativistic electrons in the radio lobe. This optical emission would not be polarized, so it could be distinguished from optical synchrotron. There are other possible causes for optical emission in radio lobes, but these are the major ones.

With this in mind, we started a sensitive systematic search for such optical emission. Since we needed high-resolution radio maps, southern galaxies were excluded as there is no high-resolution radio interferometer in the southern hemisphere. We looked through the 3C Catalogue and chose three radio galaxies with classical double-lobed structures, measured redshifts, and position well outside the galactic plane to avoid contamination by objects in the Milky Way. Our initial choices were 3C285, 3C265, and 3C390.3.

We took limiting IIIa-J plates, using a GG 385 filter, of these sources at the Kitt Peak 4 metre telescope, in March 1977. The seeing was better than one arcsecond and the plates showed images of ~ 24th magnitude. Tyson took several plates of each radio source, and analyzed them on the Berkeley PDS and the Kitt Peak Interactive Picture Processing System (IPPS) machines. In all three cases we found optical emission within one or two arcseconds of the radio peak in the most powerful component of each source. Their visual magnitudes are typically between 22nd and 23rd. Preliminary results of this work have been pub-

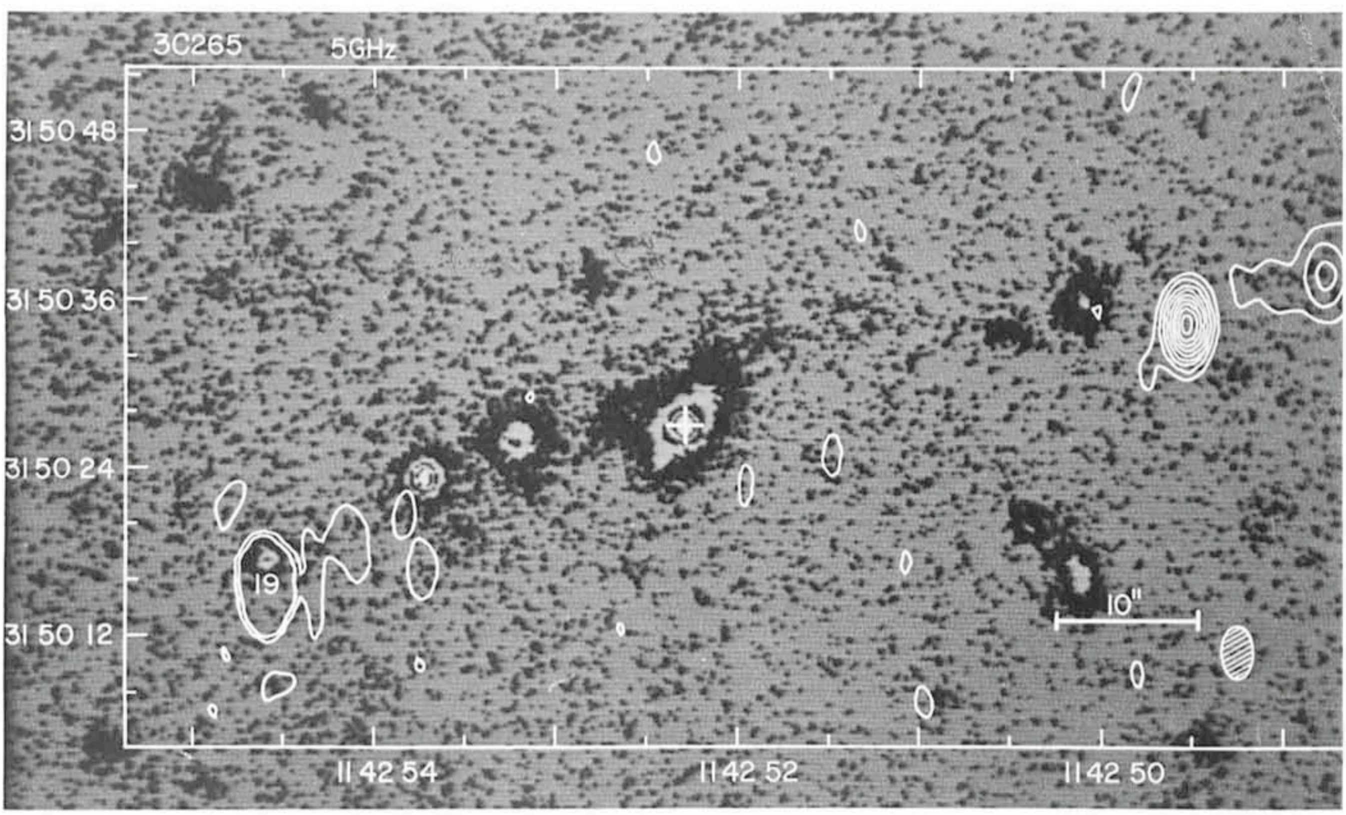


Fig. 2. — *This shows a sum of three 4-metre plates of the distant radio galaxy 3C265. The 5 GHz radio map is overlaid. There is an optical object coincident with the radio peak in the lower left. Many radio contours have been left out here in the extremely bright radio spot.*

lished (Tyson, Crane and Saslaw; *Astron. & Astrophys.*, **59** LIS, 1977) and a more definitive paper will be published in the *Astrophysical Journal* (see also ESO preprint No. 9).

The objects we have the most information about lie in the east radio lobe of 3C285, shown in Figure 1. The 15.5-magnitude galaxy in the centre has a redshift $Z = 0.0797$, putting it 320 Mpc away if the Hubble constant is 75 km s^{-1} Mpc. The galaxy is distorted, possibly by tidal interaction with nearby companions, and may even be of spiral type. It radiates about 3×10^{41} erg s^{-1} in the radio lobes, and the radio maps were made at 2.7 GHz with the Cambridge 5 km synthesis telescope.

