P2IO JWST meeting

Friday 9 June 2017

Carbonaceous dust in proto-planetary disks: survival, evolution and signatures

Thomas Boutéraon, Emilie Habart, Nathalie Ysard

Two approaches

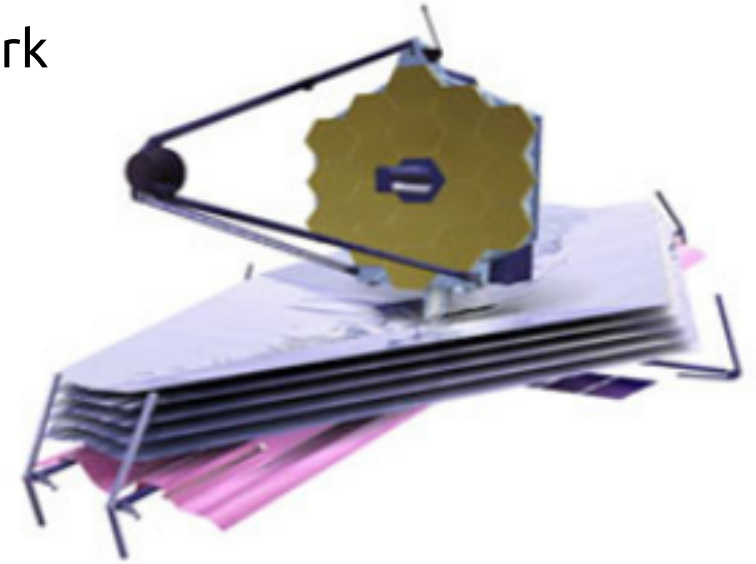
> Observational VLT/NACO data processing and analysis
L-band : 3.2 – 3.76 µm / 0,1'' / R ~ 1000

> Modelling with DUSTEM in THEMIS framework
G0, grain composition, radius

Outline

> Disk SED and structure
> Observed object and spectra
> Characteristic spectra and comparison

> THEMIS framework
> Main considerations and results
> Grid exploration
> Constraints on carbonaceaous materials

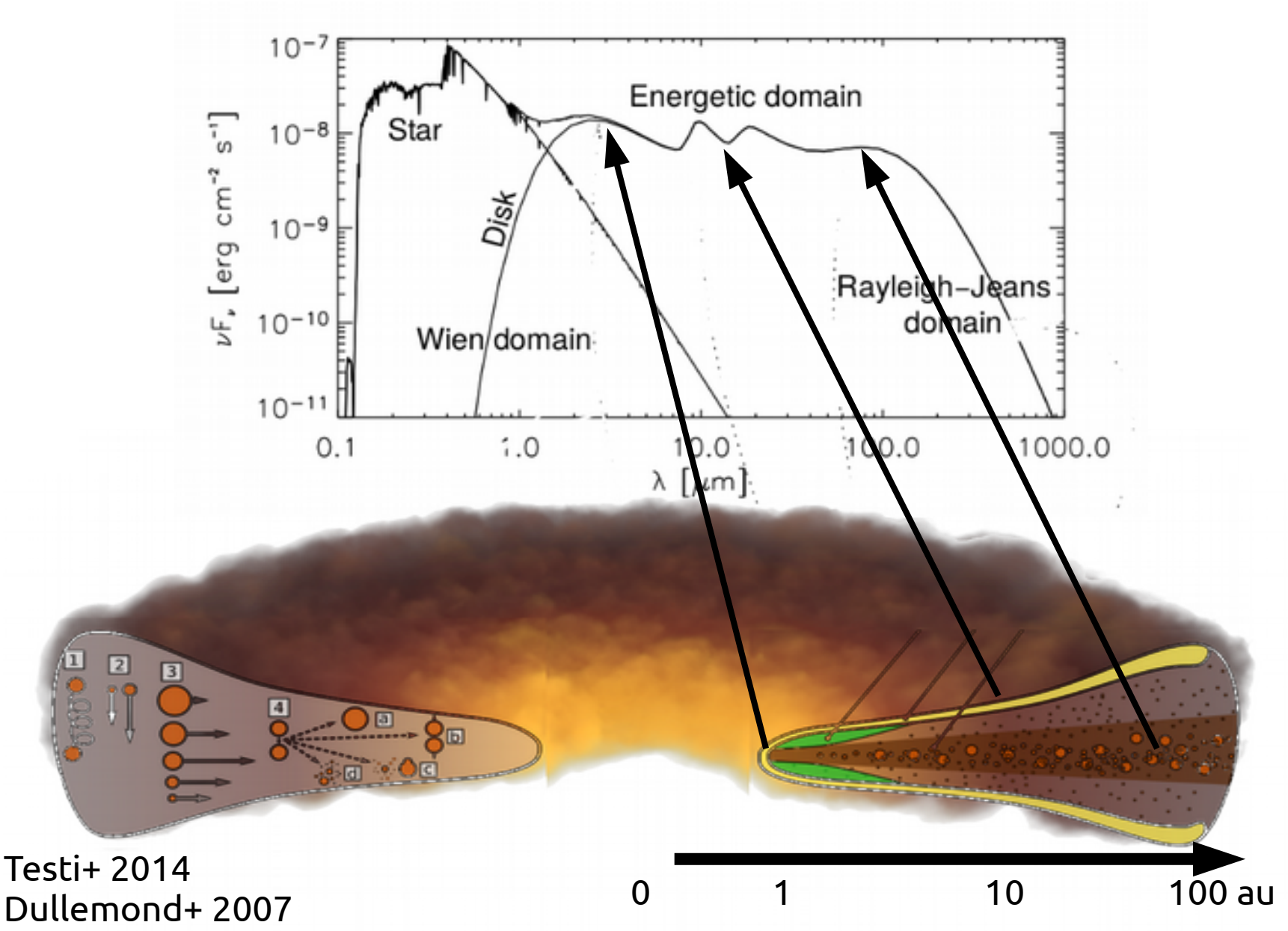


NIRSpec :
0.6 – 5.0 µm / 0,1'' / R ~ 1000 - 3000

MIRI :
5.0 – 28.6 µm / 0.2'' - 0.8''/ R ~ 1000 - 3000

0.1'' = 10au at 100pc

Dust into protoplanetary disk – processing and probing



Testi+ 2014
Dullemond+ 2007

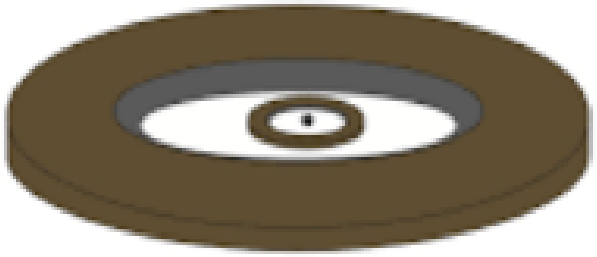
HD100546 – Overview

> One of the nearest Herbig Be stars
B9Ve / d ~ 97 ± 4 pc — Acke & van denAncker 2004 / van Leeuwen 2007
L ~ 36 L_{sol} M ~ 2.5 Msol
T ~ 11000 K
Age ~10My

> First disk in which have been detected
crystalline silicates / PAHs — Hu+1989 / Malfeit+ 1998

