sel/Strupat/Boenhardt/Herczeg, Liller/Alcaino.

September: Liller/Alcaino, Richtler, Maurice/Bouchet/Martin/Prévot.

50-cm ESO Photometric Telescope

April: Manfroid/Sterken/Arpigny, Antonello/Conconi/Mantegazza, Arlot/Thuillot/Morando/Lecacheux, Antonello/Conconi/Mantegazza, Carrasco/Loyola, Gustafsson/Morell/ Edvardsson, Fischerström/Liseau/Lindroos, Kohoutek.

May: Kohoutek, Bouvier/Bertout/Bouchet/Bastien, Herczeg/Drechsel, Busso/Scaltriti.

June: Busso/Scaltriti, Manfroid/Sterken/Arpigny, Giovannelli/Vittone/Covino/Rossi C./Foing/Nastari/Bisnovatyi-Kogan/Sheffer/Lamzin, Group for Long Term Photometry of Variables.

July: Group for Long Term Photometry of Variables.

August: Group for Long Term Photometry of Variables, Thé/Westerlund/Singh Vardya, Thé/Westerlund, Carrasco/Loyola, Debehogne/Zappala/De Sanctis, Vittone/Covino/Milano/Rigutti.

September: Vittone/Covino/Milano/Rigutti, Group for Long Term Photometry of Variables.

GPO 40-cm Astrograph

April: Koutchmy/Lamy/Castinel/Verseau, Seitter/Tsvetkov/Duerbeck.

May: Seitter/Tsvetkov/Duerbeck, Elst.

June: Elst.

August: Debehogne/Machado/Caldeira/Vieira/Netto/Zappala/De Sanctis/Lagerkvist/Mourao/Tavares/Nunes/Protitch-Benishek/Bezerra/Pereira.

September: Debehogne/Machado/Caldeira/Vieira/Netto/Zappala/De Sanctis/Lagerkvist/Mourao/Tavares/Nunes/Protitch-Benishek/Bezerra/Pereira.

1.5-m Danish Telescope

April: Mayor/Duquennoy/Andersen/Nordstroem, Stobie/Miller/Cannon/Hawkins, Arpigny/Dossin/Manfroid, Quintana/de Souza, Ilovaisky/Chevalier/Angebault/Motch/Mouchet, Reinsch/Beuermann/Weißsieker/Pakull.

May: Galletta, Reimers/Koester, Maccagni/Vettolani, v. Paradijs/v.d. Klis, Baade/Danziger, Barbuy/Ortolani/Bica.

June: Barbuy/Ortolani/Bica, Ortolani/Gratton, de Jong/Lub, Fransson/Lindblad/Palumbo, Picquette/Mauron/Lacombe.

July: Lewin/Pedersen/van Paradijs.

August: Lewin/Pedersen/van Paradijs, Mayor/Mermilliod, Mayor/Duquennoy/Andersen/Nordstroem, Clementini/Cacciari/Prévot/Lindgren.

September: Ardeberg/Lindgren/Maurice/Prévot/Lundström, Cameron/Sandage/Binggeli/Brinks/Klein/Danziger/Matteucci.

50-cm Danish Telescope

May: Barrera/Vogt, Group for Long Term Photometry of Variables.

June: Group for Long Term Photometry of Variables, Ardeberg/Lindgren/Maurice/Prévot.

July: Ardeberg/Lindgren/Maurice/Prévot, Tobin/Viton/Sivan.

August: Tobin/Viton/Sivan, La Dous/Cacciari/Clementini, Group for Long Term Photometry of Variables.

September: Group for Long Term Photometry of Variables, Ardeberg/Lindgren/Maurice/Prévot/Lundström, Grenon/Oblak.

90-cm Dutch Telescope

April: van Genderen/Steemers/van der Hucht, Gathier/Atherton/Pottasch/Reay, de Loore/Monderen/van der Hucht.

May: Manfroid/Vreux/Scuflaire.

