NARROW SPECTRAL RANGE OBJECTIVE-PRISM TECHNIQUE APPLIED TO A SEARCH FOR SMALL MAGELLANIC CLOUD MEMBERS

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I. INTRODUCTION

The Magellanic Clouds are exceptional galaxies for the study of massive stars and other luminous objects, because they are close and seen in directions where the galactic interstellar extinction is relatively low. In addition the Small Magellanic Cloud (SMC) is of special interest because of the possible peculiar effects that its low metal abundance, compared to the Solar neighbourhood, may have on the evolution of its stellar population. Consequently, a search for the most luminous SMC members has been the subject of many studies. Among the different means used to detect SMC members, the wide field cameras equipped with objective prisms, Grisms or Grenses have played a prominent part. The method consists of selecting stellar objects showing high luminosity or typical spectral features. Such surveys have been especially successful in detecting SMC Hα emission-line objects (Henize, 1956; Lindsay, 1961), OB and blue supergiant stars (Sanduleak, 1968, 1969), planetary nebulae (Sanduleak et al., 1978; Sanduleak and Pesch, 1981) or carbon and late M-type stars (Blanco et al., 1980).

II. A SEARCH FOR SMC MEMBERS

One of the major difficulties encountered in surveying SMC members comes from the projected high stellar density of this galaxy which is due to its orientation along the line of sight, and the presence of numerous nebulosities. To minimize this difficulty the classical method usually consists of reducing the length of the spectra using the lowest dispersion possible. This is done in order to reduce the number of overlapping images and to reach fainter stellar objects in a given exposure time. Although adequate, this method has the serious disadvantage of lower spectral resolution, reducing the quality and the accuracy of the spectral classifications.

Another technique for reducing the length of the spectra, and therefore the number of overlapping images, consists of using an inter-

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ference filter to select the spectral range which includes the more characteristic spectral features of a given type of object. In addition, the use of interference filters, by reducing the background fog due to the sky, allows longer exposure times and hence the possibility of reaching fainter stars. This method, which Martin and Rebeirot (1972) initially used to detect OB stars in some crowded Large Magellanic Cloud regions, has been used intensively with success by the author and associates to survey different kinds of luminous stars in the SMC.

i) OB stars and blue supergiants.

The survey of OB and blue supergiant stars was carried out at La Silla with the 40 cm objective prism astrograph (Fehrenbach, 1966) of which the dispersion is roughly 121 Å mm^{-1} at Hγ. Two interference filters of about 260 Å band width centered at λ3940 and λ4390 respectively were used. The former filter was intended to detect OB stars and the latter blue supergiants. Exposures of 8 and 6 h respectively on IIa-O nitrogen baked plates permitted us to reach stars up to a limiting photographic magnitude of about 15. Within these limited spectral ranges the available MK spectral classification criteria adapted to objective prism spectra by Fehrenbach (1958) were used. Four fields were explored, 3 square degrees each, located in the bar and in the wing (region of NGC 456, 460 and 465), and all partially overlapping. The survey resulted in the detection of 520 stars showing high luminosity spectral features, 327 of them being new SMC members. A complete description of this survey as well as the list and identification of the objects has already been published by Azzopardi and Vigneau (1975, 1979). A third interference filter of 250 Å band width centered at λ4350 having a homogeneous transmission of 85 ± 1% throughout permitted the measurement of the Hγ line intensity. For this purpose, interactive programs for computing equivalent widths on objective prism spectra were written by Azzopardi et al. (1978). Using standard galactic stars, this method allowed us to determine the MK luminosity class or subclass of 172 O9 to A7 stars when their spectral types were known (Azzopardi, 1981; Azzopardi and Vigneau, 1982).

ii) Wolf-Rayet stars.

The detection of Wolf-Rayet stars was carried out at La Silla with the same instrument (dispersion 150 Å mm^{-1} at λ4650) using an interference filter centered at λ4650 and having a pass band width of 120 Å. Wolf-Rayet stars show up strongly in this spectral region due to the emission mainly from either λ4650 CIII (WC) or λ4686 HeII (WN). Five circular fields of 85 arc min diameter each, all partially overlapping, were required to cover the bar and the wing of the SMC. IIa-O nitrogen baked plates were used and 6 h exposures for each field permitted us to reach the continuum of 16.5 mpg stars in the most crowded SMC regions. This survey resulted in the identification of the 3 already known WR stars and the detection of 4 new faint WR stars, afterwards confirmed by slit spectrography (Azzopardi and Breysacher, 1979). Recent observations at the prime focus of the 3.6m ESO telescope equipped with a Grism did not discover any new WR stars down to magnitude 20 confirming, the completeness of this survey at least in the regions explored.

iii) Hα emission-line objects.

More recent observations with the Curtis Schmidt Telescope at C.T.I.O. allowed us to secure good to very good SMC plates using an interference filter of 110 Å band width centered at λ6565. Exposures of 4 and 2 h were taken permitting us to reach the continuum of stars up to about 18 photographic magnitude in very crowded fields. A preliminary examination of the plates has already revealed, in the central regions of the SMC, a large number of new faint Hα emission line objects not identified in the previous surveys by Henize (1956) and Lindsay (1961). In order to discriminate the Hα emission line stars from planetary nebulae or unresolved H II regions an additional set of IIIa-J forming gas baked plates were taken through an interference filter of 80 Å band width centered at λ5000. Although a substantial number of faint objects show λλ4959, 5003[OIII] emission lines, we have so far not detected any other candidate than the planetary nebulae discovered by Sanduleak and associates.

III. WORK IN PROGRESS

From the foregoing, it is clear that objective prisms (astrographs or Schmidt Telescopes) equipped with various interference filters properly chosen for the detection of different types of objects make possible very deep surveys in fields of high stellar density. However, this technique was until now only applied to the study of the stellar populations of the Galaxy and the Magellanic Clouds. To survey other external galaxies a variant of this technique can be adapted to large telescopes using Grisms or Grenses (dispersion ≈ 2000 Å mm^{-1}) and suitable colored filters. At present, we are using this technique, described in detail by Breysacher and Lequeux (1983), to survey Wolf-Rayet stars, planetary nebulae and carbon stars in nearby galaxies.

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