In the centre of the radio lobe lies a 20.6-visual-magnitude optical object, which may be diffuse. Its optical emission is quite peculiar. The colours are very blue; using the 2.1 metre Kitt Peak telescope, we found photometric values $B–V = 0.26 \pm 0.4$, $U-B = -1.2 \pm 0.5$ magnitude. These colours are much more blue than normal Seyfert galaxies. They are the colours of quasars. Moreover, we also find that its radiation is $10 \pm 5\,\%$ linearly polarized. This suggests it is optical synchrotron. Its power would be consistent with an extrapolation of the radio synchrotron emission into the optical regime. To produce optical synchrotron requires something on the radio lobe to generate highly relativistic electrons with $\gamma = (1-(v/c)^2)^{-0.5} \gtrsim 3 \times 10^6$.

There is another optical object in this radio lobe. It is of blue magnitude 23.6 and coincides with the region of peak radio emission to within one arcsecond. It is too faint to measure accurate colours or polarization with the KPNO 2.1 metre telescope, but we hope to find this information with the KPNO 4 metre. The probability of an optical object of 24th magnitude or brighter lying within one arcsecond of anywhere on our plate is about 3×10^{-3}.

The second radio galaxy we looked at, 3C265, is associated with a 20th-magnitude galaxy having redshift $Z = 0.811$. Figure 2 shows our plate with the Cambridge 2.7 GHz map superimposed. There is a remarkable choice of seven optical objects having about the same angular extent and position angle as the radio double. Again the strongest radio lobe coincides with an optical object, this time with $B = 22.4$ magnitude. We plan to measure its other optical properties in the near future.

The third radio galaxy, 3C390.3, is identified with a $V = 15.4$-mag N-type galaxy. One of the radio lobes, shown in Figure 3, is near a peculiar optical structure which points away from the central galaxy. An optical extension of this structure is seen to coincide with part of this radio lobe, which is itself double. A preliminary observation suggests the optical emission from this peculiar structure may also be polarized, but we want to repeat this measurement more sensitively.

The random probability of finding all these associations between optical objects and radio lobes is very small. But we plan to look at more radio galaxies to determine whether we have discovered the "tip of an iceberg" of information. If so, a new astronomical industry will soon arise, based upon radio, optical, and perhaps infrared, ultraviolet and x-ray emission from sources ejected by galaxies.

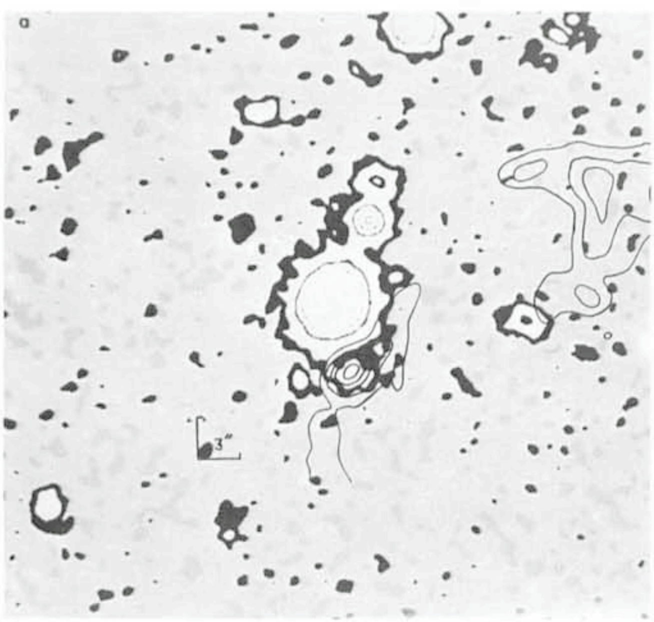


Fig. 3. — *This shows the north-west radio lobe of the radio galaxy 3C390.3. The galaxy itself is several minutes of arc away to the lower left. Several radio contours have been overlaid here to show a probable faint source just coincident with the radio peak. The bright object just above has V = 19.6 and the same redshift as the parent galaxy of 3C390.3. This picture is 45" across.*

Peculiar A-type Stars at ESO

H.-M. Maitzen and W. W. Weiss

The study of peculiar A stars is a fascinating chapter of modern astronomy. It combines measurements of light variability, variable spectral lines and magnetic fields. This review article by two Austrian astronomers, Drs. H.-Michael Maitzen and Werner W. Weiss from the Figl-Observatorium für Astrophysik (Vienna) discusses not only the observations, but also the attempts to explain theoretically the Ap phenomenon. It is probably true to say that the stellar models still are somewhat uncertain, but new and improved observational methods continuously refine the interpretation. The authors are frequent observers on La Silla.

Thirty years ago H. Babcock found for the first time a stellar magnetic field (78 Vir). Not quite as old is the history of Ap-star research at ESO. However, there exists already a long list of observational programmes in this field which were carried out at La Silla since ESO was founded. In what follows, we will try to give a very short historical background and our related contribution based on observations obtained at ESO.

Magnetic Fields

Babcock's observations for his famous catalogue of magnetic stars (1958) were made with a simple Zeeman analyzer in front of the slit of a coudé spectrograph which was designed by himself. This analyzer permits to separate left- and right-hand circular polarized components of stellar lines which are split by a magnetic field. Using the Landé g-factor and the measured shift between both components of a particular line, one can determine the longitudinal component of a stellar magnetic field averaged over the