June: Manfroid/Vreux/Scuflaire, Trefzger/Pel/Blaauw, de Zeeuw/Lub/de Geus/Blaauw.

July: Grenon/Lub.

August: Grenon/Lub, Thé/Westerlund/Singh Vardya, Thé/Westerlund.

September: v. Amerongen/v. Paradijs/Blondel.

61-cm Bochum Telescope

April: Kohoutek/Schramm, Grewing/Barnstedt/Bianchi/Gutekunst/Kappelmann.

May: Grewing/Barnstedt/Bianchi/Gutekunst/Kappelmann, Schober/Surdej/Albrecht, Schneider/Maitzen/Catalano F.

June: Schneider/Maitzen/Catalano F., Gammelgaard.

July: Di Martino/Zappala/Farinella/Cellino.

IMPROVED MASKING TECHNIQUE APPLIED TO GRISM PLATES

Identification of New Carbon Star Candidates in SMC Globular Cluster NGC 419

M. AZZOPARDI, B. DUMOULIN and J. QUEBATTE, ESO
E. REBEIROT, Observatoire de Marseille

For quite some time we have been surveying the Magellanic Clouds for carbon stars. We have used the ESO 3.6-m telescope equipped with the red wide field corrector and a Hoag grism having its maximum transmission (85%) at about 4850 Å. Each field covers a circular area of about 0.8 square degrees of which a sector of about 18% goes from slightly to fully vignetted. In order to minimize the number of overlapping images, the instrumental spectral domain has been reduced to the useful spectral range 4350–5300 Å by combining a IIIa–J emulsion with a Schott GG 435 filter. In spite of the limited spectral range and the low dispersion used (2200 Å/mm), carbon stars can be identified, on our grism plates, by means of the strong Swan band of the C_2 molecule at 5165 Å (see Fig. 2 in the paper by Azzopardi and Westerlund, 1984).

About 8 observing nights in the autumns of 1981 through 1984 were necessary to observe, with reasonably good seeing ($\lesssim$ 2 arcseconds), 8 fields located in selected regions of the Large Cloud and 13 fields, partially overlapping, together covering the main body of the Small Cloud. Exposures of 60 minutes and 5 minutes have been secured for each field. At present all SMC grism plates have been systematically searched for C stars with a binocular microscope, and the spectrophotometric study completed for two fields (Westerlund, Azzopardi and Breysacher, 1985). Deep surveys in 37 small selected areas in the SMC have also been carried out by Blanco, McCarthy and Blanco (1980) using the grism technique in the near infrared. From this sample, Blanco and McCarthy (1983) estimated that the total number of carbon stars in the Small Cloud is about 2,900.

The degree of completeness of our green grism survey for SMC carbon stars has been investigated (Westerlund and al., 1985) by comparing the objects we identified in the very crowded field SMC B (bar) with those found by Blanco and associates (1980). This study shows that 11 objects have been identified only by our survey. The most likely explanations for the few stars not being detected by us is that they are either variable or very red and therefore too faint to be seen in the blue-green spectral range, or that they have extremely weak C_2 bands. From this comparative study we ascertained that the slight rotation of the spectra of one plate with respect to the others allows one to identify a number of overlapping objects in the field in common. Finally, the survey of short exposure plates reveals some relatively bright objects which are not visible on the deeper grism plates because they are overexposed. Consequently, we may consider that our survey technique allows a reasonably complete detection of the field C stars in the SMC, even in the most crowded regions of the bar. However, this detection technique is powerless in the areas of the plate where the optical density is particularly

