The surprising mid-infrared diameter of W Hya

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Summary

We observed the dusty circumstellar environment of the Asymptotic Giant Branch (AGB) star W Hya with the MIDI interferometer (N-band). Such observations allow us to fit for the stellar diameter and look for its dependence on the pulsation cycle.

A fit of the mid IR data of W Hya to a basic fully limb darkened model gives, in comparison to the near IR, an about 1.5 times greater diameter. Its change throughout the mid IR N-band gives rise to the speculation that this is due to very close amorphous alumina dust additional to a warm molecular layer of water in the extended atmosphere. Due to an unfavorably scheduled observation it is very difficult to distinguish the effect of the pulsation from an asymmetric stellar atmosphere.

Introduction & Observation

W Hya is an AGB star with a pulsation period of about 388 days and was observed 75 times throughout the last 3 years with MIDI (in Sci-Phot mode) in the N-band. Since AGB stars have a very extended atmosphere, it is expected that different wavelengths probe different atmospheric layers.

Results: Diameter

The best fitted model to the calibrated visibilities, in the wavelength range between 8 and 12 µm, was a fully darkened disk (FDD) (Fig. 1):

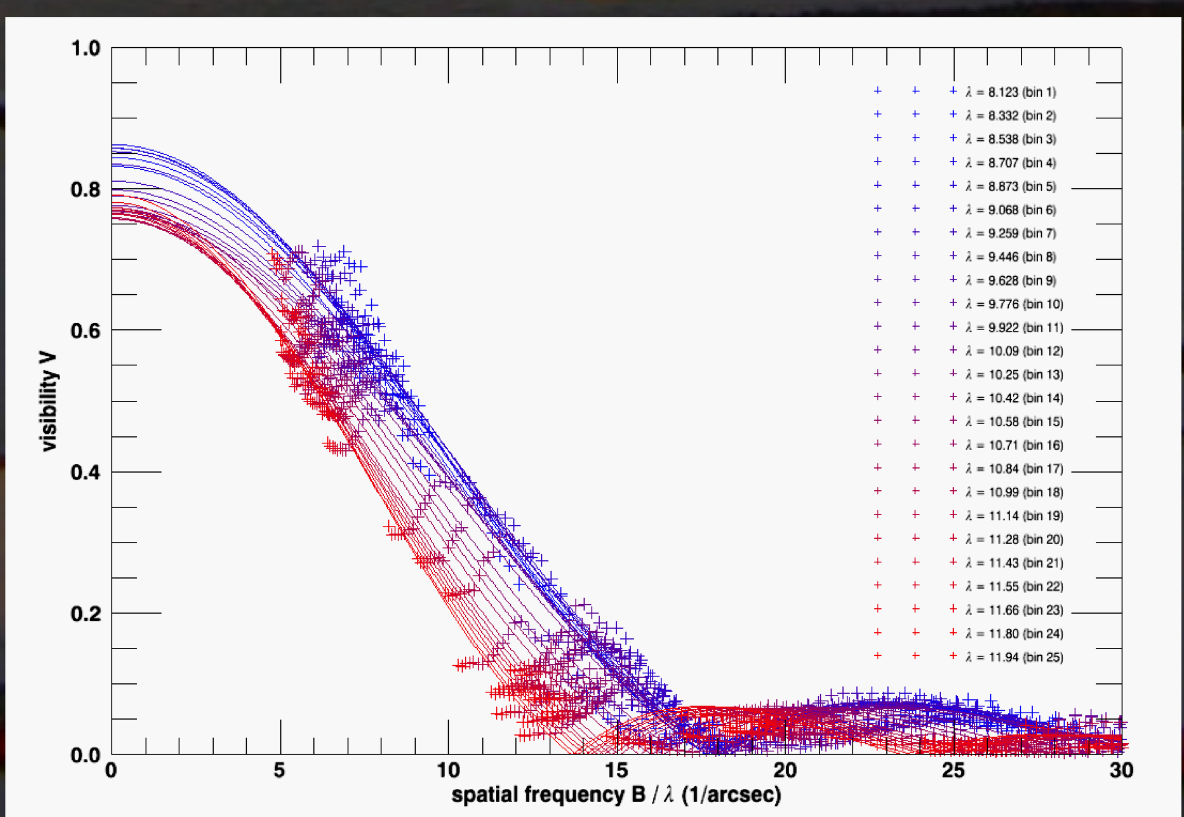

Fig. 1. FDD fit to all 25 wavelength bins. Clearly the first zero shifts to lower spatial frequencies with increasing wavelength (blue to red), i.e. the diameter increases.

