Keplerian disks around binary post-AGB stars

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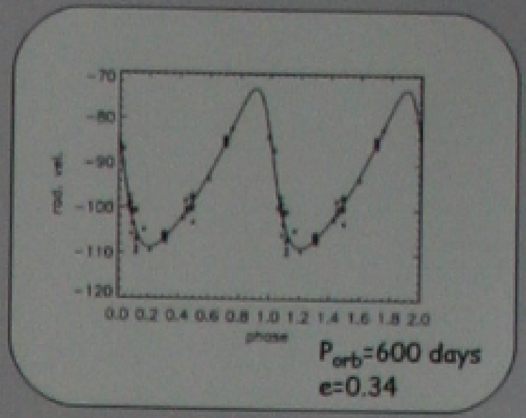
1. Introduction

The number of binary post-AGB stars known in the Galaxy is significant, yet their evolutionary status is far from understood. The orbital elements indicate that these objects must have undergone severe binary interaction when the primary was at giant dimension. Evidence is growing that all these evolved binaries are surrounded by circumbinary Keplerian dusty disks. We present the first results of our SED-modelling and detailed study of the mineralogy using Spitzer-IRS spectra. We conclude that these objects are ideal to be studied with the AMBER and MIDI interferometric instruments on the VLTI. Interferometry will enable us to constrain the geometry and the chemical conditions within these disks.

