ESO Workshop on Modern Techniques in Astronomical Photography

A workshop on the above subject took place in Geneva, Switzerland, on May 16–18, 1978. It was organized by the European Southern Observatory, in collaboration with the Working Group on Photographic Problems of the International Astronomical Union.

During three days, about 65 participants from 19 countries discussed the latest news in the field of astronomical photography. Review papers were presented about the dramatic history of photography of the skies (Wm. C. Miller, Hale Observatories, Pasadena), the newest hypersensitizing techniques (M. E. Sim, Royal Observatory, Edinburgh), the all-important photometric calibration of the plates (A. A. Hoag, Lowell Observatory, Flagstaff) and other subjects. These included colour photography (beauty versus scientific value!), copying of plates and special photographic techniques (or rather magics) to bring out what you do not see in the photos, but what is really there (very faint details or overexposed). The current photographic work at some of the world's leading telescopes was also described, well illustrated by photos—also from the soviet 6 metre telescope.

The workshop clearly demonstrated the enormous potential of photography in astronomy. Although some applications are now being taken over by other, mainly electronic detectors of higher quantum efficiency, the photographic plate is still the only detector available for large-scale information storage (10^{10} bits on a single 14 x 14 inch plate!) and, for many other purposes, by far the cheapest and easiest to use.

The main conclusions of the workshop were brilliantly summarized by Dr. Al Millikan (Kodak, Rochester) who is also the chairman of the Working Group on Photographic Materials of the American Astronomical Society. Specific recommendations for optimum use (including hypersensitization and calibration) of the various types of emulsions were given. This information will be of great value for photographic work at the observatories—and not the least for interested amateur astronomers.

The Proceedings have been edited by R. M. West (ESO) and J.-L. Heudier (Nice Observatory) and will be available by the end of June 1978.

Proceedings of the ESO Workshop on Modern Techniques in Astronomical Photography

The Proceedings of this workshop have now been edited and will be available in print by the end of June 1978.

The price for the 300-page volume is Sw. Fr. 16.– (in Europe) and US $ 10.– (elsewhere), including postage. Please send your order to:

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Sign-posts of Star Formation in Interstellar Clouds South of Declination –30 Degrees

G. F. Gahm

A major investigation of star formation in the southern hemisphere was recently undertaken by Dr. Gösta F. Gahm from the Stockholm Observatory at Saltsjöbaden, Sweden. He obtained direct plates and spectra with the 3.6 m telescope and here reports some very interesting preliminary results. Working with a newly-commissioned telescope may also create some exciting moments . . .

The galactic dark cloud complexes south of declination –30° have not been studied in as much detail as the corresponding complexes north of this limit. This circumstance is of course a result of the previous paucity of large optical, infrared and mm-telescopes in the southern hemisphere.

However, there is a number of interesting regions south of –30°. For instance, there are two clouds in the Chamaeleon constellation, close to the southern celestial pole, at $\delta = -77°$. These clouds contain a number of recognized pre-main-sequence objects, like T. Tauri stars and the so-called Herbig type Ae- and Be-stars. Also, there are Herbig-Haro objects which are often found in regions of star formation. The Chamaeleon associations are the nearest regions of star formation that we know of, and we may therefore observe intrinsically fainter stars in pre-main-sequence phases of evolution in these clouds than in others. The most extensively studied region in the southern sky is the η Carinae nebula, which is a relatively distant giant H II region, very complex and with a number of interesting features as observed at optical, infrared and radio frequencies.

The Coalsack

The well-known Southern Coalsack is another region which has been subject to several studies. This dark cloud is remarkable in the sense that there are no sign-posts of star formation known so far. The fact that the region contains a number of Barnard-Bok globules may or may not be taken as an indication that star-formation processes have started. We do not know, however, whether the Southern Coalsack is a virgin interstellar cloud in a very early stage

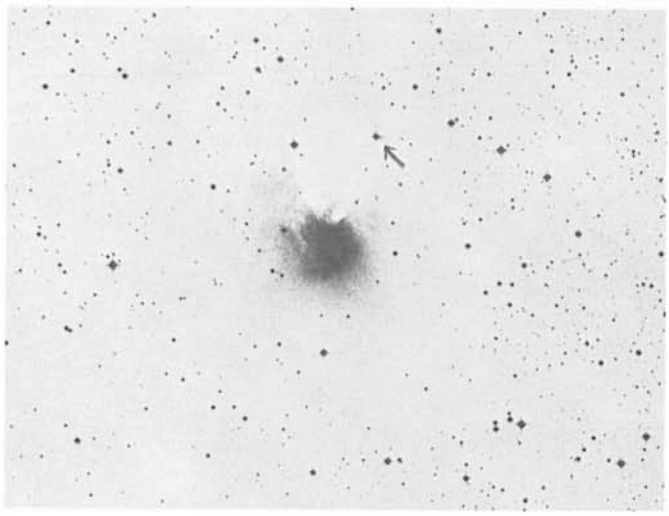

Fig. 1. — *NGC 2264 is connected to a relatively nearby, compact cloud where a bright (dark in this negative print) reflection and emission nebula is generated by a B1 V star in the cloud. The star at the arrow turns out to be a B9 V star with emission structures at the Hβ line. This star is the centre of a small reflection nebula. A few additional stars in this region were observed but were found to be foreground stars.*

