CARBON STARS WITH OXYGEN-RICH CIRCUMSTELLAR ENVELOPES

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Abstract. We observed two carbon stars with silicate emission, C1003 and BM GEM, and we calculated the abundances ratios. The results are compared with them of R0 stars(Dominy, 1984).

Introduction

Typical spectra of carbon stars present 11.2μm SiC emission. From a study based on IRAS observations Little-Marenin(1986) and Willems and de Jong(1986, 1988) identified independently nine carbon stars surrounded by circumstellar shells with silicate dust grains.

Little-Marenin(1986) and Willems and de Jong(1986) presented some suggestions to explain this anomaly:

1)These stars could be components of binary systems with an M and a C star;

2) We may be observing an unusual chemical equilibrium in the circumstellar shell (Little-Marenin, 1986);

3) The transit time of material through the circumstellar shell could be longer than the time scale of the transformation M-S-C, allowing the existence of an oxygen-rich envelope around the carbon-rich star.

Recently Lloyd Evans(1990) and Lambert et al.(1990) proved that these anomalous carbon stars with 9.8μm silicate emission are J-type carbon stars and questioned the considerate evolutive sequence for the carbon stars. They suggested that early R stars(R0, R1...) are J-type carbon stars progenitors.

In an earlier work we studied, and rejected, the first hypothesis (Silvia Lorenz Martins, Master's Thesis, 1990) and this paper presents the abundance ratios C^{12}/C^{13},C/O and the **s** process abundances for two of the special carbon stars (C1003 and BM GEM) and R0-type carbon stars. There are great difficulties in the determination of these abundances in cool carbon stars. One is due to the spectral density of rotational molecular lines of CN molecule.

The Method

The method applied is the spectral synthesis in small regions (20 Å), as suggested by Kilston(1973, 1975). The synthesis program includes ionized elements and molecular chemical equilibrium calculations, (Tsuji, 1973). The Hönl-London factors in the gf values for the molecules are normalized by the sum rule (Whitting et al., 1980); the gf values for the atomic lines are taken from the Kurucs' dates. The regions were chosen because of the physical parameters and elemental abundances. The spectra were obtained at Laboratório Nacional de Astrofísica,Brasópolis, Brasil.

P. D. Singh (ed.), Astrochemistry of Cosmic Phenomena, 403–404.

Results

The results of the synthesis for the C1003 and BM GEM are compared in the table with of Dominy(1984) for early R stars.

COMPARISON TABLE

	C1003	*BM GEM*	*Early R stars**
[<s>/<Fe>]	+0.95	+0.68	+0.14
C/O**	2	3	2
C^{12}/C^{13}	3	3	9

* HD 113801, R0; BD +33∘2399, R2; HD 156074, R0 (Dominy,1984);
** $C/O = (C^{12}+C^{13})/O$
$[X] = \log X_* - \log X_\odot$

Conclusions

The **s** abundances and C^{12}/C^{13} ratios for C1003, BM GEM are expected for J-type stars (see Utsumi, 1985) and such abundances are relatively similar to the early R stars. Abundance analysis(Dominy, 1984) showed that these R stars are C^{13}-rich with no detectable enrichments of the **s**-process elements. The temperature of R0 stars are about 4200-5000K and the J-type carbon stars are about 2500-3000K. As these R stars evolve to become cooler and more luminous, they can appear as J-type cool carbon stars.

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