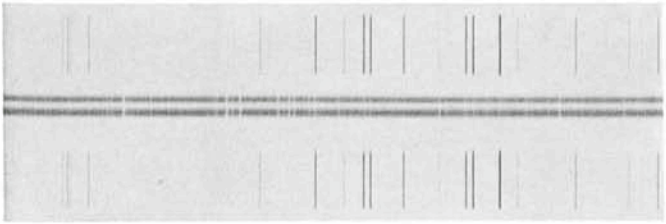


Fig. 1. — *HR 5049 Zeeman spectrogram (plate No. H348z, ESO 1.5 m coudé), IIa-O, 5h31m exposure time; observer H. J. Wood (March 26, 1971). Centre wavelength approx. 4200 Å, increasing wavelengths to the right.*

visible hemisphere. Typical Zeeman shifts for magnetic fields in the range of one kilogauss are of the order of a few microns if one observes with a Zeeman analyzer attached to the coudé spectrograph (3.32 Å/mm) of the 1.5 m telescope at La Silla. Exposures of about 6 hours are required for a star of 6^m. This Babcock technique was introduced at La Silla by Dr. H. J. Wood, while he was an ESO staff member. He started the first survey for southern magnetic stars in 1970. The excellent spectra which he obtained (fig. 1) require an adequate measuring and reduction technique. Both have been achieved meanwhile at the Vienna observatory. For a PDS-1000 microdensitometer controlled by a PDP-12 computer, software was developed (in cooperation with R. Albrecht, H. Jenkner and H. J. Wood) which enables us to measure line positions in photographic spectra with an accuracy of 0.2 micron and stellar magnetic fields (in the best cases) of the order of 50 gauss.

Those objects, where a magnetic field is measured (usually of the order of several hundred gauss up to several kilogauss), are nearly always identical with young stars of spectral type A. In addition, these stars show an unusual spectral behaviour. Especially Rare Earths, the Strontium and Iron group lines are enhanced and variable. Periods range from about one day up to hundred days. Parallel to the spectral variations the stars are also photometrically variable. The amplitudes of these light variations are of the order of several per cent. This is illustrated by measurements of the Ap star HD 125248, obtained at La Silla. Figure 2 shows the light curves in different colours. The characteristic features for the light curves are double waves, which also correspond to double variations in the spectra.

Astronomers already early found that the longitudinal magnetic field strengths are reversing in many cases and with the same period as the spectral and photometric variations. The maxima of the line variations were in phase with the maxima of the magnetic variations and also with those of the photometric light curves. Furthermore, an outstanding feature of Ap stars is the marked slow rotation, producing sharp spectral lines. All these phenomena justify to call these objects peculiar A stars.

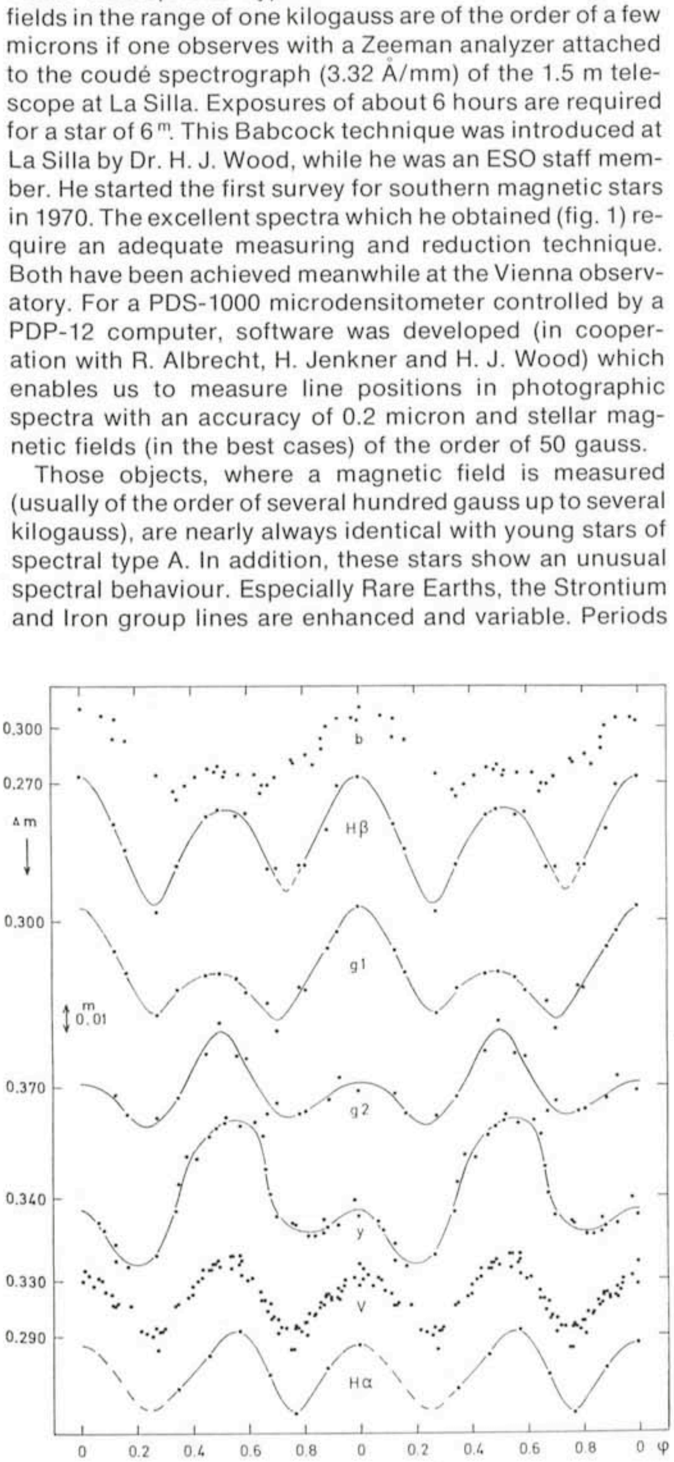


Fig. 2. — *Light curves of HD 125248 (Maitzen and Moffat, 1972).*

The "Oblique Rotator"

In the early 1950s Stibbs and Deutsch created a simple model which to a large extent explains the phenomena just mentioned. This model, also referred to as "Oblique Rotator", is certainly one of the strongholds in the theoretical understanding of Ap stars up to now. It postulates the non-coincidence of the rotational and magnetic axes. Such a configuration causes a beacon effect and has also been used for treating the pulsar geometry. The magnetic poles and the associated patches of enhanced line intensities appear and disappear periodically. This results in radial velocity variations due to approaching and receeding spots. This oblique rotator model also allows us to understand very easily the double waves in light curves. These waves reflect the contribution of different parts of the stellar surface with different abundances, different temperature and effective gravity.