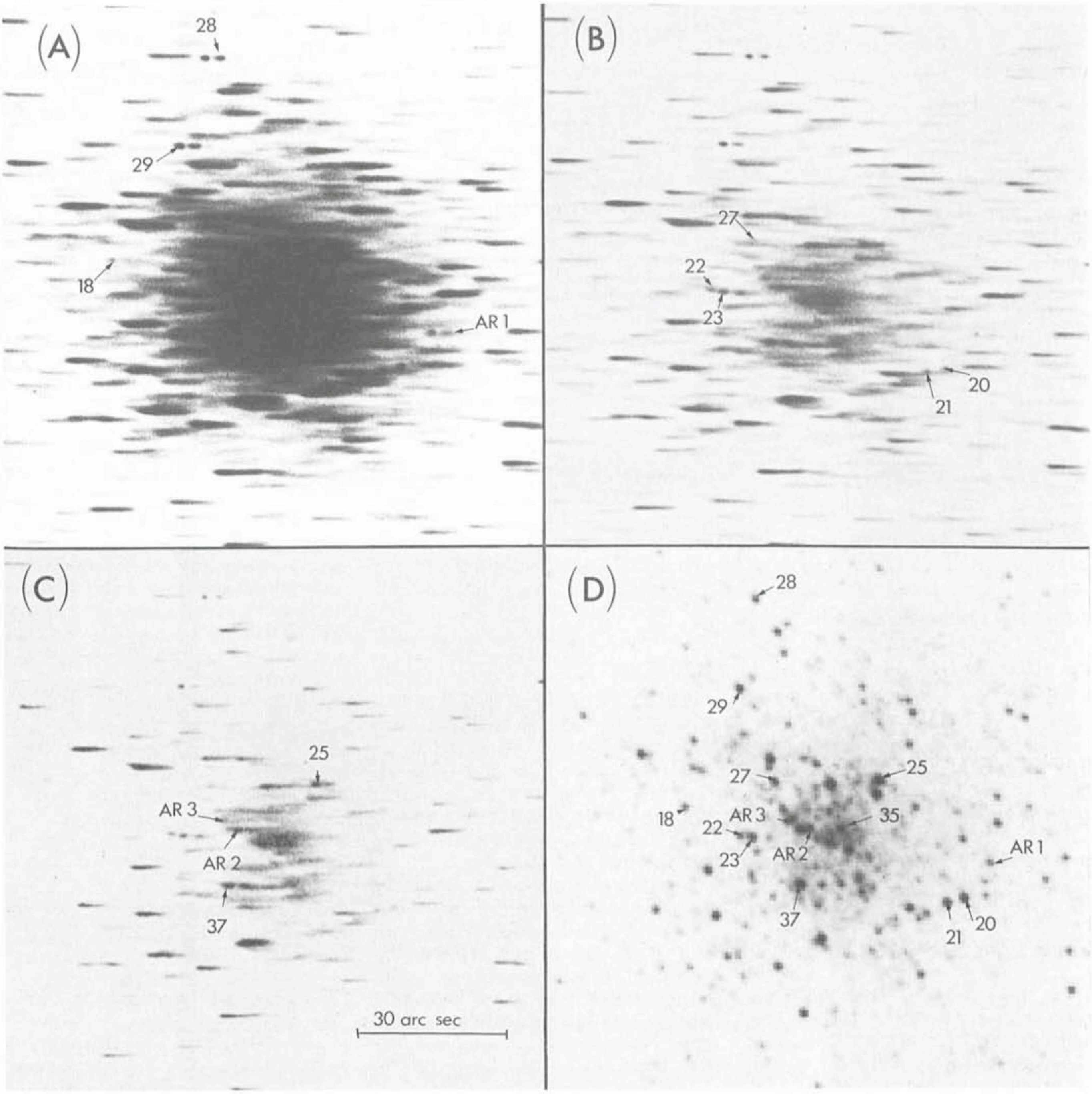

Figure 1: *Carbon stars in the SMC globular cluster NGC 419. Confirmed or possible carbon stars lying within 1 arcminute of the cluster's centre are identified as follows: numbers in the range 18–31 are from Lloyd Evans (1980) while AR numbers are from the present survey.*

Upper panels: Prints made by enlargement (~ 15 times), (A) from an unmasked positive plate copied from an ESO 3.6-m telescope grism plate (forming gas baked IIIa–J emulsion, 1-hour exposure); (B) from a positive plate made from the original grism plate with the special masking technique (see text).