preceding that of widespread star formation, or if the physical properties in the cloud are such as to prevent stars from forming. Future observations over the infrared and mm wavelengths will be most helpful in claryfying the nature of this cloud complex. It is understandable that astronomers hesitate to start long-wave mapping of such an extensive region in the sky, since the outcome of the programme may very well lead to publications entitled "A negative search for . . .". However, even if such mappings will only lead to few discoveries, they may still tell us important things about the processes that do occur or do not occur in dark interstellar clouds.

With the ESO 3.6 m telescope in operation one can start to think of a number of useful programmes directed towards a deeper understanding of star formation and early stellar evolution. The "great leaps" forward in describing the physical conditions of young stars will undoubtedly come from higher spectral and/or spatial resolution. There also appears to be much information to gain from repeated high-speed photometric and spectroscopic observations. It is my hope that the 3.6 m will soon provide facilities for such observations.

3.6 m Observations

At the moment, the 3.6 m can be used with the Boller and Chivens spectrograph plus the Carnegie image tube to obtain slit spectrograms at dispersions of 60 Å/mm and lower. It is of course tempting to start spectral investigations of the intrinsically faint members of the nearest young stellar associations. We thought, however, that as a first step it would be of value to make an inventory of southern dark cloud regions with sign-posts of star formation. As sign-posts of star formation we consider stellar groups seen in dark nebulae where at least one star is surrounded by an emission and/or reflection nebula. Such regions can often be grouped in what is generally referred to as R-associations.

We therefore searched the ESO "Quick Blue" Sky Atlas for such regions, giving emphasis to regions located in the general area of the Southern Coalsack. Telescope time for spectroscopic observations of the stars in such bright nebulosities was allotted in March 1978, and when additional time was offered due to programme changes on La Silla, it was possible to extend the programme to include a total of 25 regions south of declination −30°.

Many of these stellar groups with associated bright nebulosities have been observed previously by S. van den Bergh and W. Herbst. Their survey gives important information on the U, B and V magnitudes for a number of stars and in some cases also the spectral type for the brightest member or members in the group. With the 3.6 m it was possible to extend the spectral survey to include stars from 12th to 17th magnitude. All spectrograms were taken at a dispersion of 60 Å/mm and are in general widened to 0.4 mm.

The observational material is now under reduction and I do the work in collaboration with Miss Margareta Malmort. Most of the stars turn out to be normal O and B stars on the main sequence. Some stars are situated in bright H II regions, some are not. We derive the distance to each region which makes it possible to check whether a given region belongs to an established R-association or not. These associations are then used to map the corresponding galactic structure. The spectral survey immediately tells us which stars are members and which are not members of the stellar groups. It is our hope that the survey will prove to be useful as a background for future studies of southern regions of star formation.

Emission-line Stars

Several stars of spectral types B or A show strong and broad Balmer line emission. These stars are likely to be pre-main-sequence stars of the Herbig Ae- or Be-type. There are also examples of stars with metal-line emission. The most conspicuous example is the star listed as No. 65 b by van den Bergh and Herbst (vdBH 65b). This star, situated in a cometary nebula, shows a very interesting spectrum with strong P Cygni-type profiles in several lines. The star was listed by Sanduleak and Stephenson as a suspected

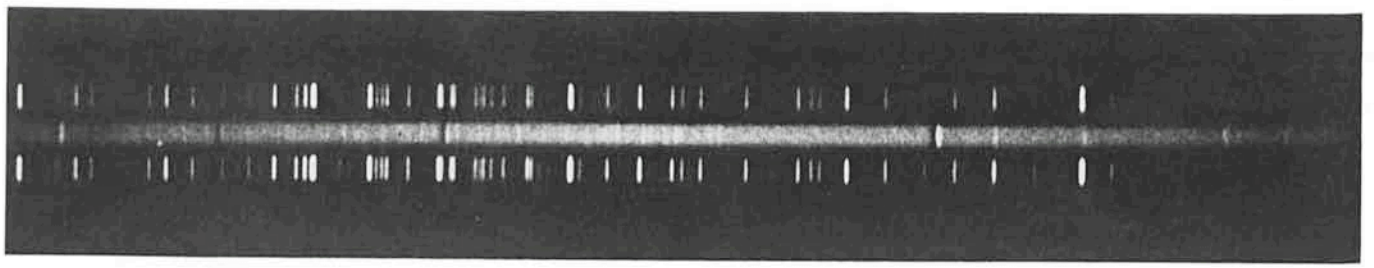

Fig. 2. — *The star vdBH 65 b is situated in a cometary nebula and shows a very interesting spectrum, rich in emission lines and with P Cygni structures in several lines.*

symbiotic star. The present investigation suggests that this object is a pre-main-sequence star with a remarkable spectrum.

