CARBON STARS AND INTERSTELLAR DUST

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Extensive recent infrared observations of carbon stars (Gillet et al. 1971, Hackwell 1972, Morrison and Simon 1973) have shown that spectra of some cool variable carbon stars reveal infrared excesses, which are believed to be due to thermal radiation of the dust envelopes surrounding these stars. Observations of the visual intrinsic polarization made by Dyck et al. (1971) have confirmed this discovery. The relation existing between stars loosing their mass and those revealing the infrared excess (Geisel 1970) gives evidence for the reality of mass loss from cool variable carbon stars. On the other hand, several investigations (Kamijo 1967, Donn et al. 1968, Salpeter 1974), although differing considerably in details, do agree that conditions in the atmospheres of cool carbon stars are appropriate for the condensation of carbon grains. Hence, it is believed that evolutionary advanced cool variable carbon stars supply carbonaceous material, mainly graphite, into the interstellar matter, in which carbon seems to be the major constituent (Donn et al. 1968).

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TABLE 1

Stars investigated for interstellar extinction

Object	Var.type	V(mag.)	M(mag.)	(11)-(3.5)	Ref.
TT Tau	SRb	8.02	-2.7	-	2,9
BL Ori	Lb	6.15	-2.8 - -3.3	-0.53	3,7
TT Cyg	SRb	7.37	-2.7	-0.40	1,2
RS Cyg	SRa	7.90	-3.0	-0.67	3,5
U Cyg	M	6.7 - 11.4	-3.3 - -2.5	-1.61	3,4,5
V Cyg	M	7.7 - 13.9	-2.7	-2.84	5,9
WZ Cas	SRa	7.16	-3.0	-0.50	3,6
MSB 37	const.	9.4	+0.9	-	1,10
HD65424	const.	7.85	+0.9	-	1,9
HD 7636	const.	8.89	-0.5	-	1,11

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So we found interesting to study the interstellar extinction in the vicinity of carbon stars to search for expected relations between the interstellar dust and these stars, which could be expressed by correlation (if any exists) between the value of the infrared excess measured by the difference of infrared magnitudes (11)-(3.5) (Gillet et al. 1971), and the increase of interstellar extinction around carbon stars. For this purpose, we have succeeded to gather the data pertaining the interstellar extinction in the direction of seven variables and three non-variable carbon stars. The basic data related to these stars are presented in Table 1. The infrared magnitudes of studied stars were taken from the paper of Gillet et al (1971). Since the V magnitudes are not available for U Cyg, V Cyg and MSB 37 we adopted their photovisual values for further considerations. The compilation of the absolute magnitude data for carbon stars, which are derived by indirect ways, involves most of uncertainties, since they differ sometimes significantly between different authors, and it is not certain that the finally assumed values are the most reliable.

In this investigation of interstellar extinction we have applied the method of colour excesses. From the Photometric Catalogue of Blanco et al. (1968) and the paper of Deutchman et al. (1976) we could collect sufficient number of stars with known B, V magnitudes and two-dimensional MK spectral classification for scarcely seven 4^{o} regions centered on carbon stars. For the fields of WZ Cas, TT Tau and U Cyg we have used our own data based on photographic photometry transformed to the B, V system and the two-dimensional classification derived by a visual inspection of objective prism spectra (Krawczyk et al. 1977). In these cases we used circular regions of about 1.5 degree diameter. Employing the intrinsic properties of normal stars as published by Detschman et al. (1976), we could plot colour excess E_{B-V} versus distance modulus to determine the average E_{B-V}/V-Mv/ curve in the direction of ten carbon stars. Since there is no great variation of the total to selective interstellar absorption ratio (Whittet 1977, Serkowski et al. 1975) we have adopted the normal value of 3 for determination of interstellar visual absorption A_v. Assuming the average E_{B-V}/V-Mv/ curves we could calculate distances to selected stars in particular regions and derive the interstellar absorption - distance relationships in the direction of ten carbon stars. Fig. 1 presents these results for seven variable carbon stars. Vertical dashed lines in Fig. 1 indicate the positions of carbon stars in particular plots according to the adopted values of absolute and observed magnitudes. The resulting data i.e. visual interstellar absorption A_v, gradient of interstellar extinction curve ϕ are presented in Table 2.

