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THE EXTINCTION LAW AND THE COMPLEX OF OB STARS IN THE CARINA NEBULA

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RESUMEN

En base a observaciones ultravioletas con el telescopio espacial *Glazar* se muestra que la ley de extinción en la Nebulosa de Carina es anormal y que todas las estrellas OB observadas en la nebulosa probablemente componen un solo complejo estelar el cual se encuentra a una distancia de aproximadamente 2200 pc.

ABSTRACT

Ultraviolet observations with the space telescope *Glazar* show that the extinction law in the Carina Nebula is abnormal, and that all observed OB stars in the nebula compose a single star complex at a distance of about 2200 pc.

Key words: **DUST, EXTINCTION — ISM: INDIVIDUAL OBJECTS (CARINA NEBULA) — ULTRAVIOLET: INTERSTELLAR**

1. INTRODUCTION AND OBSERVATIONS

We discuss in this talk the problem of the interstellar absorption law in the region of the Carina Nebula and the distribution of OB stars in it on the basis of observations made with the space telescope *Glazar* at λ1640 A (Tovmassian et al. 1991). The limiting visual stellar magnitude of these observations was about $8.^m5$ at λ1640 A.

Because the observed emission of starlight is more strongly influenced by absorption at shorter wavelengths, the far ultraviolet observations permit to differentiate more easily the stars located at different distances and thus to reveal their groups.

The study of the distribution of the observed OB stars in space is done by means of variable extinction plots. To draw them, the so called photometric spectral types were determined by the method devised by Johnson & Morgan (1955) using known spectral and colorimetric data for 63 out of 93 stars observed in the area of about one square degree centered on the Carina Nebula. Knowing the stellar spectral types and luminosity classes, the absolute stellar magnitudes M_{1640} and normal colors $(m_{1640} - V)$ were determined. Hence using stellar magnitudes m_{1640} and V the needed values of color excesses $E(m_{1640} - V)$ and distance moduli $(m - M)_{1640}$ were evaluated.

2. RESULTS AND CONCLUSIONS

The variable extinction plot drawn using 10 stars of the cluster Tr 16 (Figure 1) shows that the value R_{1640} is equal to 2.30, while in the case of a normal extinction law it should be equal to 1.75. Four points in Fig. 1 correspond to stars of the clusters Tr 14 and Cr 232. It is evident that the latter two clusters are at the same distance as Tr 16. One star was observed in each of the clusters Tr 15 and Bo 11, showing that they are most probably located farther and are seen through the Carina Nebula.

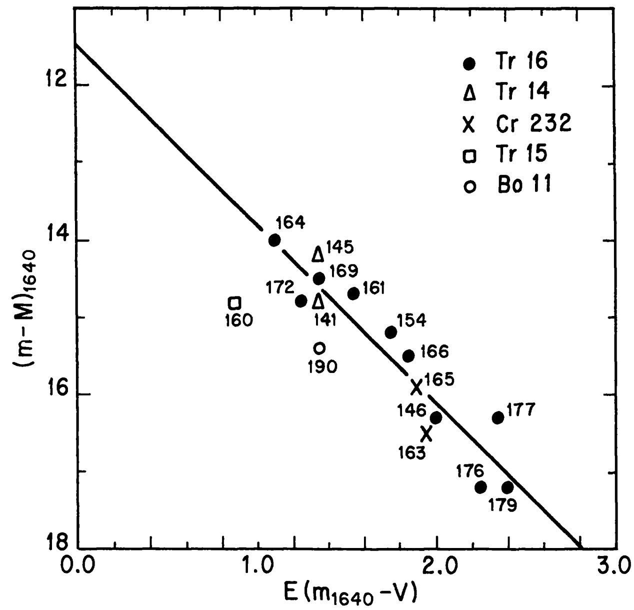

Fig. 1. Variable extinction plot for stars in Tr 14, 15, 16, Cr 232 and Bo 11.

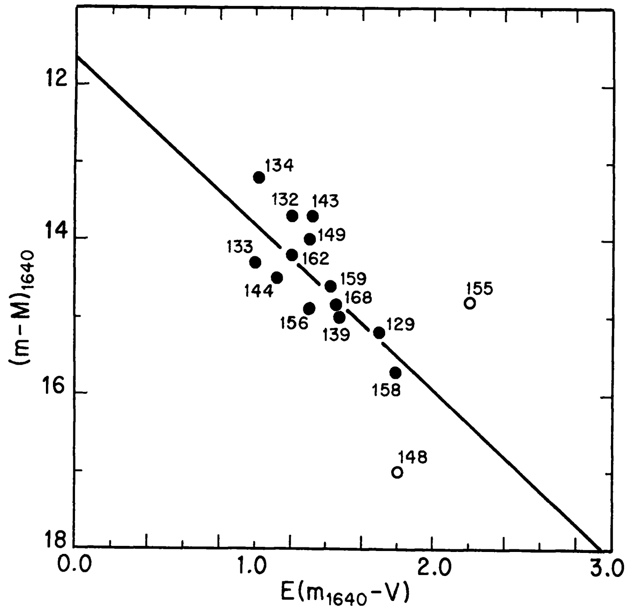

Fig. 2. Variable extinction plot for stars in Cr 228.

The variable extinction plot for 15 stars of the cluster Cr 228 (Figure 2) shows that R_{1640} here is equal to 2.23, i.e., the extinction law is abnormal in this cluster as well.

