БОЛГАРСКАЯ АКАДЕМИЯ НАУК . BULGARIAN ACADEMY OF SCIENCES

АСТРОФИЗИЧЕСКИЕ ИССЛЕДОВАНИЯ, 5 . ASTROPHYSICAL INVESTIGATIONS, 5

София . 1989 . Sofia

Foreground contamination of the spiral arm S3 in the M33 galaxy

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The examination of the foreground contamination in the nearby galaxies gives the necessary information for the separation of the member stars. The contamination by the galactic foreground makes (especially in M33) the calibration of bright stars very difficult.

It is well known that the *U* plates provide an extremely useful discriminant against the foreground contamination. It was just the *U* plates that allowed Kunchev and Nikolov (1984) to count about 8300 stars down to $U=20{,}3$ in M 33. The aim of this paper is to separate the foreground stars in three fields of the S3 spiral arm in M33 on the basis of UBV photometry. In this way the studying of the properties and distribution of the luminous member stars would be facilitated.

M33 plates with good quality were taken in the UBV system by the 2 m Ritchey-Chretien telescope of the Bulgarian Academy of Sciences. The observational material enabled us to carry out UBV photometry of more than 200 stars in three fields in the southern region of the spiral arm S3 (Ivanov and Kunchev, 1985). These were the associations BO110, OB112 and an area (NA) north of them in which independent associations were absent (Kunchev et al., 1986). The stars were measured many times. The methods of measurement were described in the work of Ivanov (1985). A comparison of the individual values shows that the *V* and *B* magnitudes are accurate within $\pm 0^m.1$ and the *U* magnitudes within $\pm 0^m.15$.

Figure 1 *a*, *b* shows the colour-magnitude and the colour-colour diagrams for the measured stars in the three fields. The Main Sequence stars and the red supergiants were dicussed in the work of Kunchev et al. (1986). In the present paper we will focus our attention in detail on the stars with colours between $(B-V)=1{,}0$ and 2,0 and $(U-B)>0$. These stars are in the limits delineated in Fig. 1 *a*.

The area taken by our three fields is relatively small as compared to the whole face of M33. At the same time, as it is well known, the foreground contamination of M33 by the galactic K and M dwarfs is strong. It would be useful to compare the contamination in these three fields with that of the area SA 45. The latter is located in the nearest proximity to M33 but still outside its borders. An examination of the colour-magnitude diagram for SA 45

(S a n d a g e, K a t e m, 1977) within the 0,056 square degrees area shows that 112 stars between $V=17^m$ and $V=20^m.2$ in the colour range $0,8<(B-V)<2,0$ exist in SA 45. The whole area of the three of our fields is ~0,008 square degrees. Having in mind the correlation of the areas, we expect 16 foreground dwarfs in these fields. At the same time, as it is seen from Fig. 1 *a*, there are 31 stars in the stated photometric intervals. The agreement is not good and that is difficult to explain.

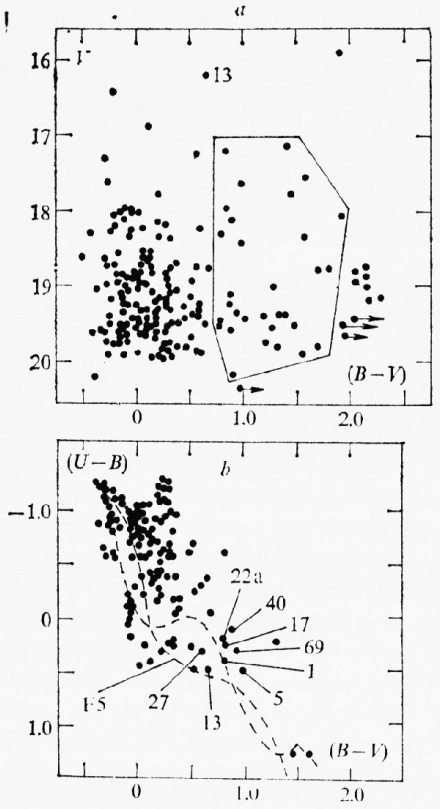

Fig. 1. *a* — Colour-magnitude diagram for the measured stars in OB110, OB112 and NA. The stars with $0,8<(B-V)>2,0$ are delineated
b — Colour-colour diagram for the stars in Fig. 1*a*. The lines of the intrinsic colours of the Main Sequence and that of the supergiants (Ia) are shown. The stars from Table 1 are marked by their numbers

The colour excesses (E_{B-V}) (see Table 1) for each of the three examined fields (OB110, OB112 and NA) are determined in the work of K u n c h e v et al. (1986). Even having in mind the values of $E(B-V)$, 24 stars remain in the stated photometric intervals. The difference of 8 stars from the expected 16 foreground dwarfs is too great to take it for a fluctuation of the foreground.

