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EXTENDED DUST SHELLS AROUND CARBON STARS RESOLVED BY “HIRAS”

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Abstract. We have examined forty-two carbon stars which show excess emission at 60 and/or 100 μm by applying maximum-entropy image reconstruction techniques to the IRAS 60 μm survey data. Thirteen stars are found to be extended in the reconstructed images. Four of them show a detached ring centered on the stellar position. In particular, U Ant may have a double detached dust shell. The implications of our results are discussed concerning the variation of mass loss on the AGB evolution.

Key words: HIRAS — carbon stars — dust shells — thermal pulses

There is growing evidence that some carbon stars possess detached dust shells that produce excess 60 and/or 100 μm emission observed with IRAS (Waters *et al.* 1994). The geometry of these dust shells allow us to investigate the history of mass loss on relatively long time scales.

We examined forty-two carbon stars with 60 and/or 100 μm excess and a 60 μm flux greater than 5 Jy by applying maximum-entropy image reconstruction techniques (HIRAS, Bontekoe *et al.* 1994) to the IRAS 60 μm survey data to examine the spatial distribution of the excess emission. Thirteen stars were found to be extended in the reconstructed images. In Fig. 1, U Hya, Y CVn and X Tra show detached rings centered on the stellar position and U Ant a well resolved central plateau. This probably corresponds to the detached shell seen in CO emission in this star (Olofsson *et al.* 1990). Furthermore, U Ant possibly possesses an outer faint shell. The shell parameters are given in Table 1. These results suggest that mass loss rates on the AGB vary considerably on time scales compatible with those of thermal pulses, and that the higher mass loss phase may be repeated several times among a certain kind of carbon stars (e.g. Vassiliadis & Wood 1993). Moreover, U Ant may imply a possibility of an interpulse period less than 10^4 years.

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Fig. 1. Reconstructed images of U Ant, U Hya, Y CVn, and X Tra. Each map shows a square area of $16' \times 16'$. The resolution is about $1'$. Contours are in steps of powers of 2 MJy sr^{-1} from 2 MJy sr^{-1} .

TABLE 1
Dust shell parameters.

Star	IRAS PSC F60 (Jy)	Structure	Radius ($'$)	Age ($\times 10^4$ yrs)	$V_e^{(1)}$ (km s^{-1})	Distance ⁽¹⁾ (kpc)
U Ant	27.1	semi-detached	<1.4	<0.6	20	0.32
...	...	detached	2.8	1.3	...	...
U Hya	17.2	detached	1.8	1.0	15	0.29
X Tra	14.8	detached	2.3	1.3	15	0.30

1) Values assumed for the fifth column.

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