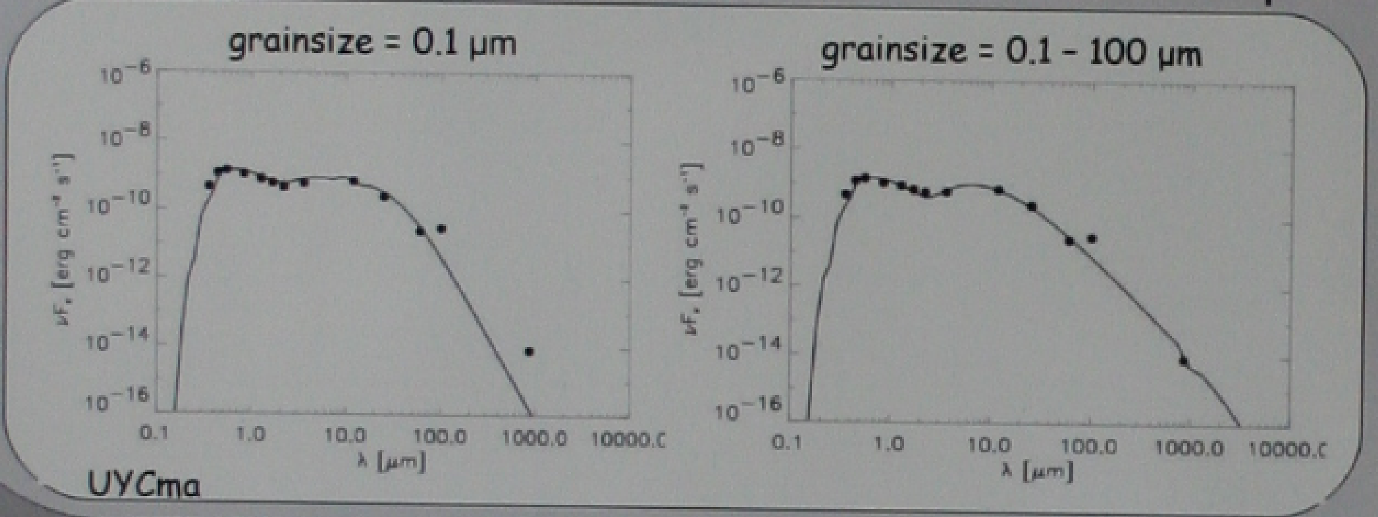
2. Sample stars

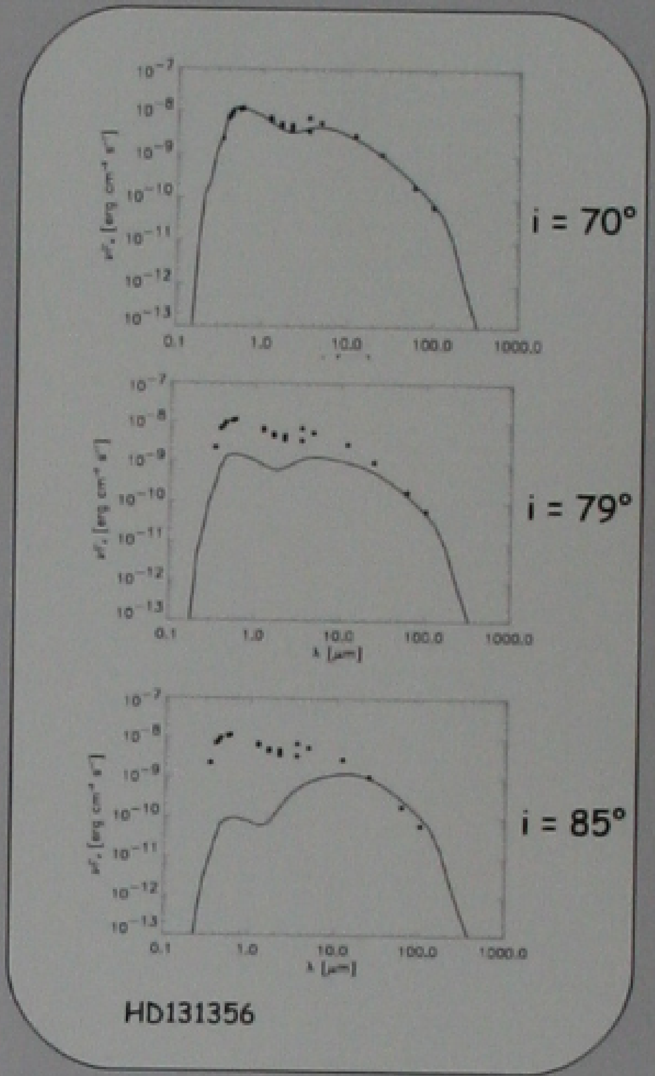
* 51 binary post-AGB stars
* orbital parameters for 21/51 stars (Maas et al. 2002, 2003; Van Winckel 2004, 2006)
* orbital periods: P_{orb} = 100-2000 days
* high eccentricities: e = 0.00-0.47
  → we would expect circularisation!
  → orbital dimensions too small to accommodate single AGB star → binary interaction necessary
  → companion likely unevolved