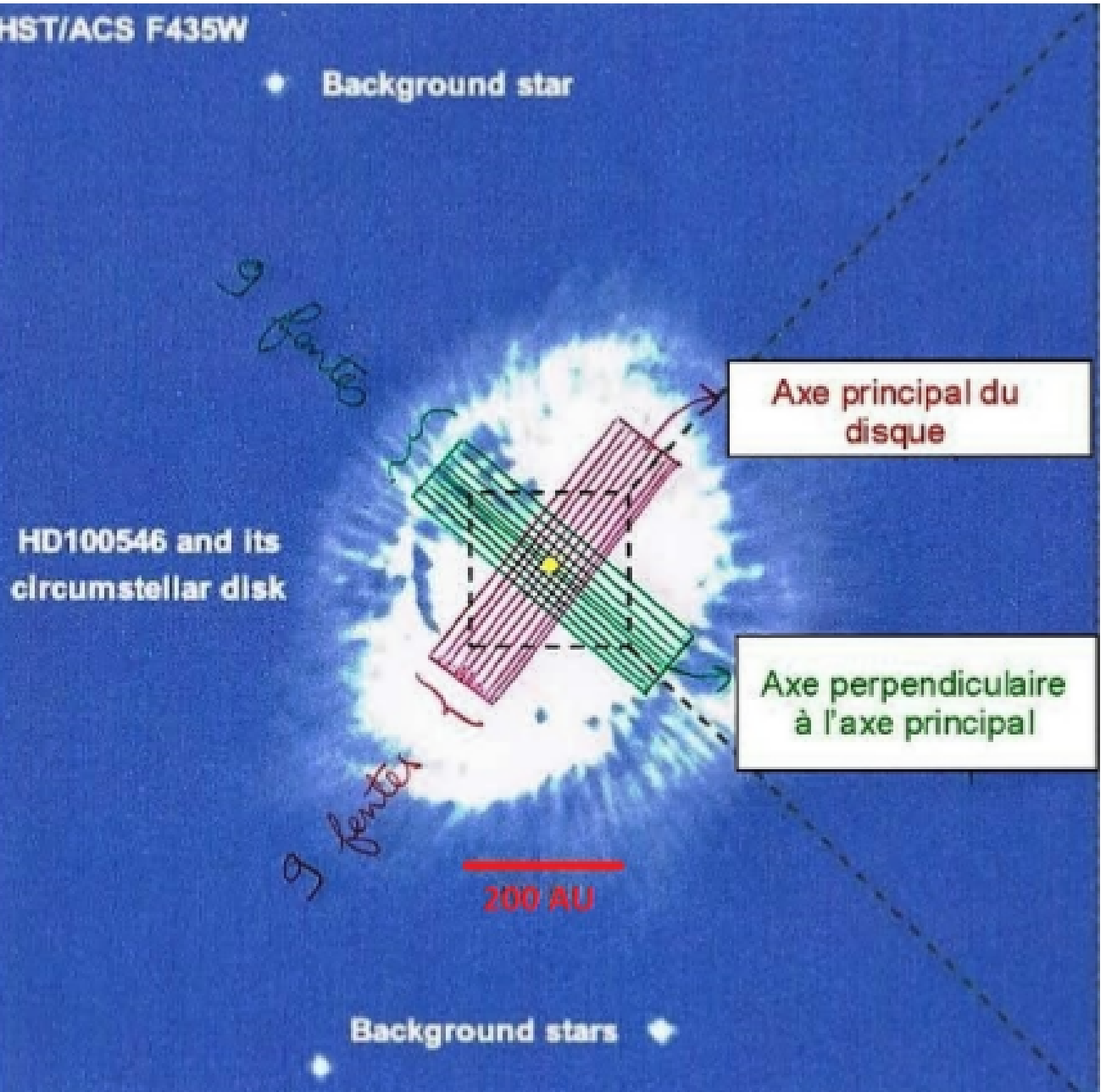
> Complex structure (gap, asymmetry, spiral) and distribution of gas and dust — Panic+ 2014, Garufi+ 2016, Follette+ 2017

> A gas giant planet in the disk ? — Quanz+ 2015



Pre-transtional Disk

Data acquisition



VLT/NACO
075.C-0624(A)

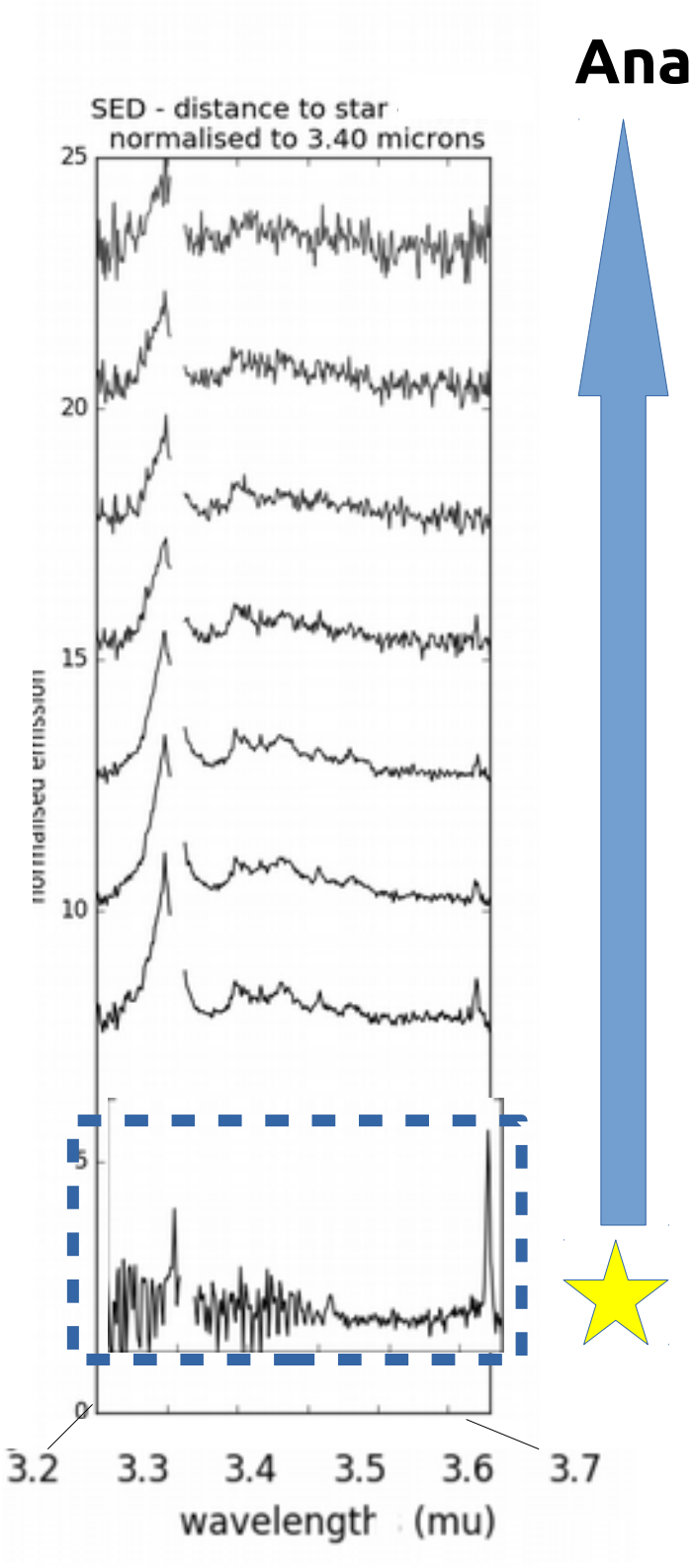
L-band : 3.20 – 3.76 µm

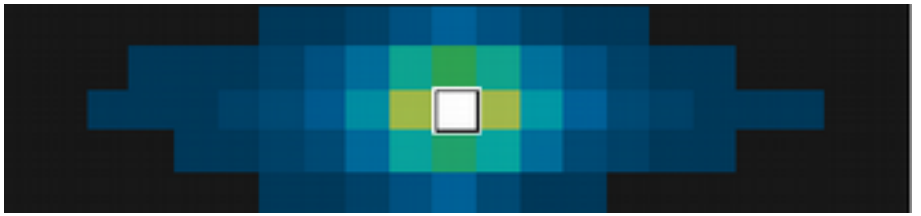
9 slit positions
shifted of half-width for each acquisition