A possible explanation of this is the mixing of the real existing F and G supergiants which are M33 members with the foreground stars. The errors of our photometric measurement are comparatively small. Due to that reason the possible mixture of the member stars with the foreground dwarfs is hardly likely for $(B-V)<0,8$ (see Fig. 1 *b*). In this case the knowing of the colour $(U-B)$ is of decisive importance.

In Table 1 are given the photometric data for 8 stars whose affiliation to the foreground or to M33 could be defined. With the exception of the two first all the rest stars from Table 1 have $V>17,5$. The affiliation of a given star when accounting for $E_{(B-V)}$ or $(B-V)_0$ is shown in the last column of Table 1.

The star 13 (OB110) is an arbitrary case because it is very bright and it is

Table 1

Star	Field	$E_{(B-V)}$	V	$(B-V)$	$(U-B)$	Remarks
13	OB110	0,30	16,16	0,66	0,51	Member
22a	OB112	0,25	17,17	0,82	0,22	Foreground?
5	OB112	0,25	17,58	0,99	0,48	Foreground
40	OB112	0,25	18,11	0,91	0,11	Foreground
69	OB112	0,25	18,45	0,98	0,33	Foreground
1	NA	0,45	18,32	0,80	0,38	Member
17	NA	0,45	19,50	0,81	0,24	Member
27	NA	0,45	19,41	0,60	0,31	Member

located outside the examined photometric interval for V. On the other hand, its location on the colour-colour diagram (when accounting for $E(B\text{-}V)$) shows that it is a star of the spectral class F5-G0 localized near the line of the supergiants. When using $(m-M)_0=24{,}3$ (M a d o r e et al., 1985) and $E(B\text{-}V)=0{,}30$ we obtain $M_V\approx-9$. Probably the star 13 is hypergiant.

According to Table 1, 4 out of the 8 observed objects are supergiants — M33 members and the other 4 are foreground stars. We must note also that according to H u m p h r e y s and S a n d a g e (1980) the foreground stars could be met rarely if $V>17{,}5$.

The latter confirms the existence of F and G supergiants in the above-mentioned photometric intervals. As a consequence from Fig. 1*b* we could claim that practically all stars with $(B\text{-}V)<0{,}5$ and $(U\text{-}B)=0{,}0$ are M33 members.

References

H u m p h r e y s, R. M., S a n d a g e, A. 1980. Astrophys. J., Suppl., **44**, 319.
I v a n o v, G. R. 1985. Astrophys. Space Sci., **110**, 357.
I v a n o v, G. R., K u n c h e v, P. Z. 1985. Astrophys. Space Sci., **116**, 341.
K u n c h e v, P. Z., N i k o l o v, N. S. 1984. Astron. Circular, No 1330.
K u n c h e v, P. Z., N i k o l o v, N. S., I v a n o v, G. R. 1986. Astrophys. Space Sci. (in press).
M a d o r e, B. F., M c A l a r y, C. W., M c L a r e n, R. A., W e l c h, D. L., N e u g e b a u e r, G., M a t t h e w s, K. 1985. Astrophys. J., **294**, 560.
S a n d a g e, A., K a t e m, B. 1977. See: Humphreys and Sandage (1980).

Звезды переднего фона в спиральном рукаве S3 галактики M33

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(Р е з ю м е)

UBV фотографическая фотометрия более 200 звезд позволила выделить звезды переднего фона в трех площадках спирального рукава S3 в галактике M33. Число этих звезд в площадках повышено по сравнению с ожидаемым из анализа звездного содержания площадки SA45. По-видимому, это несоответствие причинено не только внутренним поглощением $E_{B\text{-}V}$, но и реально существующими F и G сверхгигантами в рассматриваемых областях M33. Этот результат должен учитываться при калибровке ярких звезд — членов галактики M33.

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Received 29. 04. 1986