Extended dust shells around Carbon stars resolved by HIRAS

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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 recon-
struction techniques (HIRAS, Bontekoe et al. 1994) to the IRAS 60 μm
survey data to examine the spatial distribution of the excess emission. Thir-
teen 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 corre-
sponds 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
104 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' x 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.

<table>
<thead>
<tr>
<th>Star</th>
<th>IRAS PSC F60 (Jy)</th>
<th>Structure</th>
<th>Radius (')</th>
<th>Age (×10⁴ yrs)</th>
<th>$V_e$ (km s⁻¹)</th>
<th>Distance (kpc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U Ant</td>
<td>27.1</td>
<td>semi-detached</td>
<td>&lt;1.4</td>
<td>&lt;0.6</td>
<td>20</td>
<td>0.32</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>detached</td>
<td>2.8</td>
<td>1.3</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>U Hya</td>
<td>17.2</td>
<td>detached</td>
<td>1.8</td>
<td>1.0</td>
<td>15</td>
<td>0.29</td>
</tr>
<tr>
<td>X Tra</td>
<td>14.8</td>
<td>detached</td>
<td>2.3</td>
<td>1.3</td>
<td>15</td>
<td>0.30</td>
</tr>
</tbody>
</table>

1) Values assumed for the fifth column.

References