Major and minor axis

0.35×4.00'' area covered

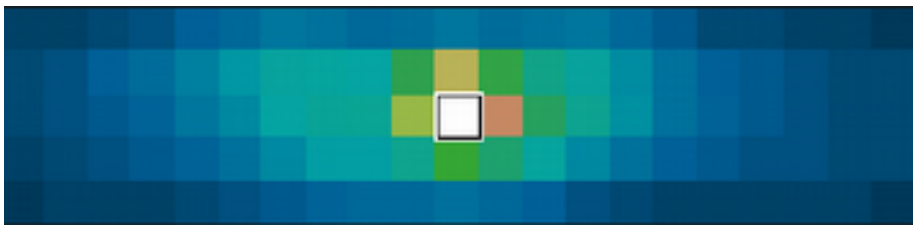
Analysis





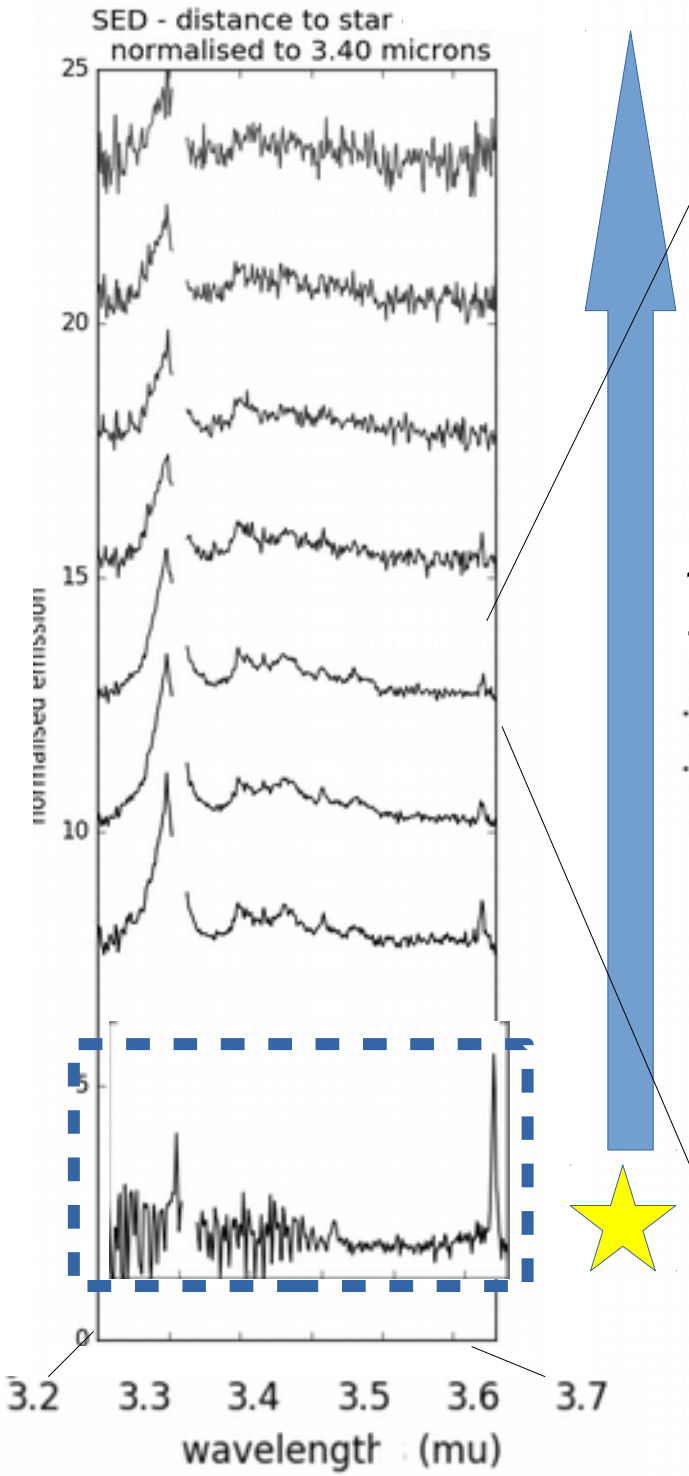
Continuum emission

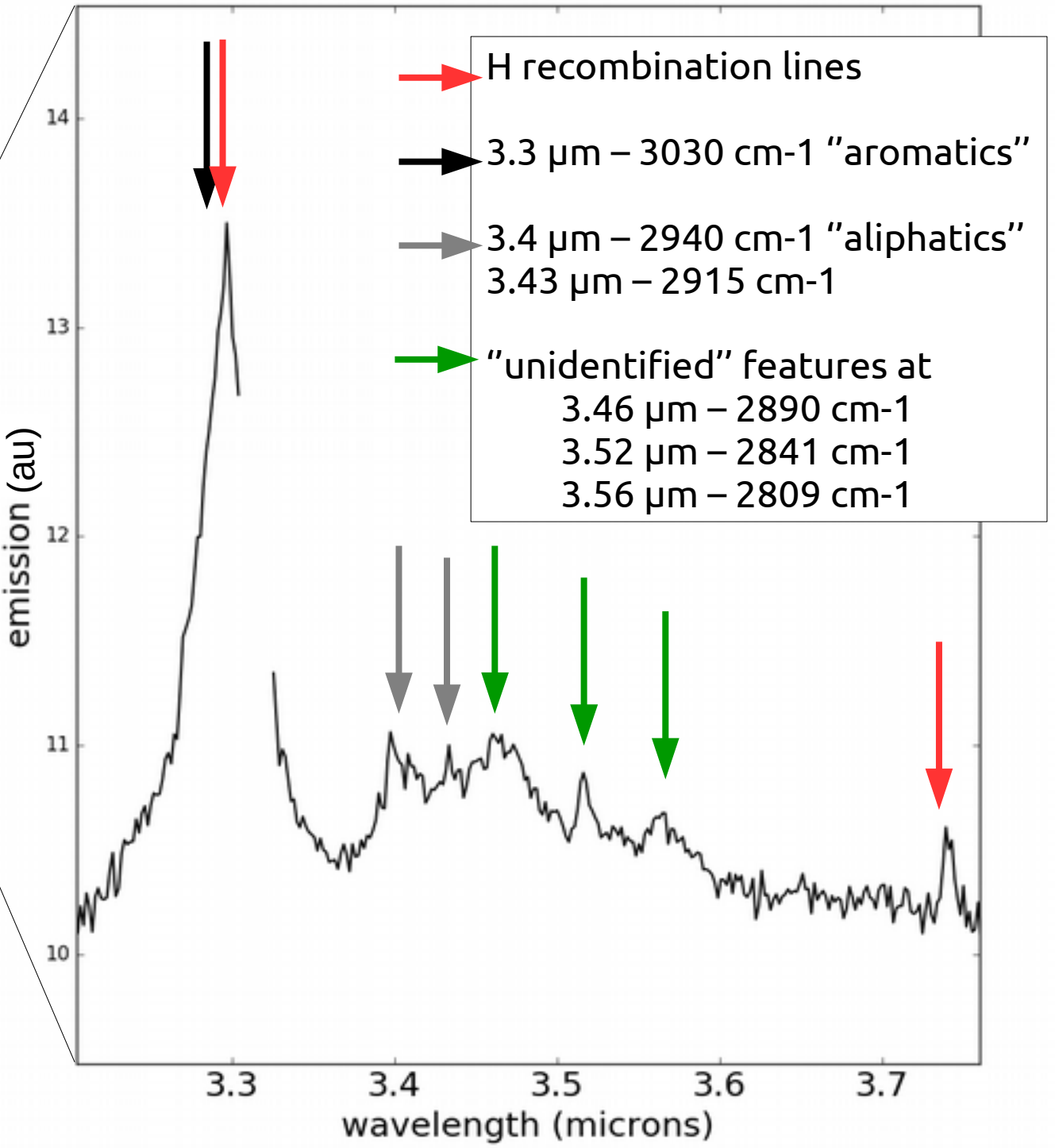
3. 3 μm emission



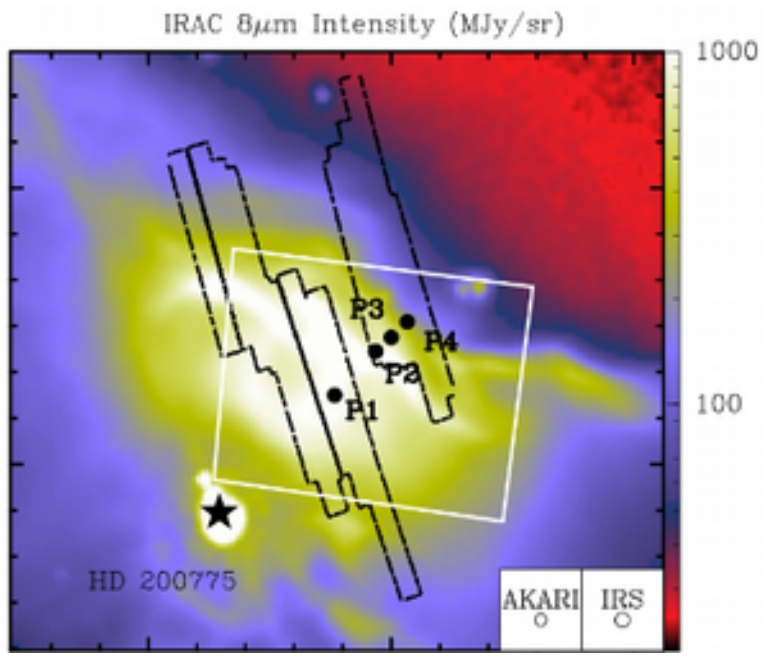
3. 4 μm emission

Analysis

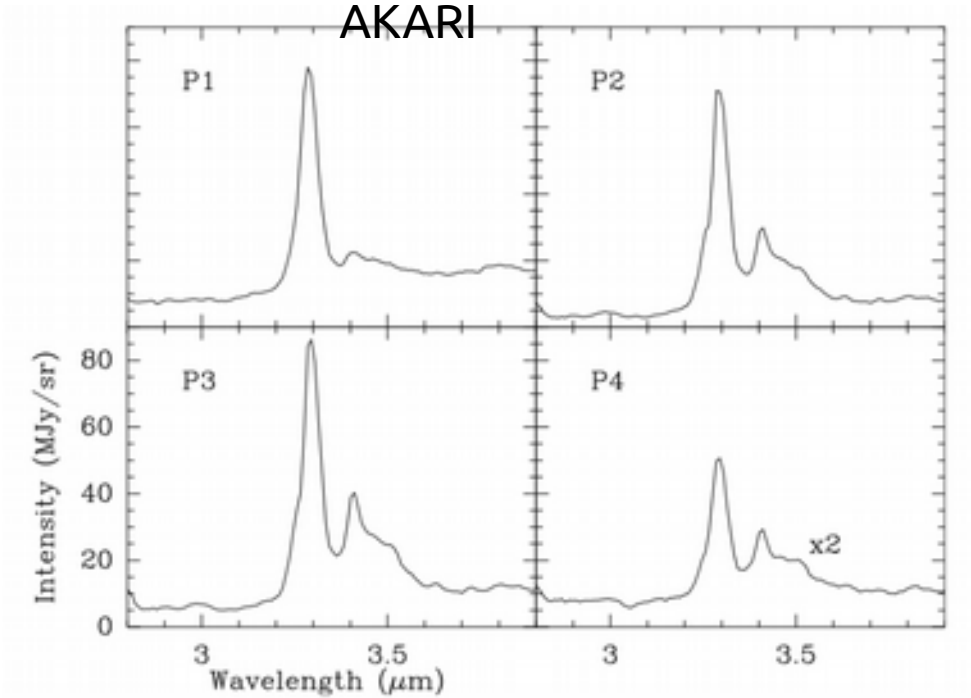

SED - distance to star
normalised to 3.40 microns