Using well-known mathematical techniques it is possible to calculate a map for the distribution of different elements in the atmosphere of Ap stars. Further spectroscopic analyses clearly demonstrate that the angle between the magnetic and rotational axes tends to be either 0° oder 90°.

The physical background for the photometric variations can be qualitatively explained by redistribution of the flux blocked in the UV by the presence of strong stellar lines. This mechanism explains why the observed brightness of Ap stars increases in the visible range although the spectral lines of elements typical for Ap-star atmospheres are also enhanced.

To be fair, we must stress the fact that quite a number of difficulties in the theoretical background have to be overcome for the oblique-rotator model, if one wants to explain all observational details. For example, in the case of non-sinusoidal magnetic field variations, decentred and sometimes non-aligned magnetic dipole fields are postulated. But how can such a field remain stable and be understood with our present knowledge of magnetohydrodynamics? In addition, there is hardly one effect described in this article which is *not* observed in some stars, even sometimes showing up in the *opposite* sense. More observations are needed!

Why are some A stars peculiar?

There remains the question why some 10 per cent of all A stars are peculiar. Related questions are:

— Why are magnetic fields almost exclusively found in A stars?

— Why do all these stars rotate slowly? Did a magnetic field brake the rotation already during star formation or is such a process going on during the main-sequence lifetime of the star?

There are two main theories to explain how A stars can become peculiar:

(1) Diffusion Theory

This theory is based on a selective effect of the radiation pressure relative to gravitation. Elements with more absorption lines will be lifted by the radiation pressure relative to other elements with few absorption lines, where gravitational forces prevail. This diffusion process requires a quiet atmosphere which implies slow rotation. Slow rotation is needed for this theory, diffusion does not explain it.

(2) Accretion Theory

Accretion works via a selective trapping of elements from the interstellar medium by a rotating magnetosphere. Roughly spoken, heavy elements penetrate deeper into the magnetosphere than light elements. This means that in the time scale of 10^8 years heavy elements will be found to be overabundant in the atmosphere. On the other hand, those light elements, which are not captured, are accelerated by the rotating magnetosphere, thus decelerating the stellar rotation.

Measuring "Peculiarity"

Generally spoken, observational evidence is required for the time span during which a peculiar atmosphere is being built up as well as for the evolutionary phase during which this mechanism is active. Hence, it is important to discuss the question whether old Ap stars do rotate more slowly than younger ones. It should be emphasized that more rotational periods are needed and also more data on the stellar ages, radius and v · sin i. Pioneering work in the field of period determination was done by K. D. Rakosch and for the southern hemisphere at ESO by observers from Bochum, Liège and Amsterdam. In addition, one needs sensitive criteria for the peculiarity of Ap stars. In this respect, the broad-band flux depression in the visual spectra of Ap stars can be used. Observations obtained at La Silla with photoelectric photometry demonstrate that there is a flux depression of about 300 Å width around 5200 Å with a depth of about 10 per cent depending on the peculiarity of the star. This flux depression is characteristic for Ap stars only. It enables us to survey even distant stellar clusters for Ap members and relate a degree of peculiarity to their age which can be determined by conventional techniques for clusters (figure 3).

Another aspect which we have investigated at ESO is the question of the stability of Ap-star atmospheres. There are two distinct groups of astronomers which have published different results for the photometric stability in the range of minutes up to several hours. One group found photometric and Balmer-line variations in a number of Ap stars which can be characterized as periodic, and where the mechanism might be pulsation, flickering or flare-like. Others found that in some cases the same Ap stars are stable and do not show any variations besides those due to rotation. Are these contradicting findings caused by an instrumental or extinction effect in our atmosphere, or do these stars switch on and off, or are only parts of their stellar atmosphere unstable, for example those around the magnetic poles?

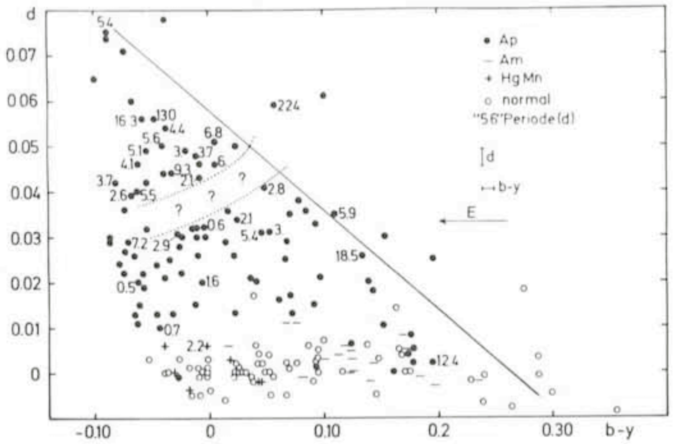


Fig. 3.—*Measurements (La Silla, 1973–74) of the peculiarity index Δd versus b-y. Error bars and the direction of the reddening vector are given, periods are in days (Physics of Ap-Stars, IAU-Coll. No. 32, Weiss et al., Eds.).*

However, if it is possible to demonstrate the existence of photometric variations in the time scale of up to some hours one can ask how diffusion is possible in such a dynamic atmosphere. In an observing run this summer, a sample of 21 Ap stars of different peculiarity has been observed and no variations larger than 0.004^m have been detected. As a by-product of this survey, two new bright δ Scuti type variables were discovered which originally were used as comparison stars.

The reader will find many question marks in this article. However, this is just the proof that Ap-star research is in a very active phase! Let us try harder!

