Constraints on the structure of hot exozodiacal dust belts

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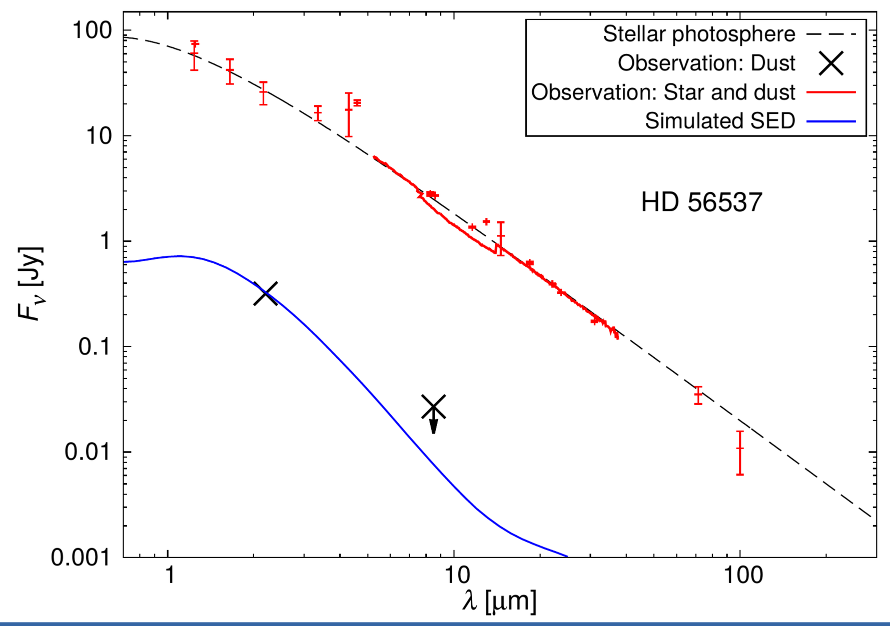
Introduction

A faint but significant near-infrared excess was detected around roughly two dozen main-sequence stars.
This excess is attributed to dust located at distances of less than 1 au – the hot exozodiacal dust.
As the hot exozodiacal dust is hard to observe, little is known about its properties. Also, the origin is highly debated.

We collected chosen observational data of reported systems and performed a modelling in order to constrain their dust properties (Study I). Furthermore, we investigated the potential of the upcoming interferometer MATISSE to further determine the dust location (Study II).

Ia) Disk modelling

- Modelling of observational data: NIR (2.2 µm; Absil et al. 2013) and MIR (8.5 µm; Mennesson et al. 2014)
- Simple model:
  - Disk ring with inner radius R, outer radius 1.5 R
  - Single grain size a
  - Geometry: Face-on and edge-on disk, spherical distribution
- SED-modelling of 9 systems with detected NIR excess, using the radiative transfer program debris (Ertel et al. 2011)



Left: Example of modelled system with hot exozodiacal dust - HD 56537, consisting of a flux in the NIR (λ=2.2 µm) and an upper limit in the MIR (λ=8.5 µm). A simulated SED is shown as blue solid line.

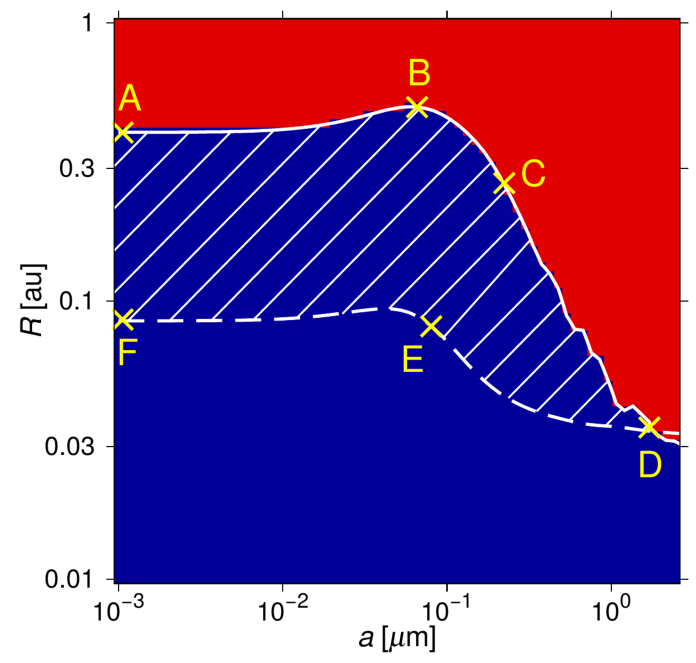
II) Simulated observations for MATISSE/VLTI