normalised emission
25
20
15
10
5
0
3.2
3.3
3.4
3.5
3.6
3.7
wavelength (mu)

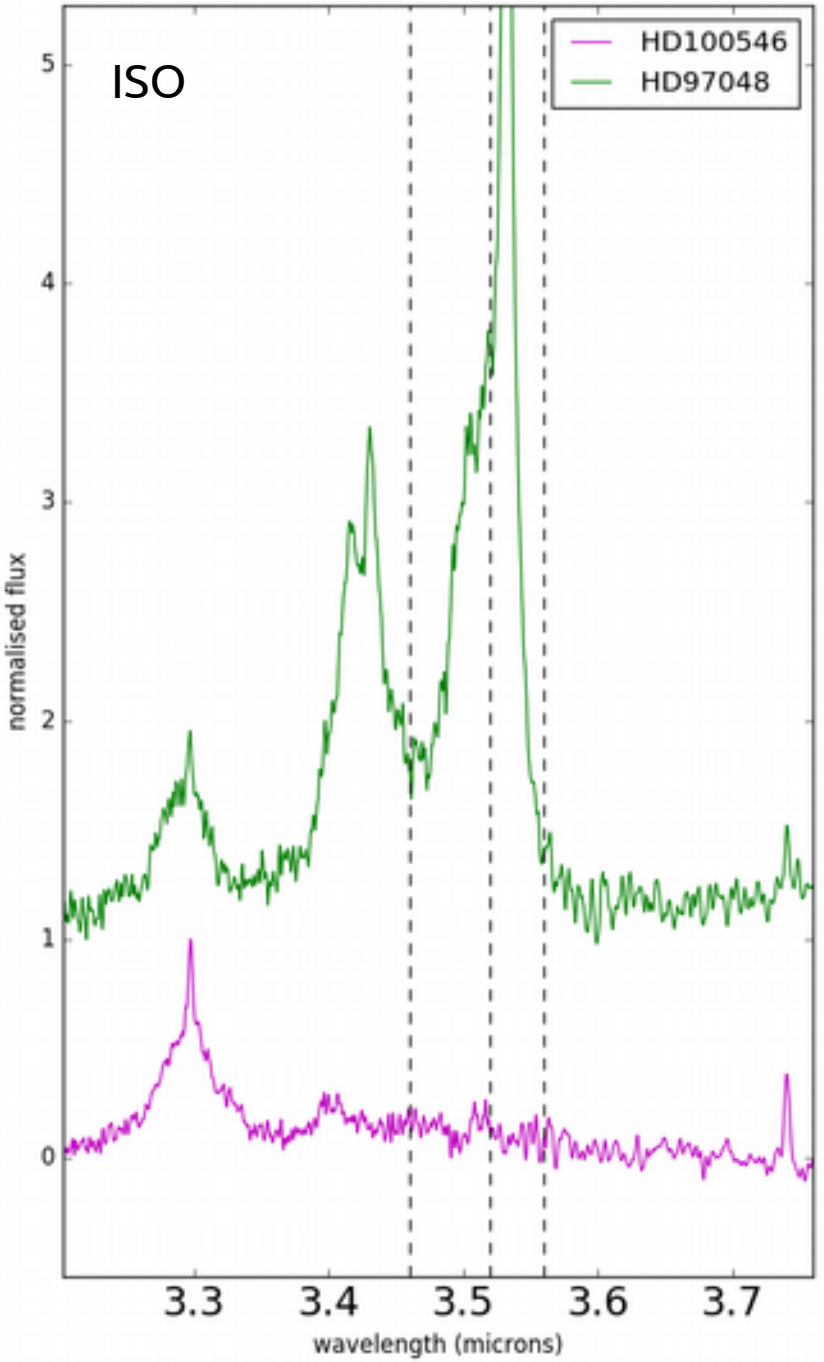

emission (au)
14
13
12
11
10
3.3
3.4
3.5
3.6
3.7
wavelength (microns)
H recombination lines
3.3 μm – 3030 cm-1 ''aromatics''
3.4 μm – 2940 cm-1 ''aliphatics''
3.43 μm – 2915 cm-1
''unidentified'' features at
3.46 μm – 2890 cm-1
3.52 μm – 2841 cm-1
3.56 μm – 2809 cm-1