NEWS and NOTES

The Sagittarius Dwarf Irregular Galaxy (SagDIG)

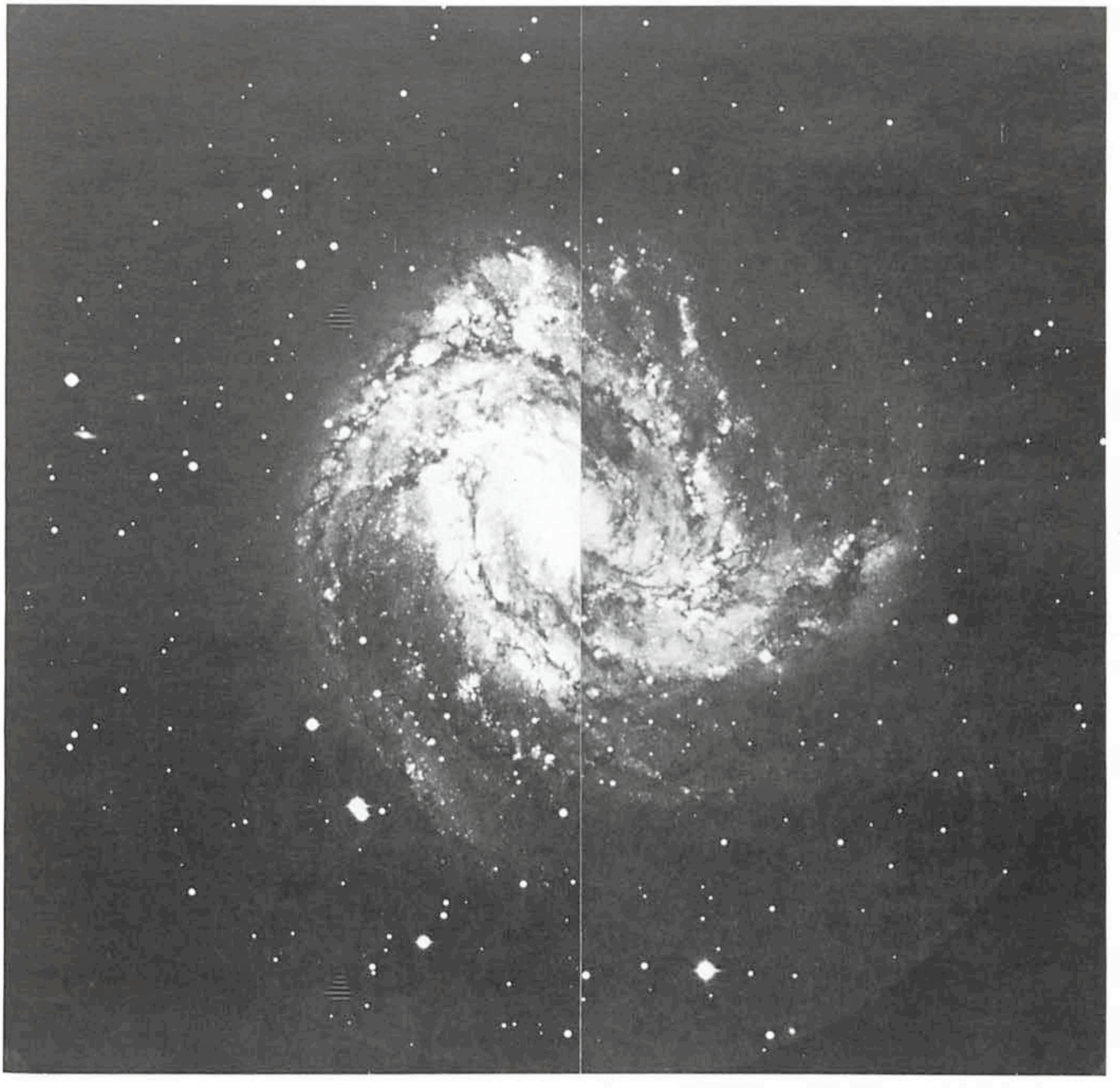
In the last issue of the *Messenger* we showed a picture of a new irregular galaxy in Sagittarius. Since then 21 cm hydrogen observations with the Nançay radio telescope have shown that it has a negative radial velocity, – 58 km s^{-1}. This is the same as the nearby member of the Local Group of Galaxies, NGC 6822, which is seen in almost the same direction. It is therefore likely that they have the same distance, 600 kpc (about 2 million light-years). In a letter to the journal *Astronomy & Astrophysics*, the Nançay and ESO astronomers Cesarsky, Laustsen, Lequeux Schuster and West write that SagDIG is "probably one of the smallest, faintest and less massive (irregular) galaxies known to date".

The Cluster of Galaxies STR 2232–380

In *Messenger* No. 10, Drs. A. Duus and B. Newell told about their new catalogue of southern clusters of galaxies. A photo of the cluster of galaxies STR 2232–380 accompanied their article. Dr. Duus asks us to mention that this cluster was discovered by MacGillivray and collaborators (1976, M.N.R.A.S., **176**, 649). We are happy to comply and would like to add that the photo of the cluster was reproduced (in October 1974) from ESO (B) Atlas plate No. 613, taken on August 20, 1974.

Planetary Nebula NGC 3132

In the same issue, Drs. Kohoutek and Laustsen showed photographs of the planetary nebula NGC 3132. We are sorry that the position was wrong: it should have been R. A. = $10^h\ 06^m$; Decl. = –40°, that is in the constellation of Vela (The Sail).



Printing High-contrast Astronomical Plates

Most photographic emulsions currently used in astronomy are rather contrasty, for instance IIIa-J and IIIa-F (formerly 127-04). This is a great advantage for reaching faint objects, but it turns into a problem when prints are made from the original plate. Photographic paper can only hold a limited range of densities and the prints therefore tend to become very unsatisfactory; either the high densities show no detail or the faint structures are lost in the background.