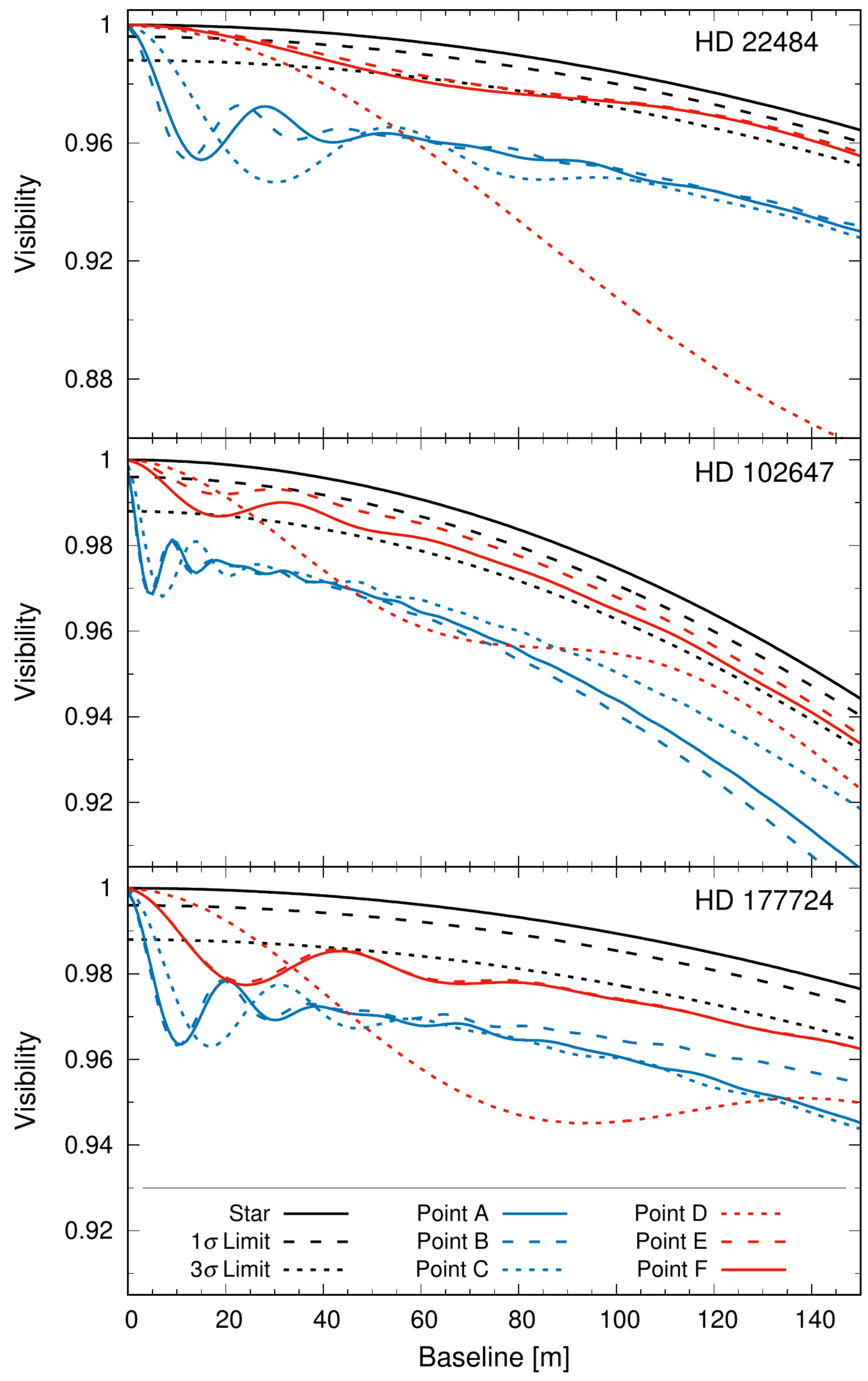
- Simulated observations for the upcoming MIR interferometer MATISSE at the VLTI
- L (λ=3.5 µm), M (4.7 µm), N band (10 µm)

Visibility drop for L and N bands slightly smaller than for the M band.