Comparison with a PDR and a disk with nanodiamonds



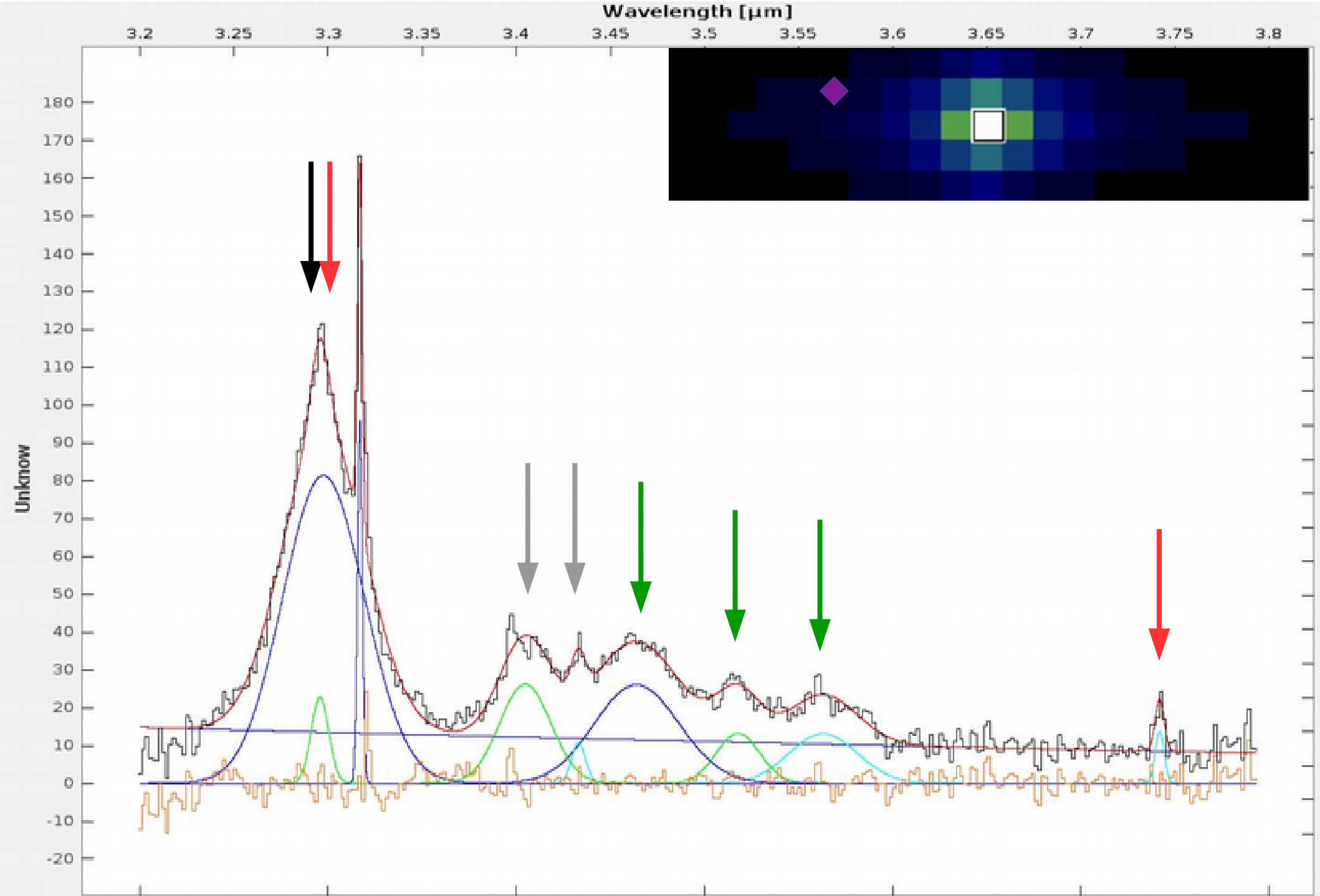
AKARI



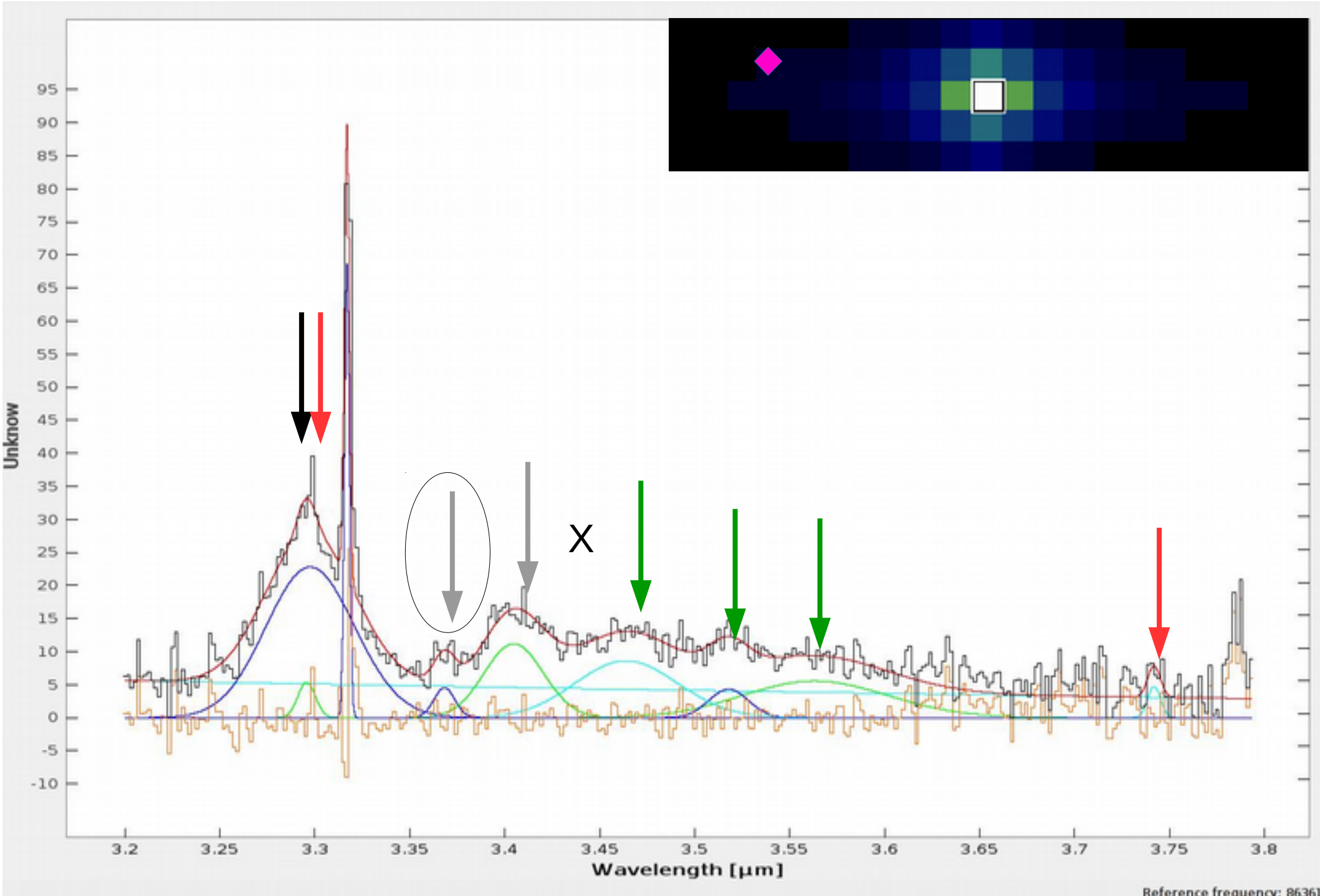


Pilleri+ 2015, Habart+ 2004