One way to overcome this problem is to introduce a photographic mask in the process. During the past months, ESO photographers B. Dumoulin and R. Saxby from the Sky Atlas Laboratory in Geneva have been experimenting with such masks in order to make better prints of the plates that are obtained on La Silla, in particular those from the 3.6 m telescope.

We here show one example of the gain by using the masking technique. It is quite obvious that one sees more detail in the right half of the photo of southern spiral galaxy NGC 5236, from the 3.6 m telescope (60 min, IIIa-J + GG385), than in the left. Whereas the left half is the best possible direct print (optimizing the exposure time and the paper grade), the right was made in the following way:

The original plate was placed in the enlarger and projected onto a film to a density of about 1.6 D when developed. The film was then put back on the enlarger table in exactly the same position (this is not easy) and the plate was printed on a paper, through the film mask. The film was then removed and a short, direct exposure was made. In this way it is possible to have the central parts of the galaxy well exposed (through the mask) without overexposing the background (blocked by the mask).

The whole operation (including test prints, etc.) takes less than one hour, thanks to the two automatic development machines in the Sky Atlas Laboratory, one for the film (same as used for the sky atlases) and another for the paper prints.

The Coudé Echelle Spectrometer

One of the most important auxiliary instruments for the 3.6 m telescope is a high-resolution spectrograph. This instrument, the coudé échelle spectrometer, will work on the floor below the telescope, in the air-conditioned coudé room. It is here described by Daniel Enard of the Optics Section in Geneva who is working full time on this project:

The coudé échelle spectrometer of the ESO 3.6 m telescope is designed to reach a very high resolution (typically higher than 100,000) with a good photometric accuracy. The spectrometer will work in two possible modes. The first is a scanning mode where an alternatively rotatable échelle 200 x 400 mm moves the spectrum with regard to a fixed slit, the photon flux being detected by a high quantum efficiency cooled photomultiplier. In order to get a higher accuracy, the beam passes, in fact, twice on the grating. The dispersion is doubled and the beam focused on an intermediate slit, the instrumental profile, i. e. the system response to a perfect spectral line being made as pure as possible. Any wings and ghosts given by the grating or the optics are removed.

The second mode uses a multi-channel electronic detector. The échelle grating is set in such a way that the interesting spectral region is centred on the detector. From then the photons are simultaneously detected in each channel and added in a computer memory.

To reach the very high accuracy expected, particularly with the scanning mode, one has to rely very much on the accuracy of the turn-table upon which the grating is set.

Recent developments in ultra-precision angular measurements and servo control systems allow angular accuracy expectation of 0.1 arcsec, with scanning frequencies up to 5 hertz. These high frequencies (if one takes into account the mass of a 400 mm grating) allow the system to be freer than in the past from the atmospheric noise, an important limiting factor.

The instrument is composed of four parts:

1. Slit Environment

Auxiliary but essential functions like TV acquisition, guiding, spectral and photometric calibration are performed here, before the entrance slit.

2. Pre-disperser

Ensures the order separation, necessary with an échelle grating. This is a medium-dispersion prism monochromator.

