tions after the passage of the Moon. From Dr. Marsden's first orbit, it appears that we may see 1976 UA in October 1983 as a faint object of magnitude 18 when it passes within 15 million kilometres from Earth. There is no doubt, however, that the small planet leads a dangerous life in the space between the inner planets, and its orbit is frequently modified when it passes relatively close to the Earth, as it certainly did this time.

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

Some French Stellar Programmes in the Magellanic Clouds

Eric Maurice

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

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

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

The Large Magellanic Cloud

A large number of objective-prism plates have been taken in this direction; the Fehrenbach "prisme-objectif à champ normal" is essentially devoted to radial-velocity determination. Its diameter is 40 cm, the photographic limiting magnitude is 12^m5 over a square field of $2° \times 2°$. The plates are measured at the Marseille Observatory under the supervision of Ch. Fehrenbach and Marcelle Duflot.

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

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

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

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

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

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

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

Three-colour (blue, visible and red) photographic photometry has also been undertaken; for this the prism was

removed from the astrograph. From these observations, colour indices will be determined and colour-colour diagrams (U-B/B-V) will be drawn.

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

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

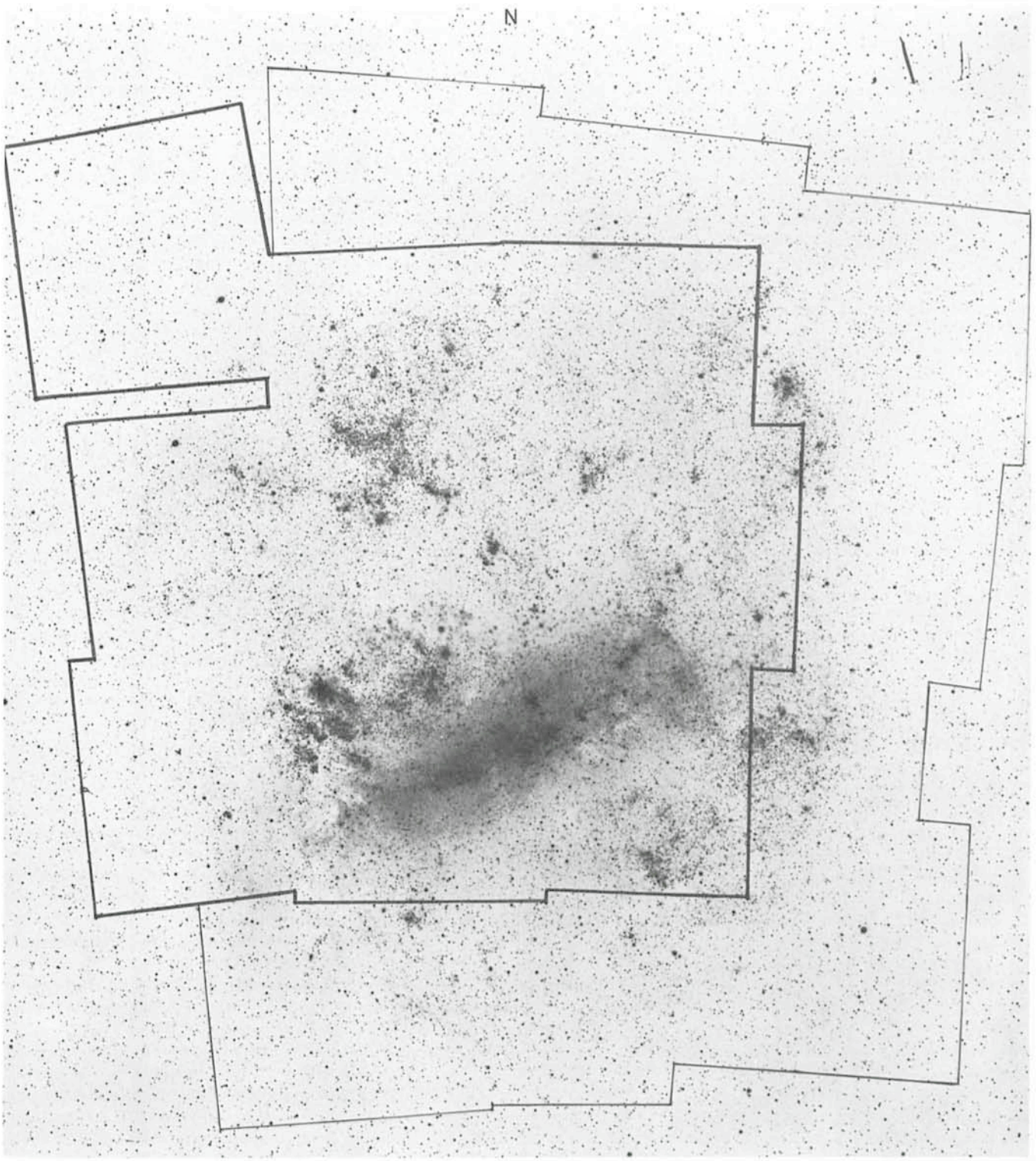

Fig. 1. — The Large Magellanic Cloud. Radial velocities have been published for 398 LMC supergiants and 1434 galactic foreground stars in the area within the heavy lines. The adjacent area (thin lines) will soon be published.

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

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

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

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

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

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

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

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

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

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

The Small Magellanic Cloud

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

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

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

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

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

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

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

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

Using this catalogue, it is possible to define a structure of the SMC shown by the supergiants. The comparison with

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

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

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

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

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

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

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

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

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

The Bochum Telescope Explores the Southern Sky

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

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

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

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

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