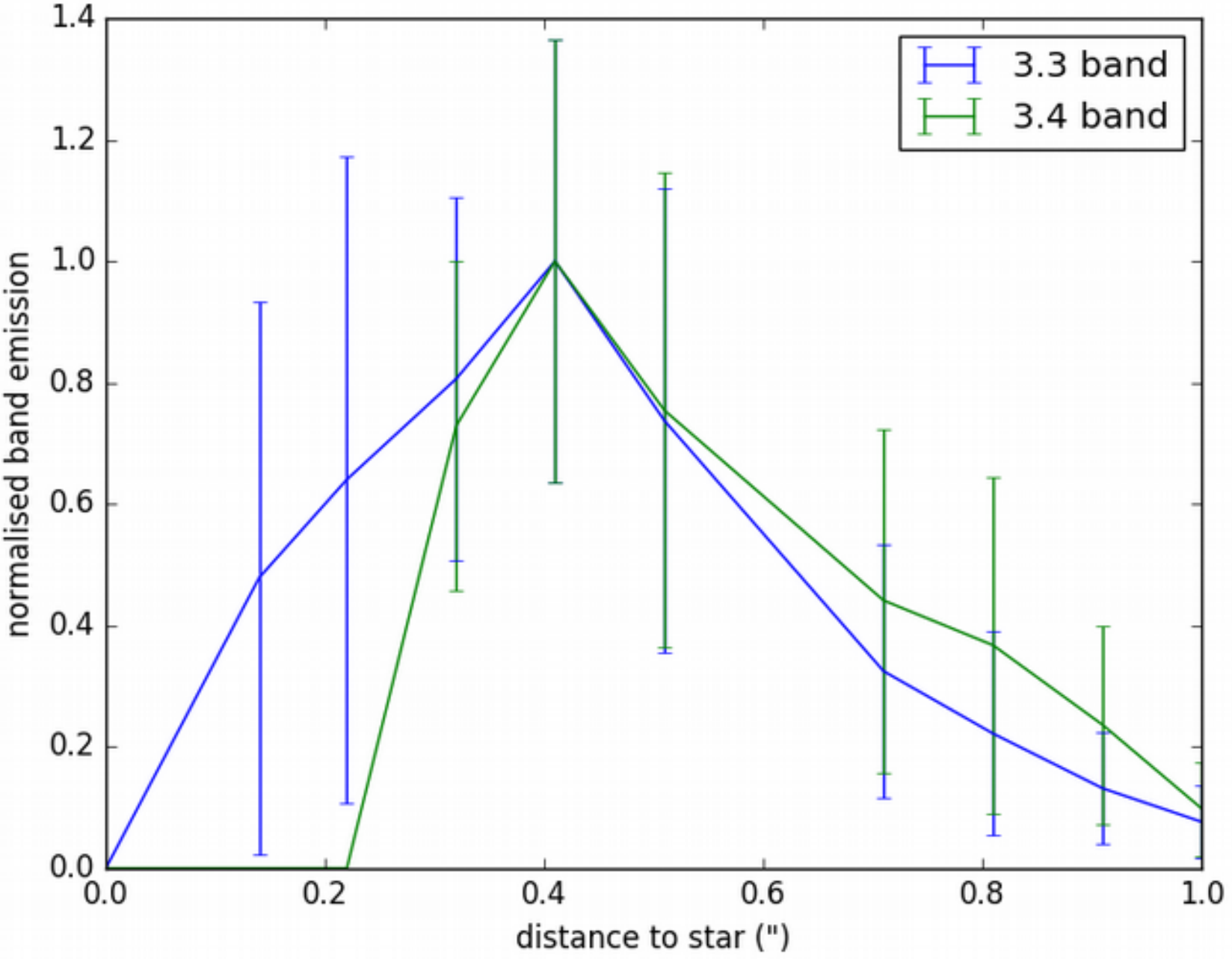
Spectrum decomposition



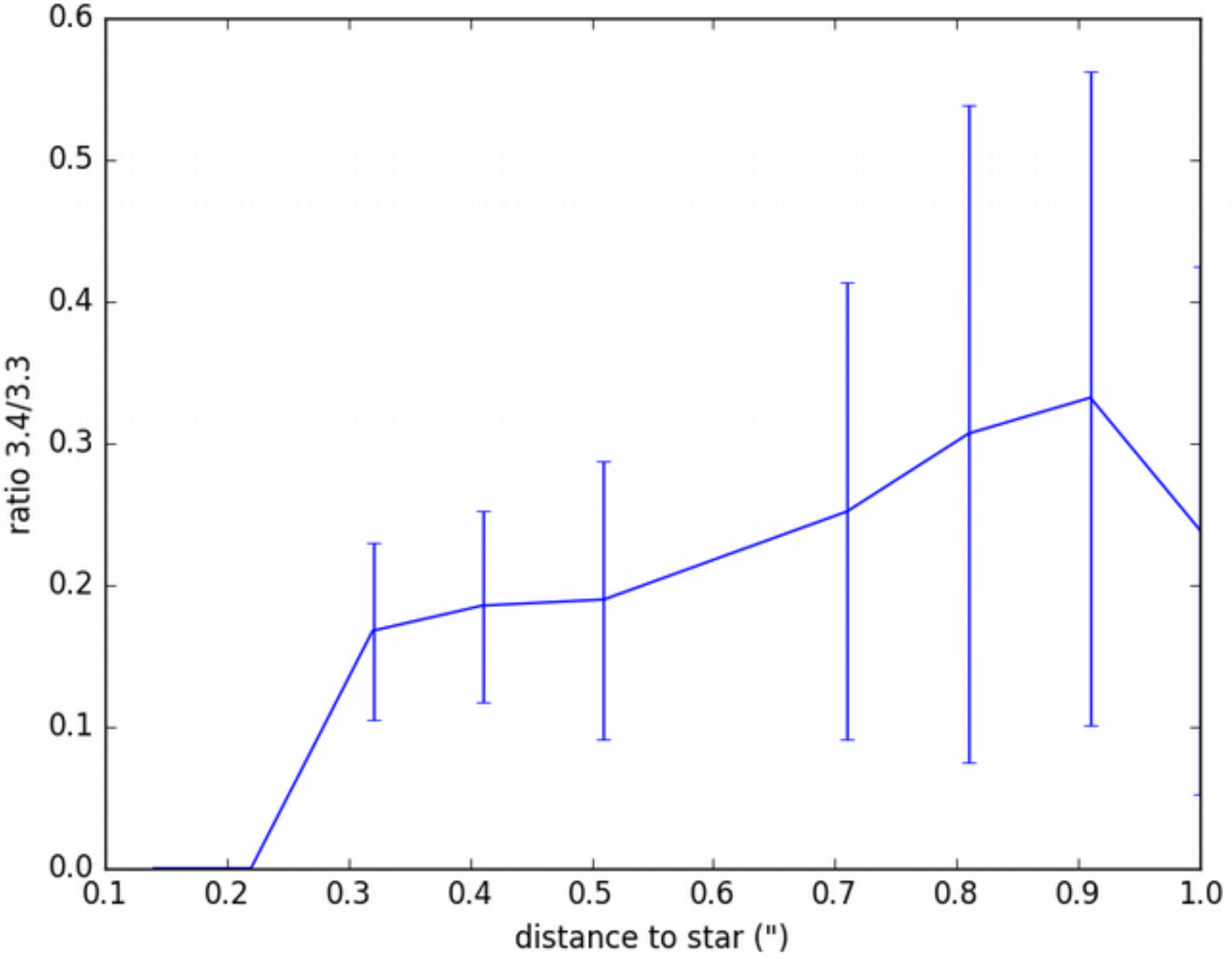
Spectrum decomposition



Decomposition results



Decomposition results