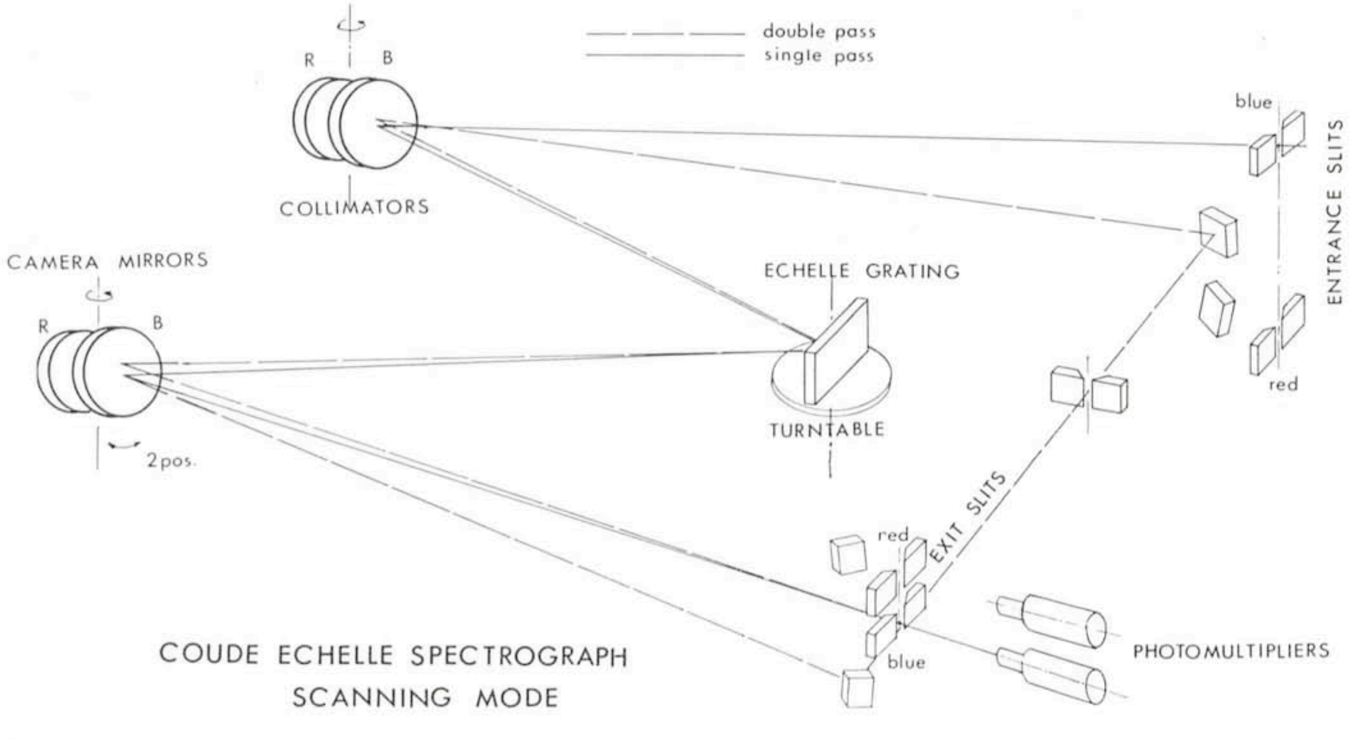
3. Scanner

This is a classical CZERNY TURNER arrangement. The angle between the beams has been exaggerated on the figure but is in fact kept very small (about 5°) to get maximum grating efficiency. For the spectrometer as well as the pre-disperser, two opticals paths can possibly be pursued—one is optimized for a maximum transparency in the blue, the other in the red. Shifting from red to blue path is achieved by tilting pre-positioned mirrors.

4. Multi-channel Camera

This is a unit which is set up on the diffracted beam between the grating and the camera mirrors. The camera itself is a Schmidt system with a relative aperture of f/5.

It is foreseen at present to use two types of detector—a reticon for work in infrared or for bright objects and a digicon for visible, low light level observations. The digicon is an intensified reticon where the diode array is put into the intensifier and directly bombarded by accelerated electrons. The device takes advantage of the extreme simplicity



COUDE ECHELLE SPECTROGRAPH
SCANNING MODE

and reliability of the reticon array, of the very good spatial resolution given by an electron beam and of the very high gain obtained with a high accelerating potential. The digicon can be compared to other detectors as being an analogue detector but with nearly photon shot noise limited performance. Both reticon and digicon will have one row of 1872 diodes, 15 x 750 microns.

The instrument relies heavily on remote control and, except for the change of optical path, the instrument will be fully operated from the control room. The observer will type in the central wavelength and the resolution, and the computer will set the slit widths, the pre-disperser prism and the grating correctly. Even the manual settings will be indicated by the computer, so the observer can be warned of any mistake before the observation starts. For both modes (except with the reticon) the signal will be available in real time, the observer will have a direct view on a graphic display of how the spectrum looks and he will end the integration when the signal-to-noise ratio seems sufficiently high for his purpose (this is, of course, a tremendous advantage over photographic plates). A possible improvement of the instrument would be to move towards larger mosaic gratings but this leads to huge and very expensive cameras. An interesting possibility is to use two contiguous échelle gratings blazed at 75°. Then either dispersion of efficiency could be doubled without modifying anything else in the instrument.

The actual schedule is to have the instrument working in the laboratory by the end of 1978, the shipping to Chile being foreseen in April 1979.

PERSONNEL MOVEMENTS

(A) Staff

ARRIVALS

Geneva

Scientific Group: Klaus Banse (German) systems analyst/ programmer, 12.12.77.

TRANSFERS

Marianne Fischer (German), secretary; from Garching to Geneva, 1.1.78.

DEPARTURES

Geneva

Instrument Development Group: Johannes van der Lans (Dutch), senior project engineer (electronics), 31.12.77.

(B) Paid Associates – Fellows – Coopérants

ARRIVALS

Geneva

Scientific Group: Manfred Pakull (German), fellow, 1.12.77.

DEPARTURES

Geneva

Scientific Group: Dan H. Constantinescu, fellow, 31.12.77.

LATEST NEWS

Further Observations of ESO 113-IG45

By monitoring the nucleus of 113-IG45 with the ESO 50 cm telescope, Drs. N. Vogt (ESO) and H. Duerbeck (Tübingen) find a 2 per cent variation in the B magnitude over a period of ten days (November 8–18)

Drs. W. Wamsteker, P. Salinari and M. Tarenghi have detected 113-IG45 with the infrared photometer at the 1 m telescope on La Silla.

ALGUNOS RESUMENES

Extinción en La Silla

Hay dos factores de vital importancia que determinan la calidad del lugar de un observatorio. Son el *"seeing"* (en qué grado es esparcido la luz de un objeto celestial durante su paso por la atmósfera terrestre) y la *extinción* (cuánto se debilita la luz durante su paso). Desde hace tiempo se sabe que el "seeing" en La Silla es excelente, pero sólo recientemente un detallado estudio ha revelado que la extinción de La Silla es muy baja en una "buena noche".

El estudio fue hecho por el Dr. H. Tüg del Instituto Astronómico de la Universidad del Ruhr en Bochum, República Federal de Alemania, quien permaneció varios meses en La Silla desde 1974 hasta 1976. Las mediciones, llevadas a cabo en el telescopio Bochum de 61 cm, comprobaron que la extinción en La Silla es más baja que en cualquier observatorio del hemisferio norte. Durante buenas noches es aproximadamente cinco veces menor que en los mejores lugares de observación en California y Arizona. Esto confirma que La Silla es uno de los mejores lugares de observación del mundo, no sólo a causa de su gran número de noches claras, sino también por la transparencia del cielo.

Estrellas variables en IC 5152

Uno de los mejores métodos para determinar la distancia a una galaxia cercana es medir los períodos y magnitudes de las llamadas cefeidas en la galaxia. Las cefeidas son estrellas variables que se encuentran comparando las placas fotográficas de la galaxia tomadas en distintas noches. Los Drs. Svend Laustsen y Gustav Tammann del Grupo Científico de ESO en Ginebra han analizado recientemente placas de la galaxia IC 5152.

De una fotografía tomada por D. S. Evans («Fotographic Atlas of Southern Galaxies», 1957) se puede llegar a la conclusión que la galaxia enana irregular IC 5152 se encuentra relativamente cercana, y por esta razón debe ser miembro del Grupo Local de galaxias.