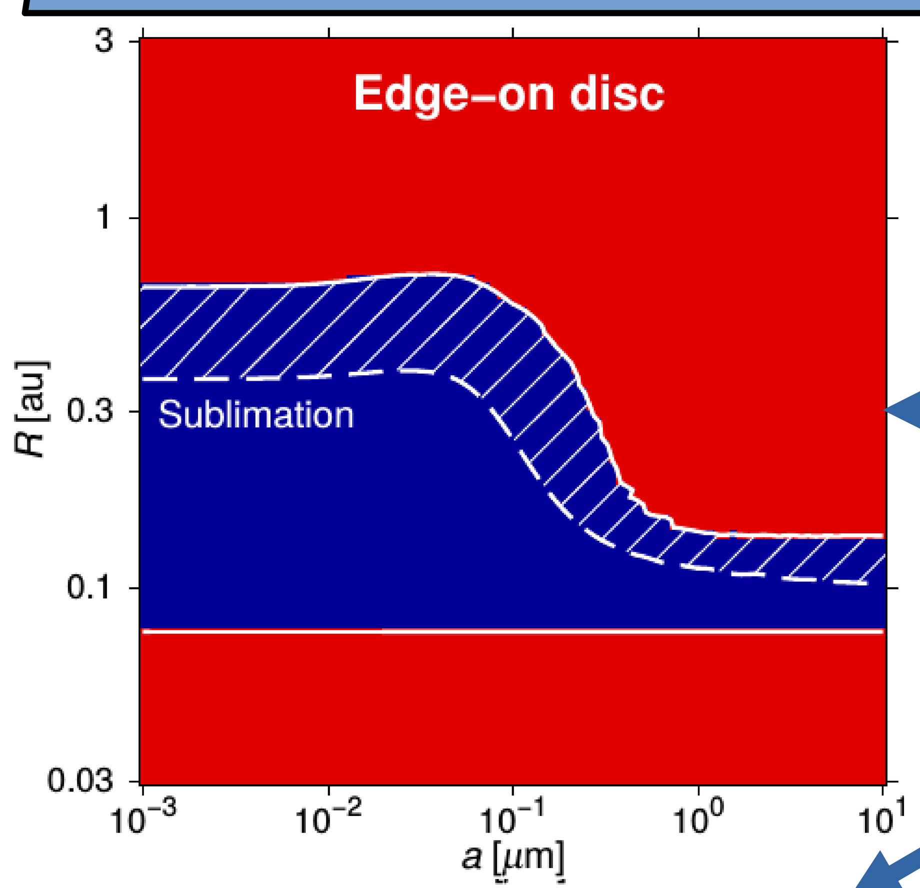
Potential to further constrain dust properties (location)

Most promising systems:
HD 22484, HD 102647,
HD 177724 (*right*)





Ib) Modelling results



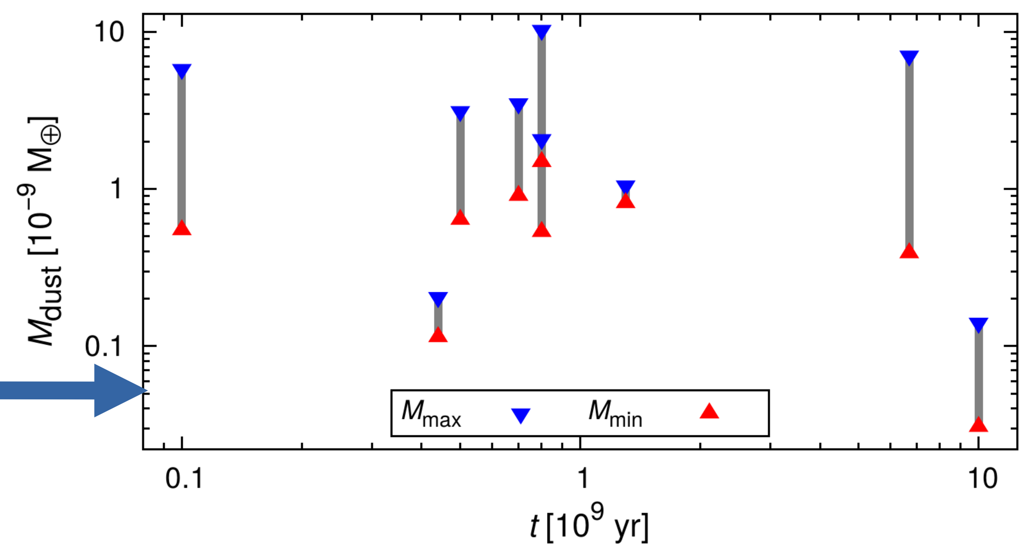
The following constraints were found:

Dust location: 0.01 au < R < 1 au

Grain size: 0.02 µm < a < 0.5 µm

Dust mass: $0.2\times10^{-9}\,M_\oplus < M_{dust} < 3.5\times10^{-9}\,M_\oplus$

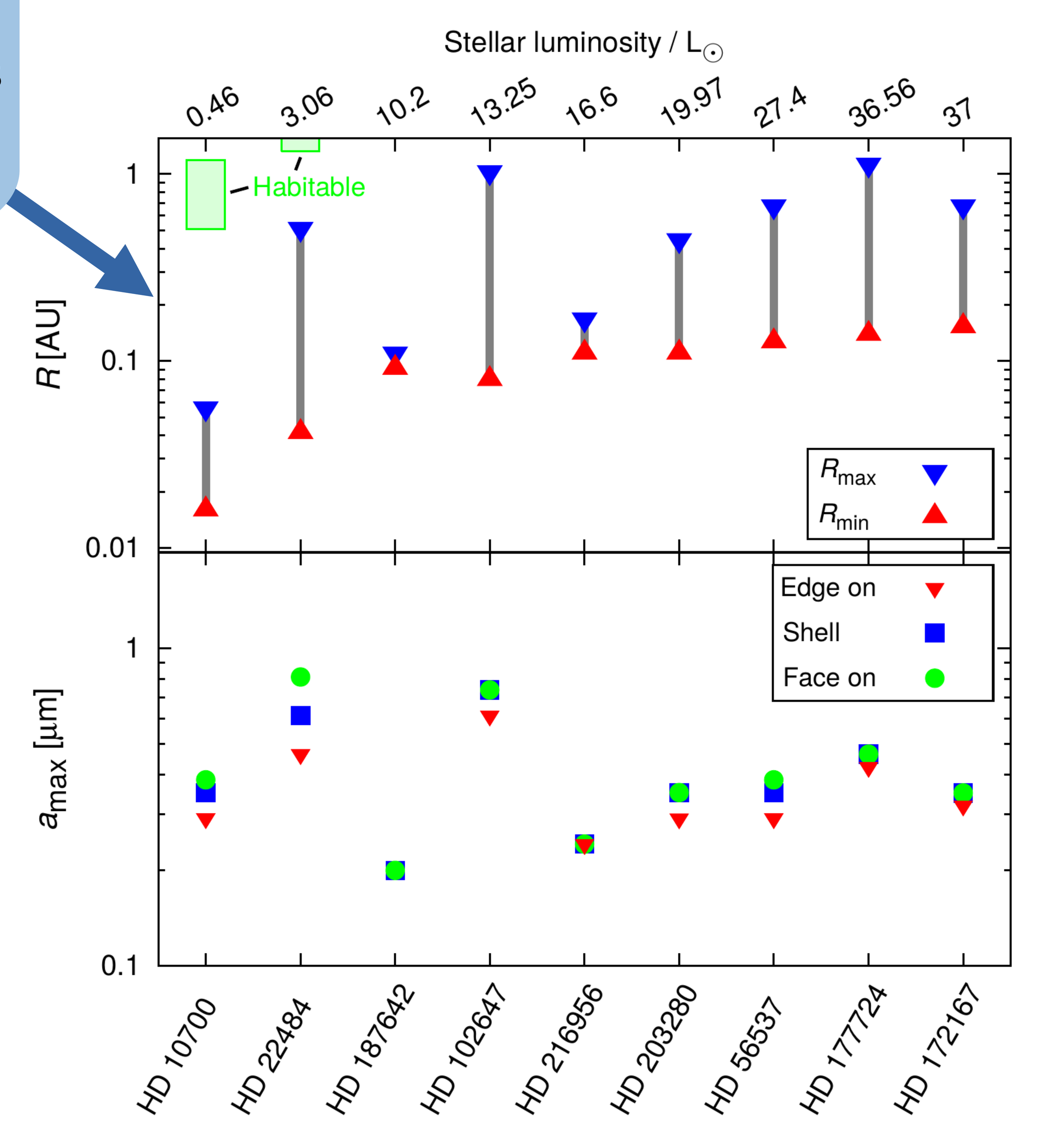
No correlation between M_{dust} and stellar age t