The variable extinction plot drawn using data of all 63 OB stars with known spectral types and luminosity classes observed within the Carina Nebula boundaries is presented in Figure 3. It shows that the bulk of the observed stars are distributed along the line I, the inclination R_{1640} of which is 2.14. The mean value of true

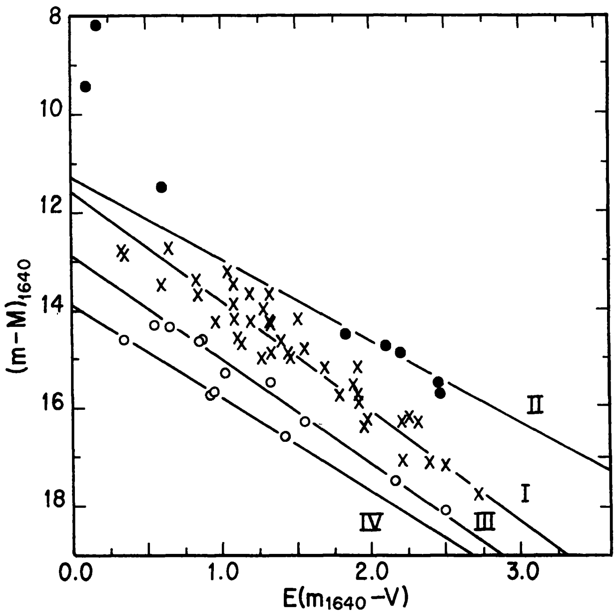

Fig. 3. Variable extinction plot for 63 OB stars in the Carina Nebula.

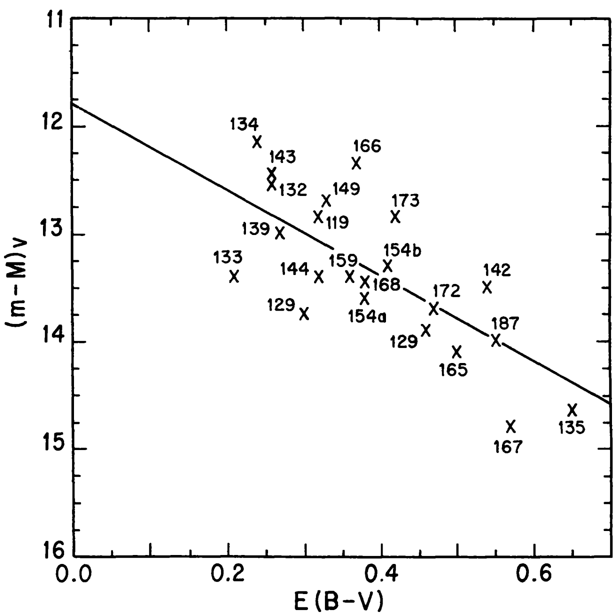

Fig. 4. Variable extinction plot for stars within the Carina Nebula, according to the data of Turner & Moffat 1980.

distance moduli of 41 stars of this group is $11.^m73$ and the mean distance of these stars is about 2200 pc. The r.m.s. deviations of the true distance moduli of individual stars from the mean value is $\pm 0.^m40$. Fig. 3 shows also that there are 14 stars which are located farther than the main group and 8 nearby stars. Three of the latter are foreground stars. Five others are fairly well aligned along line II with inclination $R_{1640} = 1.65$. The mean true distance moduli of them is $11.^m38 \pm 0.^m08$ and the mean distance is 1900 pc. Taking into account the errors of stellar magnitude measurements at $\lambda1640$ A (of the order of $0.^m1$-$0.^m2$) and uncertainties in accepted values of M_V and $(m_{1640} - V_o)$ (about $\pm\ 0.^m5$ and less than $0.^m1$ correspondingly) we may assume that these 5 stars belong to the group of 41 stars. There is an impression that 14 stars behind the Carina Nebula compose two groups. The mean distances of them are then about 3800 pc and 6000 pc. By considering data in a larger region Tovmassian et al. (1993a) showed that there are 2 groups of OB stars here at mean distances of 4000 and 5600 pc.

Thus according to our results there is no doubt that the extinction law within the Carina Nebula is abnormal. The fact that the abnormal absorbing properties have only the dust particles of the Carina Nebula explains the contradictory results obtained earlier on the extinction law in the Carina region (Turner & Moffat 1980 and references therein). The inclusion in the study of stars which are out of the Carina Nebula boundaries obviously smooths out the results. Indeed the variable extinction plot (Figure 4) drawn using Turner & Moffat's (1980) data of 22 stars which according to the *Glazar* observations are within the Carina Nebula do show that R determined by these stars is indeed equal to 4.0. According to these data the distance of the Carina Nebula is about 2250 pc, in excellent agreement with the distance obtained by ultraviolet observations made with the *Glazar*.

Results of the *Glazar* observations show that 4 star clusters (Tr 16, Tr 14, Cr 228 and Cr 232) are at the same distance of about 2200 pc. In addition to 27 OB stars observed in these four star clusters 19 other OB stars located at the distance of the Carina Nebula were observed out of these clusters. It is very interesting that all OB stars observed within the boundaries of the Carina Nebula —at its distance and located farther, compose a few regular chains. Hence one may suggest that all observed OB stars in the Carina Nebula are members of a *single complex*. Its size is less than 40 pc. Moreover it may be concluded that the division of the Carina Nebula itself into different parts is due to the specific distribution of the absorbing matter— in a few sectors with apexes in the central region of the nebula. It is prominent that absorption of stars in the region between Tr 16 and Cr 228 is the highest (Tovmassian et al. 1993b). Such distribution of the absorbing matter inevitably gives evidence that, at first, this matter is associated with the nebula. Secondly, one may suggest that such distribution of absorbing dust may be the result of an explosive event happened in the center of the nebula. Since the center of the suggested explosion coincides with the center of the nebula it follows that the explosion of η Car, which is situated at the eastern side of Tr 16, is not associated with the specific properties of the absorbing matter in the whole nebula.

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