COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 3648

Konkoly Observatory
Budapest
13 August 1991

HU ISSN 0374 - 0676

Infrared properties of the carbon symbiotic star C–1 in the Draco dwarf galaxy

The carbon giant C–1 in the Draco dwarf galaxy was discovered by Aaronson *et al.* (1982) to show H I, He I and He II emission lines. Allen (1984) classified C–1 among the symbiotic stars and the interacting binary nature of C–1 has been confirmed by the spectroscopic investigation of Munari (1991a) who also discovered radial velocity variations connected to orbital motion. Munari (1991b) presented the results of a BVI photometric monitoring during the period 1987-1990, which suggested some variability of C–1 expecially in the I band. About 90% of galactic carbon stars are known or suspected variables, half of them of the semiregular or Mira type with periods between 60 and 640 days (Claussen *et al.* 1987). The variability reported by Munari (1991b) is characterized by low amplitude and short time scale (~55 days) and appears consistent with the low metal content of the Draco dwarf galaxy and the observation that period and amplitude of red variables in galactic globular clusters are proportional to metallicity (Feast 1981).

C–1 has been observed in service mode with the JHKLM infrared photometer at the 1.5 m TIRGO Italian National Infrared Telescope. The resulting magnitudes are given in Table 1 (errors in the *local system* listed):

Table 1 JHK photometry of Draco C–1

band	mag	error
J	11.60	0.04
H	11.35	0.03
K	11.40	0.05

The corresponding C–1 absolute magnitude is M_K=–8.2, adopting a distance modulus of m-M=19.6 for the Draco dwarf galaxy and an interstellar reddening of E_{B-V}=0.03 (Stetson 1979). The absolute magnitude of a sample of 54 carbon stars in the LMC and SMC studied by Cohen *et al.* (1981) and Frogel *et al.* (1980) is M_K=–8.1±0.6. Although there is a remarkable similarity in M_K, the IR colors of C–1 appear very different from those of SMC, LMC and galactic carbon stars.

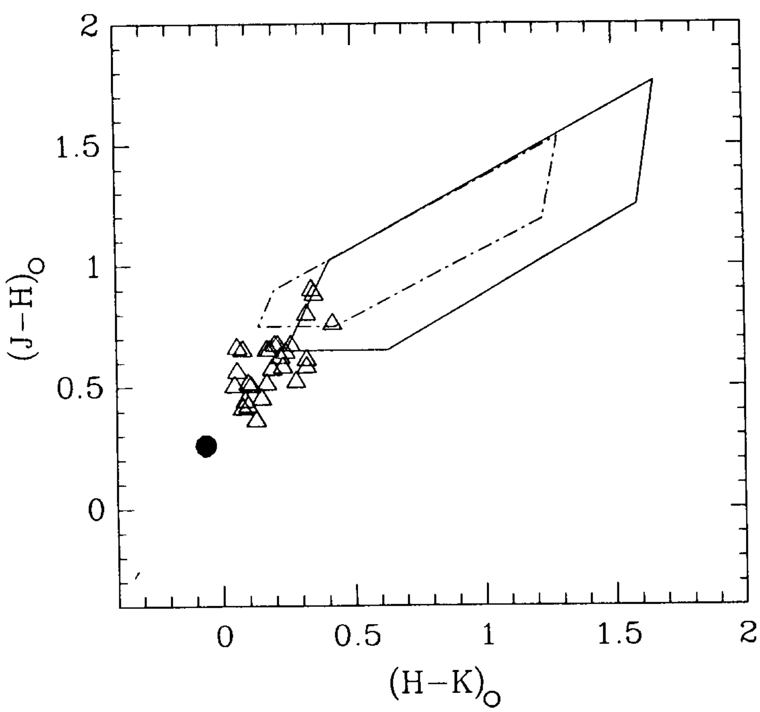

Figure 1

The figure shows where carbon stars lie in a $(J\text{-}H)_o$-$(H\text{-}K)_o$ plane, with the interstellar reddening statistically removed. The solid line encloses the region occupied by the 215 galactic carbon stars studied by Claussen *et al.* (1987), which have been detected in the course of the *Two Micron Sky Survey* and that are strongly concentrated towards the galactic plane as the population I stars, to which they belong. The dot-dashed line delimits the diagram region where LMC and SMC carbon stars lie (Cohen *et al.* 1981, Frogel *et al.* 1980 and Frogel & Richer 1983). The triangles are carbon stars belonging to the Galaxy halo, which have observed by Bothun *et al.* (1991) in the direction of north and south galactic poles.