Special attention is given to the regions in the general area of the Southern Coalsack. If any of these bright nebulosities are associated with the Coalsack, they could guide us into local regions of star formation in the large dark cloud complex. They would be important starting points for infrared and radio studies. The spectroscopic material has not revealed any associated regions, however. In fact, certain regions that are seen in the middle of the Coalsack turn out to be very distant background objects. One small bright nebula at $\alpha = 12^h45^m33^s$, $\delta = -63°33'38''$ (Object No. 1) seems to be associated to the Coalsack, however. In this nebula there is no star. I took a series of direct plates in the prime focus of the 3.6 m of this nebula as well as of a few others. A comparison between V (visual) and I (infrared) plates reveals no extremely red objects in the area around Object No. 1. We are uncertain to the nature of this object. In other regions we have discovered some extremely red objects from the prime focus plates.

Horror in the Dark

The prime focus nights were quite exciting and once the instrument somehow got disconnected and started to move towards the horizon. I could see my whole life passing by when sitting in the cage and searching for the emergency switch. Also the nights at the Cassegrain focus were not entirely without instrumental problems. The present system with several visiting astronomers staying over a 17-night period is, I believe, to prefer at the moment. In this way there is a fair chance that you will have your observational material complete at the end of the run. Looking upon it in this way I am quite satisfied with my first run at the 3.6 m on La Silla.

RR Lyrae Stars

J. Lub

The variable RR Lyrae stars are among the most important distance indicators in the Galaxy and its nearest neighbours. To obtain the highest precision, it is, however, necessary to know the physical characteristics of the individual RR Lyrae stars. This knowledge in turn is very valuable for studies of the stellar system (galaxy or cluster) in which the RR Lyrae star is a member. Dr. Jan Lub from the ESO Scientific Group in Geneva has recently terminated a first phase of a large investigation of RR Lyrae stars. He summarizes what can be learned from the study of RR Lyrae stars by means of accurate photometry, sometimes supported by spectroscopy.

A quick look in Kukarkin's 1969 edition of the General Catalogue of Variable Stars shows a striking number classified as RR Lyrae variables. In fact about two-thirds of all the stars listed (more than 20,000) belong to the class of pulsating variable stars, the most common of which are the RR Lyrae with 4,433 entries. Apart from that, over one thousand have been found in the globular clusters belonging to our galaxy and more than a hundred have already been identified in the Magellanic Clouds.

Two types can be discerned among the RR Lyrae stars: either the *ab-type* with asymmetric ("saw tooth") light curves, visual amplitudes ranging from $1^m.3$ to $0^m.4$ and periods in the range $0^d.8$ to $0^d.3$ or the *c-type* with symmetric (sinusoidal) light curves, having amplitudes of $0^m.5$ and lower, and periods ranging from $0^d.45$ to $0^d.25$. There is no physical difference between these two classes; the c-type RR Lyrae being first overtone pulsations, whereas the ab's pulsate in the fundamental mode. It goes without saying that the large amplitude of the light variation and the rather short period make the detection of these variables rather easy; a fact which largely explains the large number which have been found in the various surveys.

The Importance of Studying RR Lyrae Variables

The importance of the study of RR Lyrae stars is at least threefold: first they can be used as "standard candles" in distance determinations, and secondly they provide us with information on the chemical composition (helium and heavy element abundance) in the halo and old disk population of our galaxy. Finally, they are important test objects for a large amount of theoretical work in stellar structure and evolution and hydrodynamics. Accurate photometric data are a first prerequisite for such studies, because we need such quantities as mean light intensity, interstellar reddening, blanketing and especially in connection with the last and first points, temperature, surface gravity and radius variation.

As to the first point: on quite general grounds one expects the existence of a Period-Luminosity-Colour (Temperature) relation for any class of pulsating variable stars. For example, for the *Cepheids* with their wide range in age (and thus mass), this becomes the well-known *Period-Luminosity* relation: the colour (i. e. the width of the instability strip) being of secondary importance. This is in strong contrast to the case of the *RR Lyrae* stars where there exists a *Period-Colour* relation, the luminosities being rather similar, due to their approximately equal age (and thus mass). This luminosity has been derived by the method of statistical parallaxes or from main-sequence filling of globular clusters and an absolute visual magnitude of about $0^m.7$–$0^m.5$ is found in such a way.

A study of the strength of the Ca II K line in the spectra of RR Lyrae stars at minimum light by Preston revealed a large range in metal abundance. Moreover, he found a strong correlation between the kinematical properties of a group of field variables and their heavy element abun-