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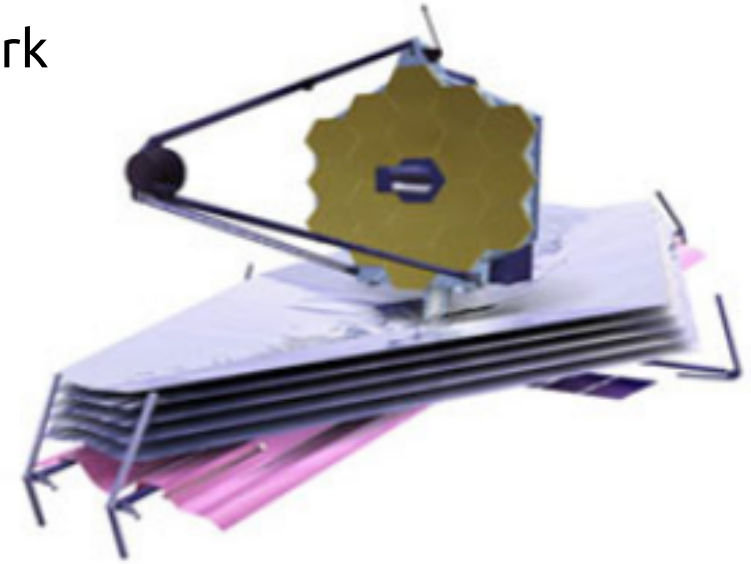


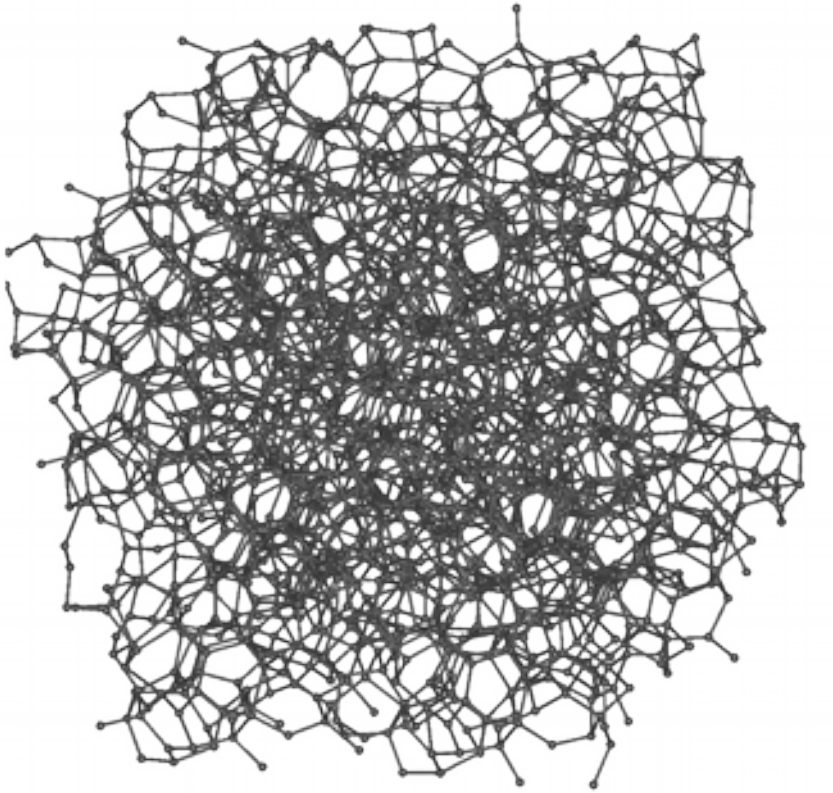
NIRSpec :
0.6 – 5.0 µm / 0,1'' / R ~ 1000