Las primeras placas de IC 5152 tomadas en diferentes colores con el telescopio de 3,6 m en La Silla no sólo muestran muchas estrellas supergigantes azules y muy rojas y algunas regiones H II extendidas — que ya habían sido observadas por J. L. Sérsic (Atlas de Galaxias Australes, 1968) — sino también han llevado al descubrimiento de las primeras tres estrellas variables en este sistema. Aun no se conoce ningún período para estas variables, pero su color, amplitud y la escala de tiempo de su variabilidad las hacen aparecer buenos candidatos para ser cefeidas.

Un cálculo muy aproximativo de la distancia de IC 5152 indica 1,5 Megaparsec. Esta distancia sugiere que el Grupo Local de galaxias es algo más grande que el radio de 1 Mpc que se había adoptado convencionalmente. Se proyectan más trabajos en IC 5152 y se espera que éstos lleven a una determinación más segura de la distancia, la que no sólo ayudará para definir el porte del Grupo Local, sino que también proporcionará un importante calibrador adicional de la escala de distancias extragalácticas.

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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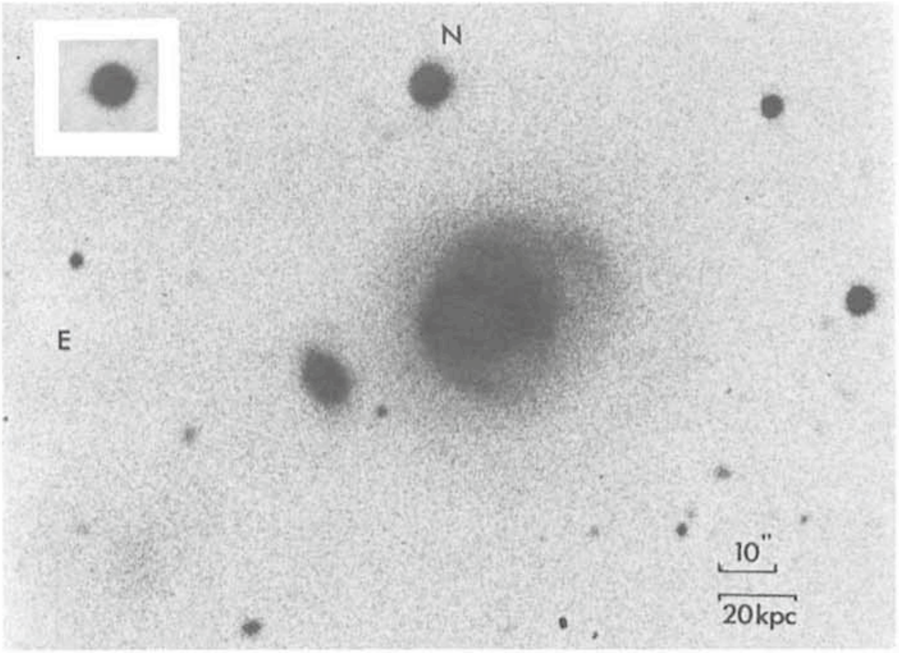

New "quasar-galaxy" ESO 113-IG45 photographed at 3.6 m prime focus. Exposure time 70 min on sensitized IIIa-J + GG385 (blue light). The insert shows a short exposure (same scale) of the nucleus, which is indistinguishable from a stellar image, cf. the star just under the "N". It is not yet known whether the companion galaxy, SE of the nucleus, is at the same distance. Original scale 19"/mm.

A Quasar in a Galaxy!

Astronomers have observed quasars since 1963. More than 600 are now catalogued, but we still know relatively little about them. Most scientists believe that they are at "cosmological" distances, i. e. that their redshifts reflect the expansion of the universe, and that they therefore are very distant and very luminous objects.

It appears that there is a smooth transition between the brightest Seyfert I galaxies (characterized by small, bright nuclei with broad emission lines) and the faintest quasars, and that quasars may simply be the very bright nuclei of galaxies so distant that we cannot see the faint spiral arms around the nucleus. This hypothesis is supported by the discovery of "fuzz" around some of the nearer quasars and of "mini-quasars" in the centres of some Seyfert I galaxies. The new galaxy, shown above, is unique, because it is relatively nearby (distance only 250 Mpc) and has a "real" quasar (absolute magnitude $M_V = -24$) in its centre.

Its name is ESO 113-IG45 (Interacting galaxy No. 45 in ESO (B) Atlas field No. 113; ESO/Uppsala list No. 5, ESO Scientific Preprint No. 8, June 1977). It was noted independently by a South African astronomer, Dr. A. P. Fairall, who obtained its spectrum by placing a grating in front of his telescope. This technique does not give the radial velocity, but Dr. Fairall classified the spectrum as "Seyfert" and commented on the stellar appearance of the nucleus (M. N. R. A. S. **180**, 391, August 1977).

Slit spectra were obtained in October 1977 with the Las Campanas 1 m Swope telescope by Dr. R. M. West of ESO. The importance of the object became clear when the redshift of the Balmer lines of hydrogen indicated a velocity of 13,600 km s^{-1} for the 13th-mag object. The lines were very broad as in a Seyfert I galaxy. Within a few days, Dr. A. Danks obtained deep plates in the 3.6 m prime focus and G. Alcaíno made UBV photometry on several consecutive nights. The three astronomers have now submitted their detailed results for publication in *Astronomy & Astrophysics*.

They find that 113-IG45 is outstanding, both among Seyfert galaxies and quasars, because it has a well-developed "spiral structure" with a diameter of not less than 75 kpc (angular 64 arcseconds) and, at the same time, a bright nucleus (apparent magnitude 13.2) of quasar-appearance and -colours.

ESO 113-IG45 (R. A. = $01^h\ 21^m.9$; Decl. = −59° 04′; 1950) will now be studied in detail in the hope that it may throw new light on the quasar phenomenon. Who knows, maybe it is really a "missing link"?

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