Lower panels: Prints made from images written on photographic film using the Dicomed image recorder and software commands of the Munich Image Data Analysis System (MIDAS); (C) PDS scan of the positive masked plate, (D) CCD imaging with the ESO Faint Object Spectrograph and Camera (EFOSC) at the 3.6-m telescope (Gunn r filter, 1-second exposure). Note that appropriate density or count cuts have been chosen to show the central region of the globular cluster.

high, namely in the large bright H II regions and near the centre of the globular clusters. In order to find out the real efficiency of our grism technique for surveying the globular clusters, we concentrated on a small field in and around the compact globular cluster NGC 419.

NGC 419 is the brightest globular cluster in the SMC. From a (V, B-V) colour-magnitude diagram of NGC 419, Arp (1958a, b) found that the brightest red giants of this cluster are redder than those in globular clusters in the Galaxy, and was the first to assume that the reddest ones were carbon stars (N stars). This was also suggested by Walker (1972), but no spectra were obtained until the spectroscopic observations by Feast and Lloyd Evans (1973) revealed the first carbon star in NGC 419 (star No. 23, Figure 1D). In order to find out the nature of the very red stars near NGC 419, Blanco and Richer (1979) secured a near-infrared grism plate. They identified 78 C stars in a 24-arcminute diameter field around the cluster, three of the stars lying within one arcminute of the cluster's centre. In fact, one had to await the 1980s to obtain the catalogue and the finding charts of the very red stars in the Magellanic Cloud globular clusters – selected from their (V-I) colour indices –

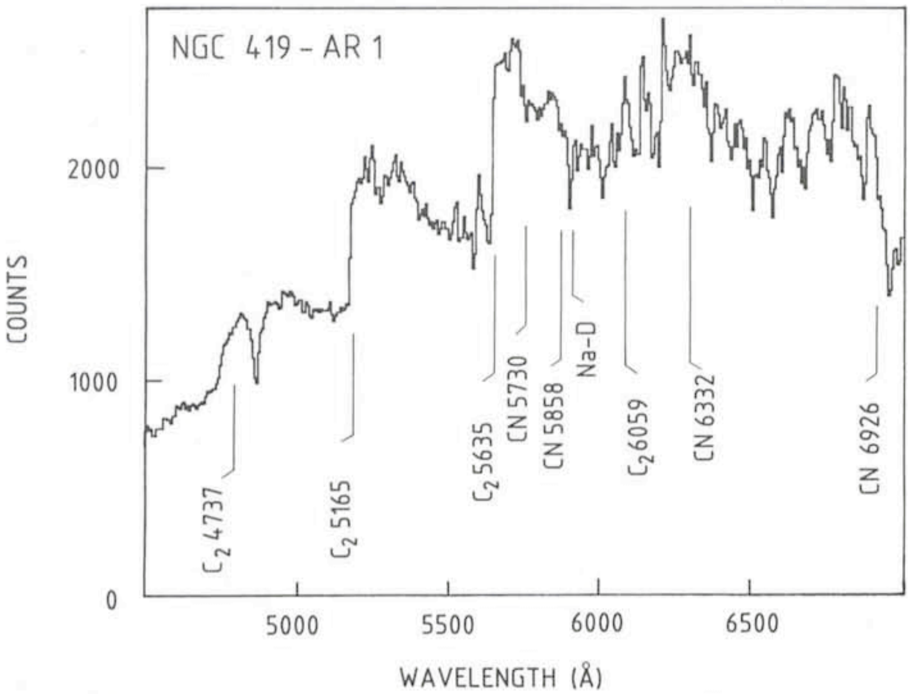

Figure 2: *Spectrum of carbon star NGC 419-AR 1 obtained with the ESO 3.6-m telescope using the Boller and Chivens spectrograph and a CCD camera. The spectral resolution is 8 Å (FWHM) and the integration time 40 minutes.*

by Lloyd Evans (1980). This author gave a list of 24 red stars, probable or possible members of NGC 419. Subsequent spectroscopic observations (Lloyd Evans, 1980; Bessel, Wood and Lloyd Evans, 1983) and infrared JHK photometry (Aaronson and Mould, 1982; Mould and Aaronson, 1982) of these selected objects allowed one to identify 12 C stars plus one doubtful candidate within the cluster boundary (~2 arcminutes radius) as seen on a deep plate (Durand, Hardy and Melnick, 1984).