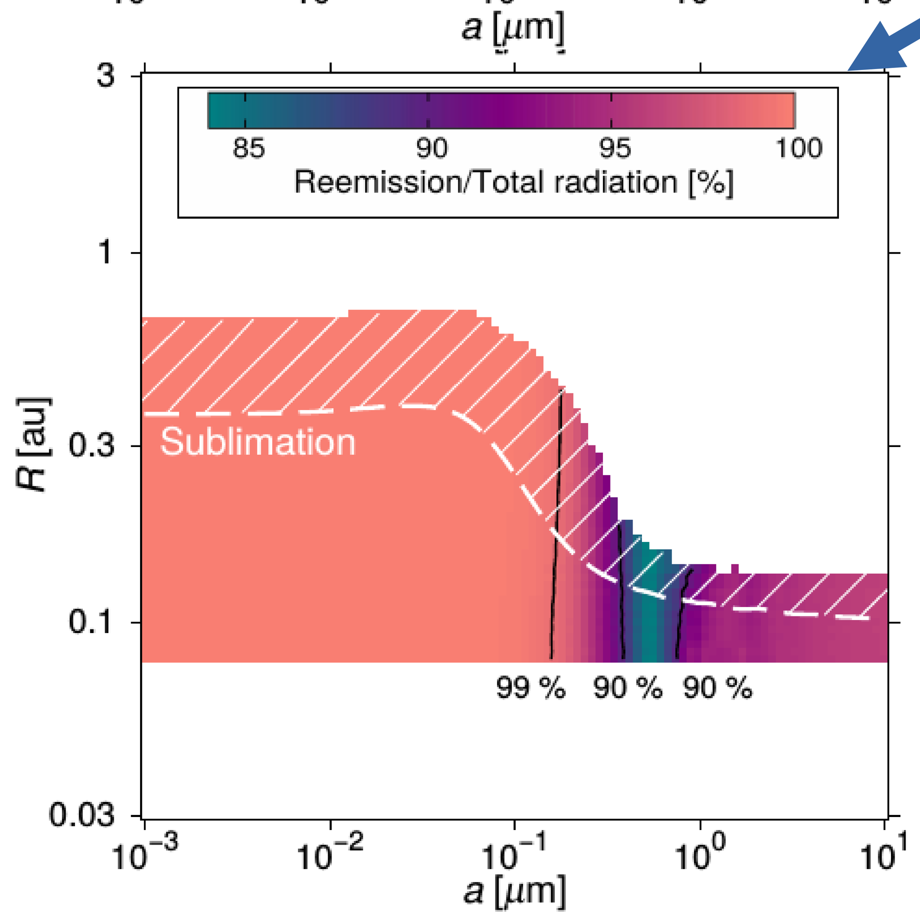


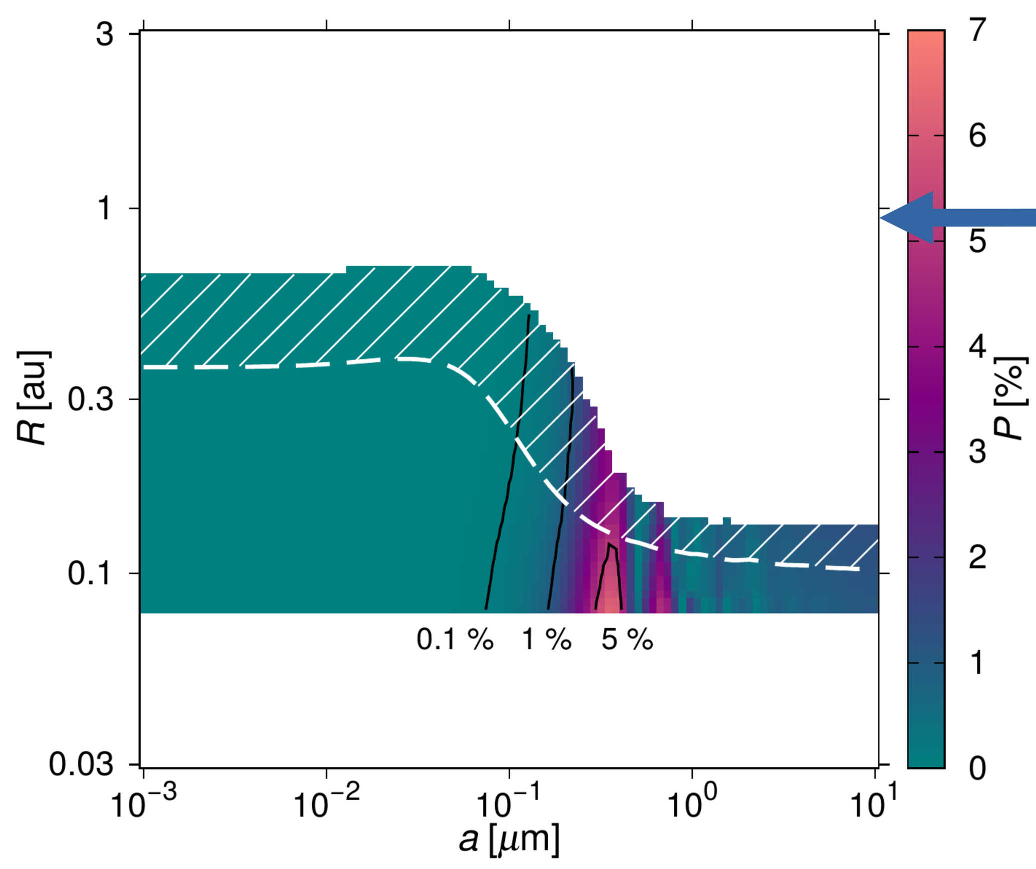
Thermal reemission dominating

Significant correlation between R_{max} and L!

$R_{max} \propto L^{0.5}$, which would imply that all exozodis have nearly the same temperature

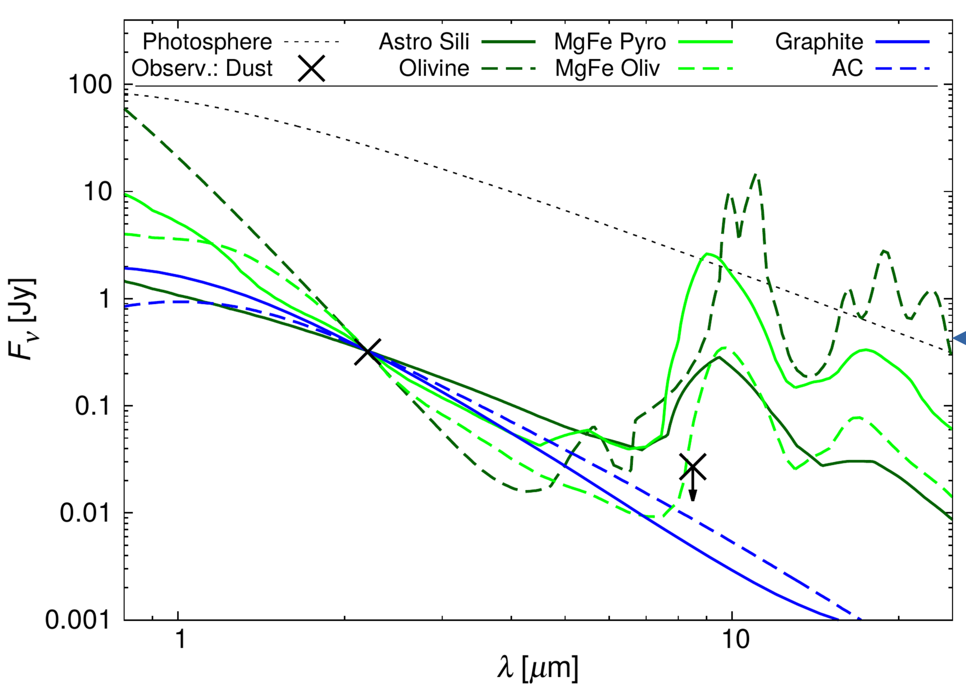






Polarisation degree:

P < 5 %



Testing different dust materials:

Silicates (green) show characteristic spectral feature around $\lambda \sim 10$ µm, causing overestimation of flux at 8.5 µm, contrary to the observations

Carbonaceous grains (blue) can reproduce the observations

References

- **Absil O. et al., 2013, A&A, 555, A104**
- **Ertel S. et al., 2011, A&A, 533, A132**
- **Mennesson B. et al., 2014, ApJ, 797, 119**

I am further interested – What to do?

For further details, please see:
Kirchschlager F. et al. (2017), MNRAS, 467, 1641,
Kirchschlager F. et al. (2018), MNRAS, 473, 2633.

The author of this poster is around and happy to answer any question!