The circumbinary disc around the J-type C-star IRAS 18006-3213

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1. Introduction:

J-type C-stars are AGB giants enriched in ^{13}C compared to "normal" N-type C-stars. Silicate J-type C-stars are a peculiar subclass showing an O-rich circumstellar environment. This is surprising because the stability of the CO molecule ensures that O-rich stars create O-rich dust while C-rich stars produce C-rich dust.

The general consensus about these objects is that they are binaries for which the silicate emission originates from a long-lived reservoir which is located either around the binary or around the companion.

Although indirect evidence for this scenario has been gathered over the years, no direct evidence could show either the binary nature of these objects or the location of the dust in the system.

2. Observations:

Four interferometric observations of IRAS 18006-3213 were performed using VLTI/MIDI. These observations provide spectral, visibility and phase information on the source morphology over the N-band. These data are shown in Fig. 1 and Fig. 2.

3. Spectral analysis:

The silicate emission was stable over 20 years.

The silicate dust of IRAS18006-3213 is much more processed than that of V778 Cyg, another silicate J-type C-star.

From an optically thin dust fit we derive:
- crystallinity degree of 35 %
- fraction of large grains (i.e. 1.5 μm) of ~ 100 %

All this shows that there must be a long-lived reservoir where the processing occurs.

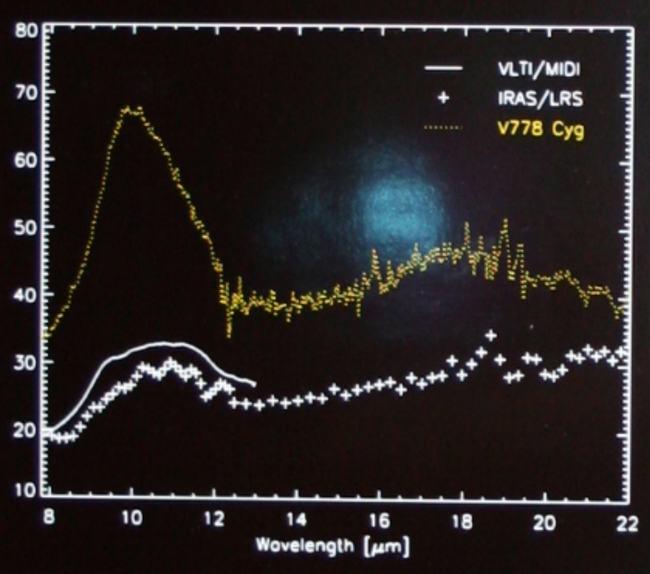

Fig. 1: The N-band spectrum of IRAS 18006-3213 is shown using a solid line while the IRAS/LRS spectrum is overplotted using crosses. Clearly the shape is very similar between both spectra, providing that the N-band emission must have been stable over 20 years. Overplotted using yellow dots is the ISO/SWS spectrum of another silicate J-type C-star, V778 Cyg. Clearly the dust emission of IRAS 18006-3213 is much more processed than the dust around V778 Cyg.

4. Global interferometric analysis:

The interferometric observations put significant constraints on the source morphology:

A. Visibilities:

- show the compact nature of the emission
- show that a one component model cannot reproduce the data

B. Phases:

The observed phase-jump shows the asymmetric nature of the source morphology.

C. Photometry:

The spectral energy distribution shows that about 10 % of the flux at 8 μm is provided by the AGB photosphere.

These observations are readily explained assuming that the observed emission comes from a long-lived [illegible]. The asymmetry [illegible] of an inclined [illegible] puts the stellar [illegible] from the IR-ex[illegible]

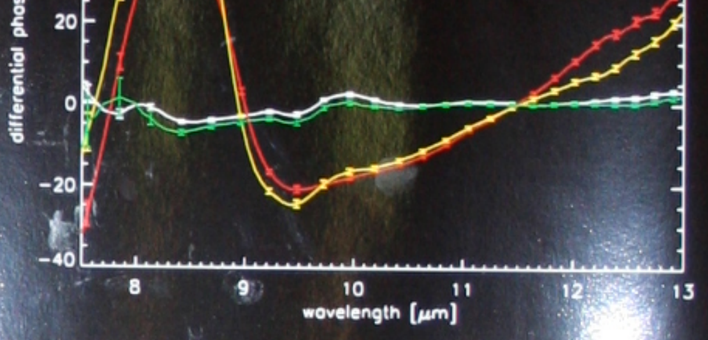

Fig. 2: The visibilities (top panel) and phases (bottom panel) observed for IRAS 18006-3213 are shown using different colors. White: PB = 47 m, PA = 30 deg ; Green: PB = [illegible] m, PA = 49 deg ; Red: PB = 102 m, PA = 25 deg ; Yellow: PB = [illegible] m, PA = 43 deg.

6. Conclusions:

The presented spectroscopic and interferometric data of IRAS 18006-3213 provide clear and direct evidence for the binary hypothesis explaining silicate J-type C-stars:

- the CSE is highly processed ➞ processing occurs in a long-lived reservoir
- compact CSE ➞ evidence for a long-lived Keplerian reservoir
- asymmetric N-band emission ➞ disc-like structure

In Deroo et al. (in prep), we explain that the disc-like structure in the system of IRAS 18006-3213 is most likely a *circumbinary* disc.

Hypothesis:

*"All silicate J-type C-stars with highly processed dust have **circumbinary** discs."*

- The infrared excess in a circumcompanion scenario originates from evaporation of the disc. The evaporated material is most likely amorphous.
- The silicate J-type C-stars with processed circumstellar material (Hen 38 & IRAS 18006-3213) show remarkable resemblence with the circumstellar environment of binary post-AGB objects, which are known to be surrounded by a circumbinary disc.

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Further reading:

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