Our grism survey of the close surroundings of NGC 419 allowed us to find all 6 carbon stars originally discovered by Blanco and Richer (1979), and to detect one more C star candidate not identified as a very red star in the previous photometric studies. Figure 1A shows the three C stars nearest to the cluster's centre found by Blanco and Richer plus the new C star candidate AR 1. Note that star No. 28 = BR 4 is a J star according to Bessel et al. (1983). This result encouraged us to better explore the spectra of the objects belonging to the unresolved central regions of the cluster. An efficient way to reduce the density range (up to D = 5) of a deep plate is the use of photographic masking. Work has been done at the ESO Sky Atlas Laboratory to improve a masking technique well adapted to our IIIa–J grism plates. More details on this method will be given later. After a quick examination of the positive plate obtained by our masking technique, we detected the other 5 C stars that had been found or confirmed by earlier spectroscopic observations (Figure 1B). Nevertheless, in order to gather more precise spectral information on the objects lying in the core of the cluster, the masked positive plate has been scanned with the ESO PDS microdensitometer. Thanks to optimized density cuts of the digitized image (10 μm square pixel size) we were able to identify 4 additional carbon star candidates (Figure 1C). Two of these objects belong to the list of red stars in the Magellanic Cloud clusters by Lloyd Evans (1980). They have previously been classified as "photometric carbon stars", according to their location in the (J-H, H-K) two-colour diagram, by Mould and Aaronson (1982) (star No. 25), and by Aaronson and Mould (1982) (star No. 37, doubtful case), respectively. The others are two new C star candidates (AR 2, 3). As far as we can see from our survey of the extreme core of NGC 419, star No. 35 (Lloyd Evans, 1980), which has also been classified by Aaronson and Mould (1982) as a "photometric carbon star", does not show, on the digitized image of NGC 419, any of the typical spectral features of a carbon star.

The goal of photographic masking is to reduce the density range of a deep original plate while keeping the fine detail of the image. The use of a soft mask has little effect upon fine detail (e.g. faint stars) but strongly affects extended areas (bright nebulae and galaxies, globular clusters). From a practical point of view, registration of the mask and the original negative is less critical when the images on the mask are slightly diffuse. This technique is particularly adapted in reducing the dynamic range of the high-contrast Kodak IIIa–J emulsion. An unsharp masking method has been developed for direct plates by Malin (1977). This masking technique has been improved at the ESO Sky Atlas Laboratory to process our grism plates using different photographic equipment and material. The basic difference arises from the use of a tungsten point source at 5 metres (100 watt opal lamp) instead of a diffuse light contact printer. Consequently, the degree of diffusion used in producing the mask is due only to the plate thickness (~1 mm). The exposure time of the mask (Kodak commercial film) is a function of the sky background density (t = 2 minutes for D = 0) while the development time (6 to 11 minutes) in Kodak D-76 developer (diluted 1 part developer with 3 parts of water) depends on the required density correction. The positive plate (Kodak Process) obtained through a mask from the original grism plate shows rather well resolved spectra in the cluster core but the spectral information is poor, mainly due to the lack of contrast. In order to restore the contrast balance, a second short exposure (10 to 20 seconds) is made, after removing the mask, through an ultraviolet filter using a standard iodine-quartz lamp. The UV filter allows one to avoid unusually short exposures. The masked positive plate is rigidly locked to the original negative during both exposures. Then it is developed 4 minutes in Kodak D-76 developer. The photographic plate has been chosen because of its higher dynamic range.