The IR colors of C–1 (J-H=0.25, H-K=-0.05) are very blue compared with the rest of carbon stars. The IR colors and the negative detection by the IRAS satellite exclude the presence of large quantities of circumstellar dust around C–1. Particularly blue colors for C–1 have already been noted in the optical by Aaronson *et al.* (1982) and Munari (1991b).

The IR blue colors of C–1 are intrinsic to the carbon star and are not due to the binary nature of the system. The contribution by the nebular material, which gives rise to the emission line spectrum, is negligible because the optical spectra well show unveiled carbon absorption bands down to at least 4400 Å (Aaronson *et al.* 1982, Munari 1991a). The blue colors could be in principle ascribed to the heating effect of the hard radiation field of the white dwarf companion illuminating the atmosphere of the carbon star or to the direct emission of an extended accretion disk around the white dwarf. These sources of blue emission can usually account for $\triangle$(B-V)=0.2÷1.0 mag in the optical photometry of symbiotic stars, but they have no impact in the IR among the ~90 object so far investigated (Munari *et al.* 1991, Whitelock & Munari 1991). Moreover, these sources of blue emission should produce an undetected veiling of carbon absorption bands in the optical spectra of C–1.

The blue IR colors of carbon star C–1 could be the effect of a very low metallicity or due to a thermal pulse the star is currently undergoing. Theoretical treatment of thermal pulses in the AGB phase suggests limited excursion in the T_{eff} and large variation in luminosity (Iben & Renzini 1983). The probability to catch a carbon star during a thermal pulse is low and the other carbon star in the Draco dwarf galaxy should be expected to show more red (or *normal*) colors. Instead the only other carbon star in the Draco galaxy that Aaronson *et al.* (1982) have photometered, shows blue optical colors too, also if not extreme as those of C–1. The interpretation of the C–1 blue IR colors in term of particularly low metallicity is suggested by its location in the $(J\text{-}H)_o$-$(H\text{-}K)_o$. It lies on the blue side of population II carbon stars which in turn lie on the blue side of population I carbon stars. A particularly low mass loss rate could contribute to the blue IR colors of C–1.

Detailed investigation of the carbon stars in the Draco dwarf galaxy, particularly IR photometry, appears worthwhile.

ULISSE MUNARI
Asiago Astrophysical Observatory
I-36012 Asiago (VI)
Italy

References

Aaronson,M.,Liebert,J.,Stocke,J.: 1982 Ap.J. 254, 507
Allen,D.A.: 1984 Proc.A.S.A. 5, 369
Bothun,G.,Elias,J.H.,MacAlpine,G.,Matthews,K.,Mould,J.R.,Neugebauer,G. Reid,I.N.: 1991 Astron.J. 101, 2220
Claussen,M.J.,Kleinmann,S.G.,Joyce,R.R.,Jura,M.:1987 Ap.J.Suppl. 65,385
Cohen,J.G.,Frogel,J.A.,Persson,S.E.,Elias,J.E.: 1981 Ap.J. 249, 481
Feast,M.W.: 1981 in *Physical Processes in Red Giants*, ed. I.Iben and A.Renzini (Dordrecht:Reidel), p. 193
Frogel,J.A.,Persson,S.E.,Cohen,S.J.: 1980 Ap.J. 239, 495
Frogel,J.A.,Richer,H.B.: 1983 Ap.J. 275, 84
Iben,I.,Renzini,A.:1983 Ann.Rev.Astron.Astrophys. 21, 271
Munari,U.: 1991a Astron.Astrophys. in press
Munari,U.: 1991b Inf.Bull.Var.Stars 3605

Munari,U.,Yudin,B.F.,Taranova,O.G.,Massone,G.,Marang,F.,Roberts,G.
Winkler,H.,Whitelock,P.A.:1991 Astron.Astrophys.Suppl., accepted
Stetson,P.B.: 1979 Astron.J. 84, 1149
Whitelock,P.A.,Munari,U.:1991 MNRAS, submitted.