The resulting values are plotted in Fig. 2. The big diameter[1] of 80 mas (corresponding to 7.8 AU at a distance of 98 pc) is mostly due to the opacity of water in this atmospheric layer. The increase upwards 10 µm coincides with the opacity dominance of alumina (Al_2O_3), the only dust species which can condense at this high temperatures[2] (see for comparison e.g. Perrin et al. 2007, A&A, 474 & Ireland et al. 2008, MNRAS, 391).

Results: Pulsation & Asymmetry

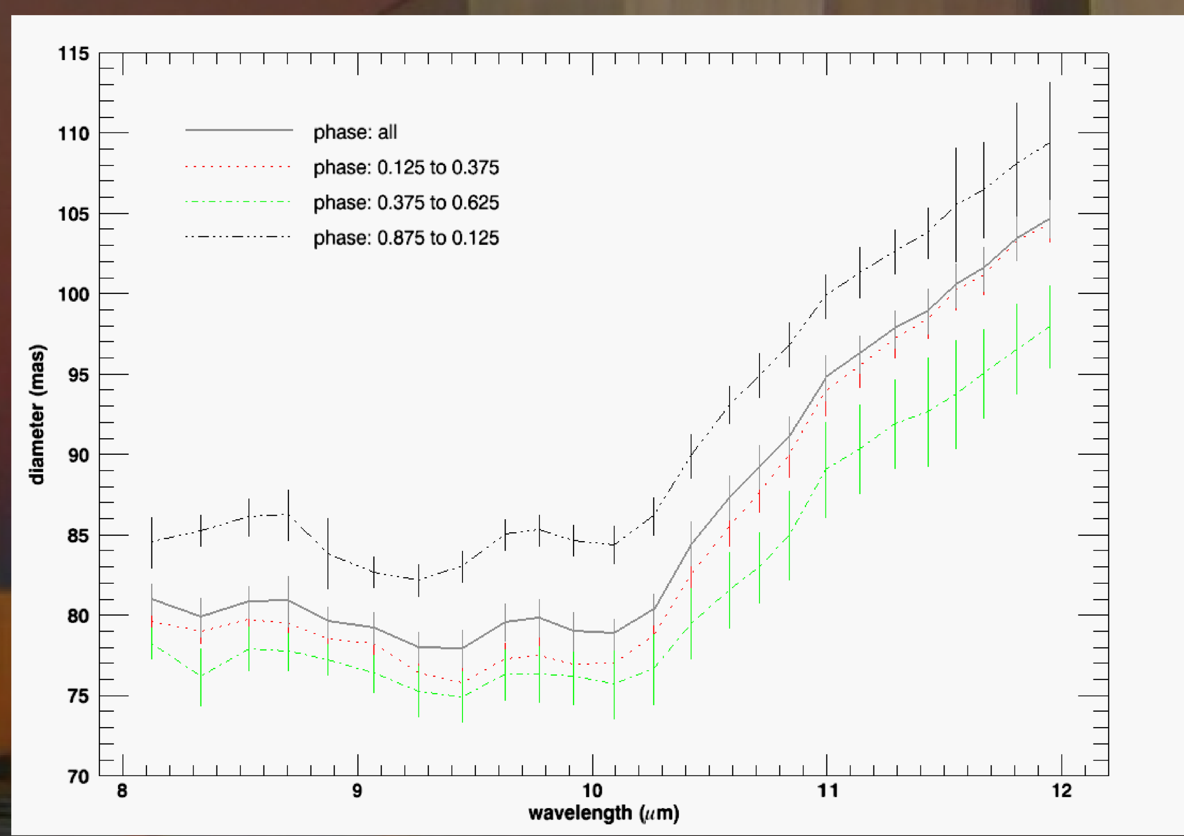

Fig. 2. The fitted FDD diameter versus the wavelength. The thick gray line includes all observations and the other lines subsequent pulsation phase bins (for phase 0.625-0.875 no data are available).

Unfortunately our observations at minimum and maximum light phase refer always to similar position angles. Therefore the different diameters for different pulsation phase bins shown in Fig. 2 are probably more due to a stellar asymmetry rather than due to a pulsation dependence. For the intermediate phase bin with a good uv coverage an asymmetric FDD fit would give a position angle of (0±15) deg and an axis ratio of (0.90±0.05).

[1] in comparison to optical and near IR diameter estimations of 30 to 70 mas (very sensitive to the absorption and emission wavelengths of abundant molecules like H_2O, OH, CO, CO_2 and SiO)

[2] typically 2500 K

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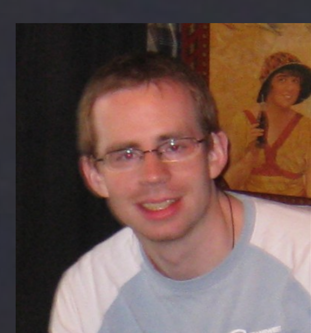

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