In short, this new grism survey of NGC 419 has resulted in the detection of the 8 C stars which were previously known via spectroscopic observations, in the confirmation of 2 of the 3 objects which had been classified as C stars by JHK photometry and in the identification of 3 additional C star candidates, within one arcminute of the cluster's centre. Since statistics by Blanco and Richer (1979) show that just 0.5 C star is expected to be among the field stars in such an area, these objects have a high probability of being cluster members. Consequently, NGC 419 is by far the richest globular cluster known in asymptotic giant branch (AGB) carbon stars. Confirmed and possible C stars in NGC 419 are identified in Figure 1D, which is a CCD image (1.3 arcseconds FWHM resolution) obtained last November at the ESO 3.6 m telescope with the ESO Faint Object Spectrograph and Camera (EFOSC).

In an attempt to confirm the nature of the newly discovered C star candidates with better spectral resolution, observations with the Boller and Chivens spectrograph attached to the ESO 3.6-m telescope were carried out last December. The grating, with 400 lines/mm and blazed at 5400 Å, provided a dispersion of 172 Å/mm in the first order. Using an RCA CCD having 30 μm square pixel in size, and a slit aperture of 2 arcseconds we achieved a final spectral resolution of 8 Å (FWHM) in the wavelength range λλ 4500–7000. These observations allowed us to confirm as C stars the candidates AR 1 and No. 25 which lie within 30 arcseconds of the centre of NGC 419, therefore having a high probability of cluster membership. The spectrum of the star AR 1 is displayed in Figure 2. Unfortunately, we were unable to observe other C star candidates lying in the core of NGC 419 because the seeing was not good enough to identify these objects with certainty.

From this study of NGC 419 we can conclude that our grism technique is able to survey the carbon stars both in the field and in the globular cluster cores of the Magellanic Clouds provided that a special photographic process is applied to copy the original plates. Concerning the clusters, the C star survey on positive masked plates seems to be complementary to, if not more efficient than, the JHK photometric method developed by Aaronson and Mould (1982), because it is less liable to errors due to the background brightness in cluster cores, and also because no preconceived colour criterion is necessary in preselecting the red stars.

The extension of the asymptotic giant branch (AGB) above the tip of the first giant branch can be used to estimate the age of the Magellanic Cloud clusters (see Aaronson and Mould (1985) and previous papers by these authors). Consequently, the luminosity function of the upper AGB in globular clusters can be used to calibrate in age the corresponding luminosity function for field stars, thus providing information on the star formation history of the Clouds. Therefore, a more complete sample of AGB stars, in the larger sample of clusters of intermediate age and older, is of special astrophysical interest. Using the available set of grism plates we are engaged in this work.