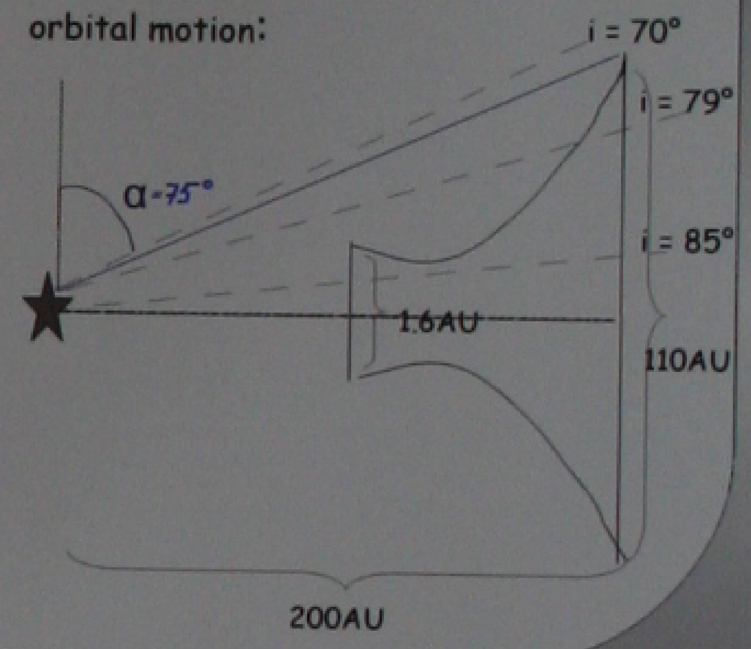
3. SED-modelling

* dust excess starting at high temperatures
  → dust near sublimation temperature (≈1500K)
* SED-fitting using 2D-radiative transfer in passive disk model (Dullemond & Dominik 2004)
  - input parameters used: stellar parameters, grain size, disk mass, R_{in}-R_{out}, inclination
  - iteration process determines vertical scaleheight H/R
* very large grains (~100 μm) necessary to fit 850 μm datapoint



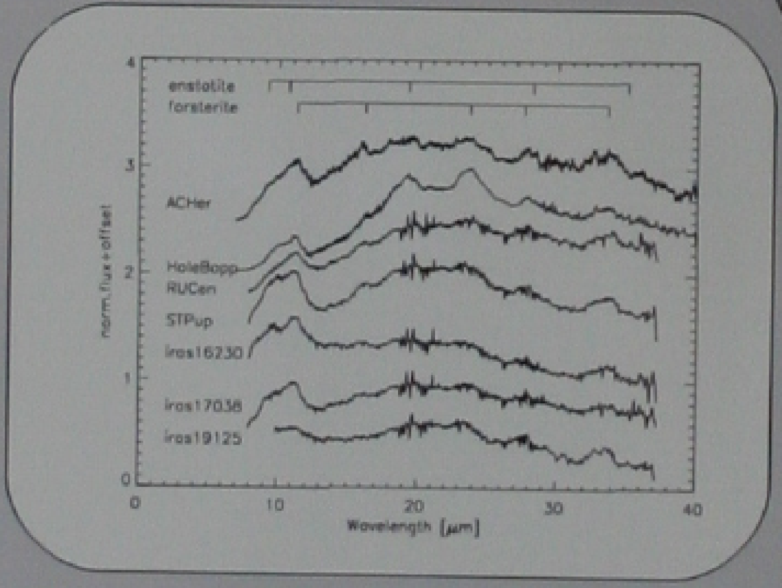


* we can use parameters of the disk (R_{in}-R_{out}, scaleheight) to constrain the inclination of the system
* example HD131356, showing variable circumstellar extinction during orbital motion:



4. Mineralogy

* observations:
  - Spitzer high-resolution IRS spectra (7-37μm)
  - N-band TIMMI2 spectra (8-13μm) (ESO 3.6 telescope)
* dust: O-rich and very crystalline
  - Mg-rich end members of crystalline olivine and pyroxene (forsterite Mg_2SiO_4, enstatite $MgSiO_3$) (De Ruyter et al. 2006)
  - very similar to spectra of ACHer and Hale Bopp
* the crystalline features are used to determine the grain size and the temperature distribution
* we find evidence for large grains and a spread in temperature distributions



5. Interferometry

* we plan to use interferometry to resolve the structure and size of the disk
  → MIDI: the spectrally dispersed fringes in the N-band allow to probe the distribution of minerals in the disk
  → AMBER: ideally suited to study the hot inner rim of the disk
* MIDI-results obtained so far (Deroo et al. 2006):
  - very compact objects
  - inner region highly crystalline
  - some objects show processing throughout the disk → radial mixing ?
    → processing during formation ?
  - cool crystallines found → also seen in spectra

Conclusions

Our SED-modelling and spectral synthesis show the presence of large and highly crystalline grains in all our objects. Hot dust near sublimation temperature is found, irrespective of the parameters of the central star. We argue that all our sample stars are surrounded by a stable Keplerian disk in which dust processing occurs very efficiently. The disk dimensions that we constrained using our SED-modelling, show that the objects are ideally suited to be resolved by MIDI and AMBER. The use of interferometry will allow us not only to map in detail the location of the different dust species and grain sizes, but also to constrain the badly understood role of the disk formation in the evolution of the binary systems.

Contact Information

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