TABLE 2

Object	A_v(mag.)	ϕ	r(pc)
TT Tau	1.83	0.30	600
BL Ori	0.57	0.07	474 - 597
TT Cyg	0.21	0.00	938
RS Cyg	1.02	0.10	946
U Cyg	1.62	0.08	496
V Cyg	2.16	0.04	900
WZ Cas	0.64	0.20	809
MSB 37	0.18	0.00	461
HD 65424	0.15	0.04	229

Searching for a relation between carbon stars and interstellar dust we could expect that stars with their infrared excess $(11)-(3.5)$ larger in absolute value 0.50 might be placed in the more dense regions where the interstellar extinction gradient exceeds the value of 0.10 mag. per 100 pc which is typical for an average extinction. The value of the gradient of the interstellar extinction curve was measured within 100 pc distance around the carbon stars and is expressed in mag. per 100 pc as shown in the third column of Table 2.

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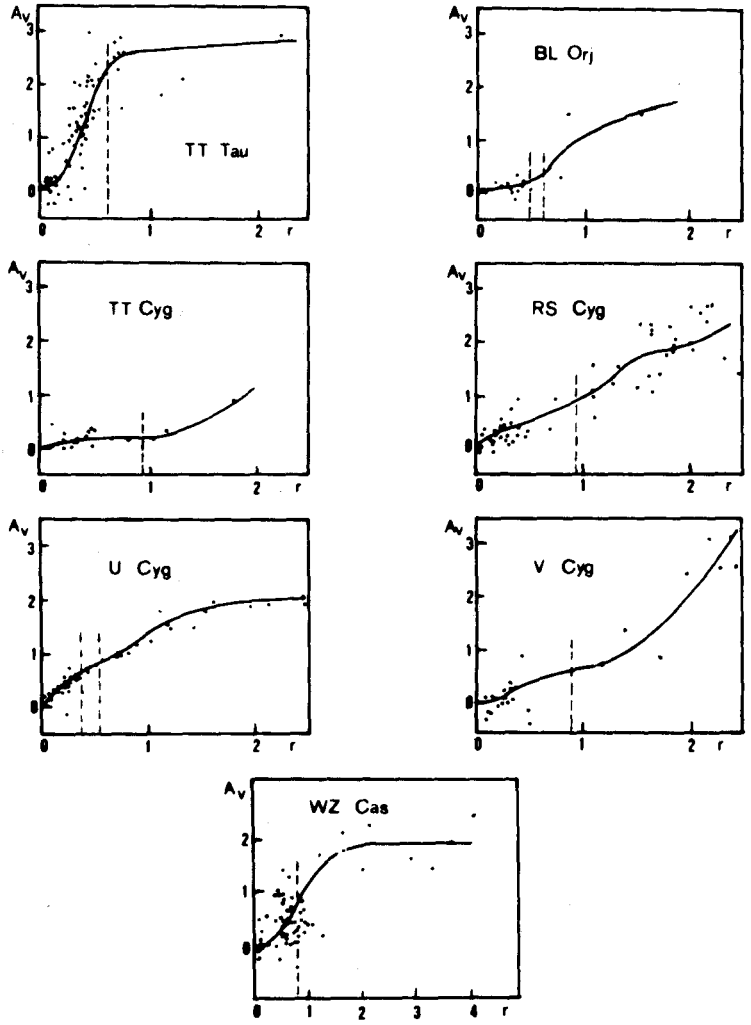

Figure 1. Interstellar visual absorption (in mag.) versus distance (in kpc) relationship for seven variable carbon stars. The positions of carbon stars are indicated by vertical dashed lines.

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In our investigations we have found no significant increase of interstellar extinction around 3 examined constant carbon stars, what is consistent with a lack of infrared colour excess for this group of stars (Vardanian 1968). Results of Eggen (1972), who determined interstellar visual absorption for 17 constant carbon stars also confirm this conclusion.

The discussion of interstellar extinction data for variable carbon stars is not so clear. There are stars exhibiting a large infrared excess as in the case of U Cyg, which are not placed in the regions of a significant increase of interstellar extinction. So we can derive the final conclusion that for variable carbon stars there is no evidence for existence of correlation between their infrared excesses and interstellar absorption (interstellar dust).

As a by-product of this investigation we have found that some of the cool variable carbon stars are placed in the regions more abundant in interstellar dust as in the case of TT Tau and WZ Cas.

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