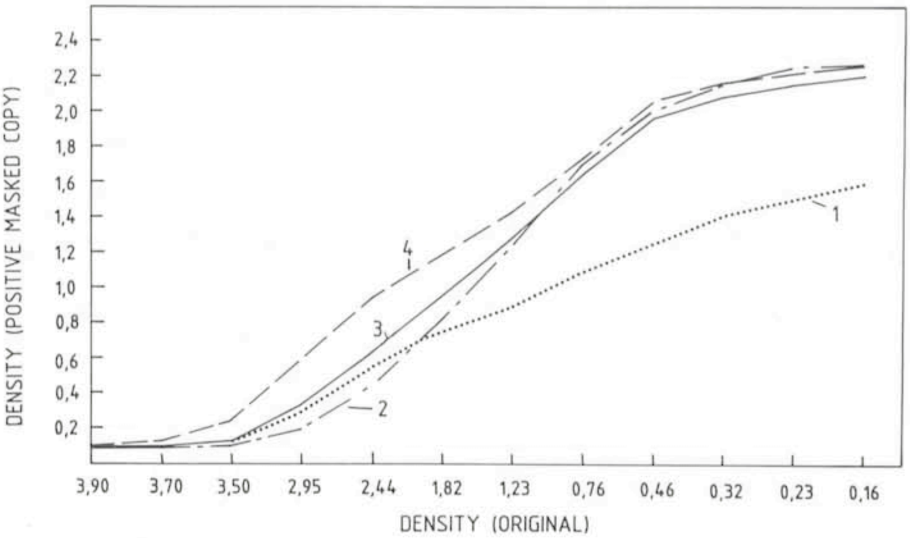

Figure 3: *Comparison of four positive plates obtained through a mask (4-minute exposure from an original grism plate) and the following photographic processing:*
(1) mask developed 8 minutes; positive obtained in 12-minute exposure through the mask,
(2) mask developed 6 minutes; positive obtained in 6-minute and 9-second exposures with and without the mask, respectively
(3) mask developed 8 minutes; positive obtained in 12-minute and 9-second exposures with an without the mask, respectively
(4) mask developed 10 minutes; positive obtained in 18-minute and 9-second exposures with and without the mask, respectively.
Note the effect on the higher densities of the short exposure without mask.

References

Aaronson, M., Mould, J.: 1982, *Astrophys. J. Suppl.* **48,** 161.
Aaronson, M., Mould, J.: 1985, *Astrophys. J.* **288,** 551.
Arp, H.C.: 1958a, *Astrophys. J.* **63,** 273.
Arp, H.C.: 1958b, *Astrophys. J.* **63,** 487.
Azzopardi, M., Westerlund, B.E.: 1984, *The Messenger* **36,** 12.
Bessel, M.S., Wood, P.R., Lloyd Evans, T.: 1983, *Monthly Notices Roy. Astron. Soc.* **202,** 59.
Blanco, V.M., McCarthy, M.F.: 1983, *Astron. J.* **88,** 1442.
Blanco, V.M., McCarthy, M.F., Blanco, B.M.: 1980, *Astrophys. J.* **242,** 938.
Blanco, V.M., Richer, H.B.: 1979, *Pub. Astron. Soc. Pacific* **91,** 659.
Durand, D., Hardy, E., Melnick, J.: 1984, *Astrophys. J.* **283,** 552.
Feast, M.W., Lloyd Evans, T.: 1973, *Monthly Notices Roy. Astron. Soc.* **164,** 15 P.
Lloyd Evans, T.: 1980, *Monthly Notices Roy. Astron. Soc.* **193,** 87.
Lloyd Evans, T.: 1980, *Monthly Notices Roy. Astron. Soc.* **193,** 97.
Malin, D.F.: 1977, *Amer. Astron. Soc. Photo Bull.* **16,** 10.
Mould, J., Aaronson, M.: 1982, *Astrophys. J.* **263,** 629.
Walker, M.F.: 1972, *Monthly Notices Roy. Astron. Soc.* **159,** 379.
Westerlund, B.E., Azzopardi, M., Breysacher, J.: 1985, ESO Scientific Preprint No. 406, and 1986, *Astron. Astrophys. Suppl.* (in press).

First Images of Globular Clusters Using a GEC CCD With UV Sensitive Coating

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Two "blue coated GEC CCDs" were recently made available for visiting astronomers at La Silla (*The Messenger* No. 41 and No. 42). We used the ESO CCD No. 7 to obtain UBV images of central regions of globular clusters at the Cassegrain focus of the 2.2-m La Silla telescope. The scientific aim was primarily to monitor the error box of the NGC 1851 X-ray source in quasi simultaneous observations with EXOSAT. This programme was carried out in collaboration with L. Koch-Miramond and J.M. Bonnet-Bidaud (C.E.N. Saclay) and J.P. Cordoni (Montpellier). The X-ray source associated with NGC 1851 is located just outside the core of the cluster (12 arcseconds north of the centre). Following our identification of the optical counterpart of the northern M15 X-ray source (1984, *Astron. Astro-*