MIRI :
5.0 – 28.6 µm / 0.3'' / R ~ 100 at 7.5 µm

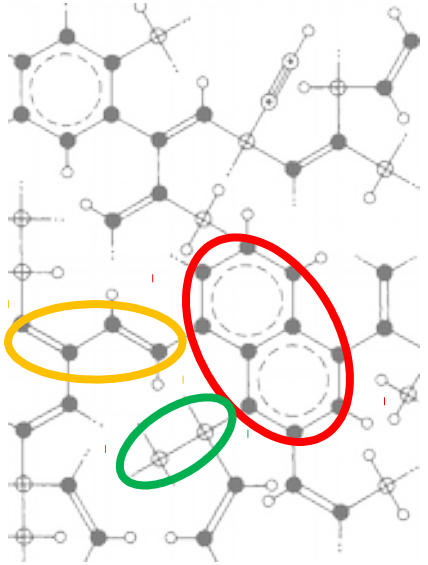
0.1'' = 10au at 100pc

THEMIS
The Heterogeneous dust Evolution Model for Interstellar Solids

Carbonaceous grain composition

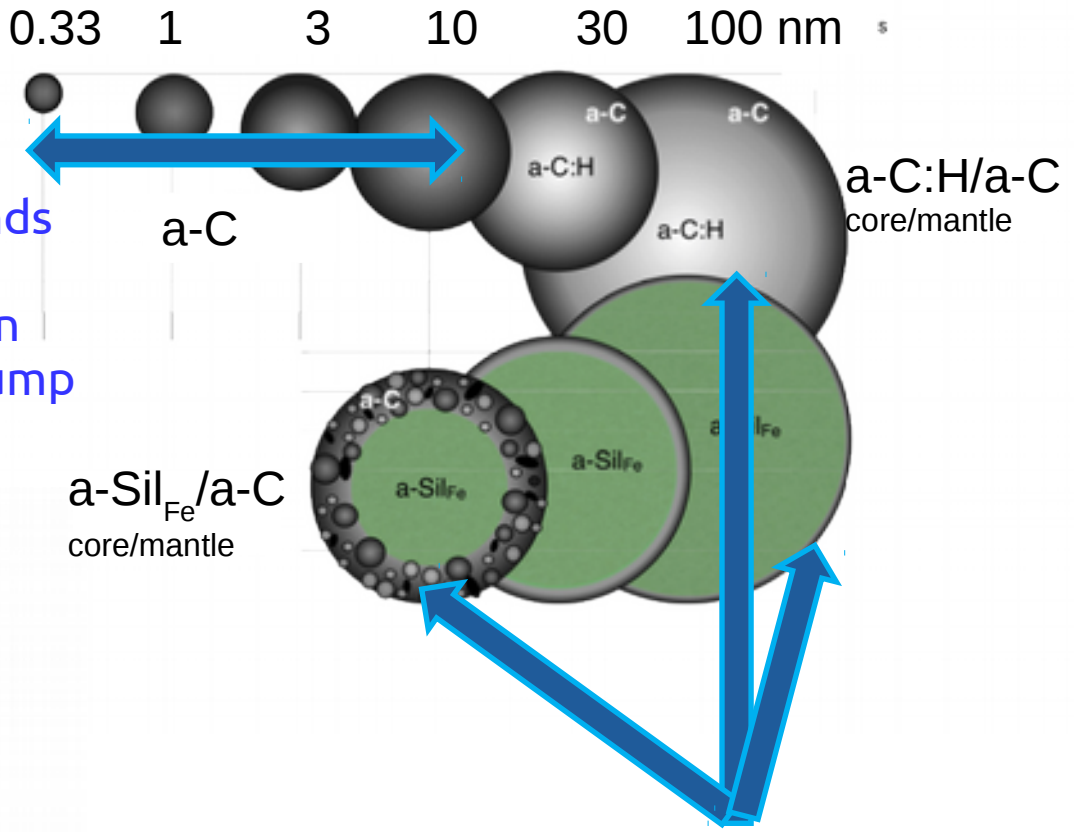


aliphatics
olefinics
aromatics



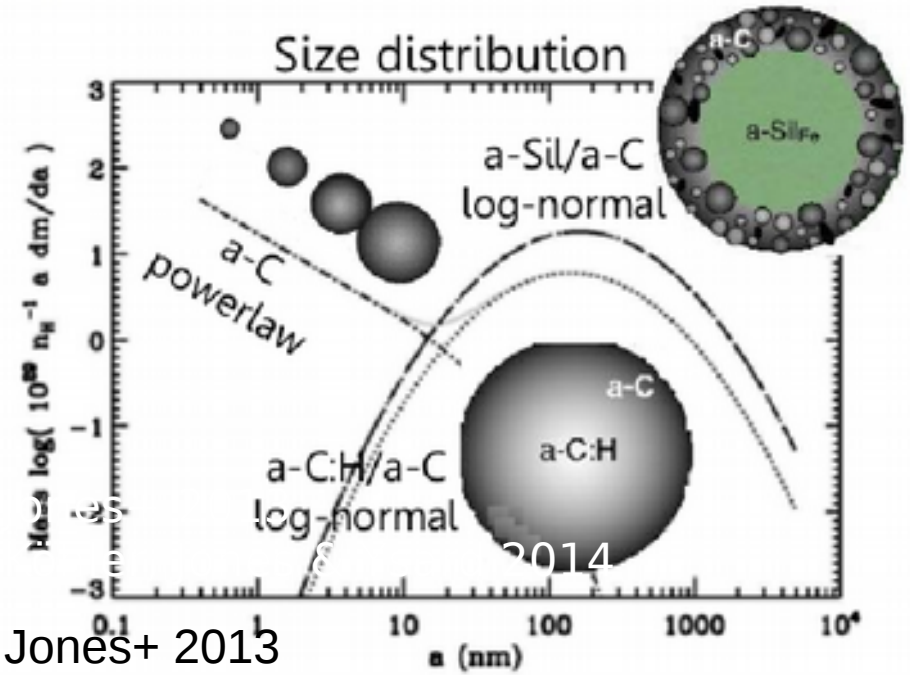
Jones+ 2013

Grain populations



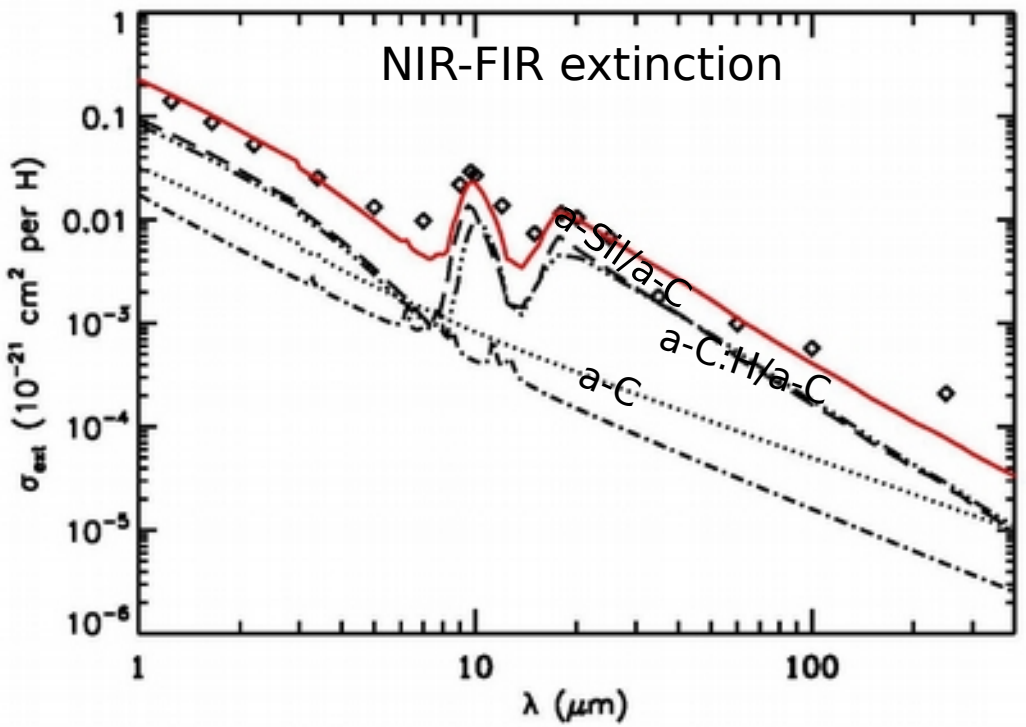
IR emission bands
MIR emission
FUV extinction
UV extinction bump

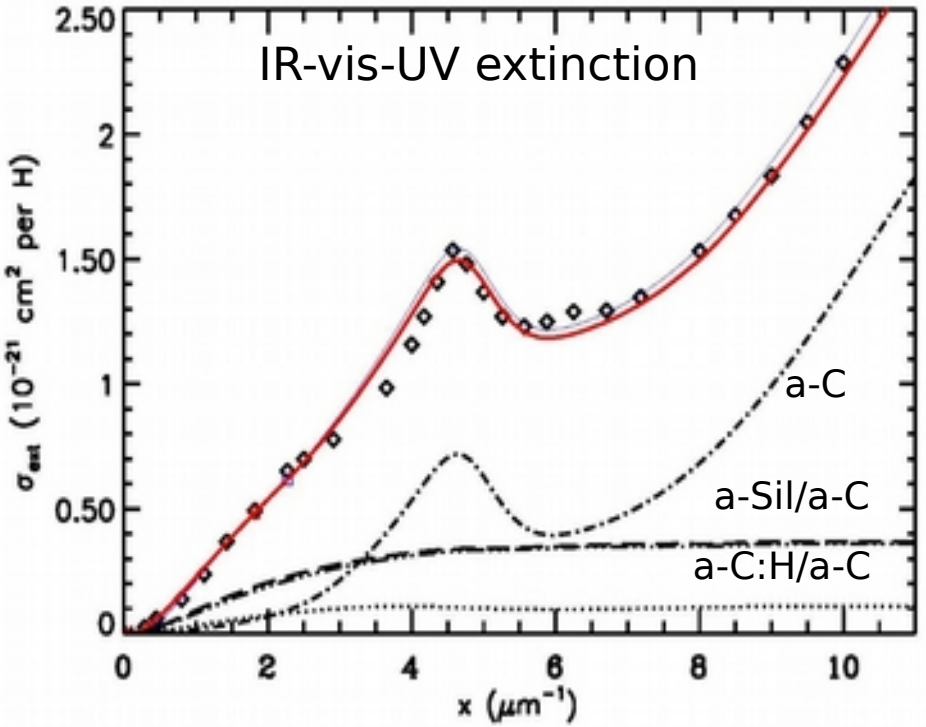
IR absorption bands
visible/MIR extinction
FUV extinction
FIR/submm emission

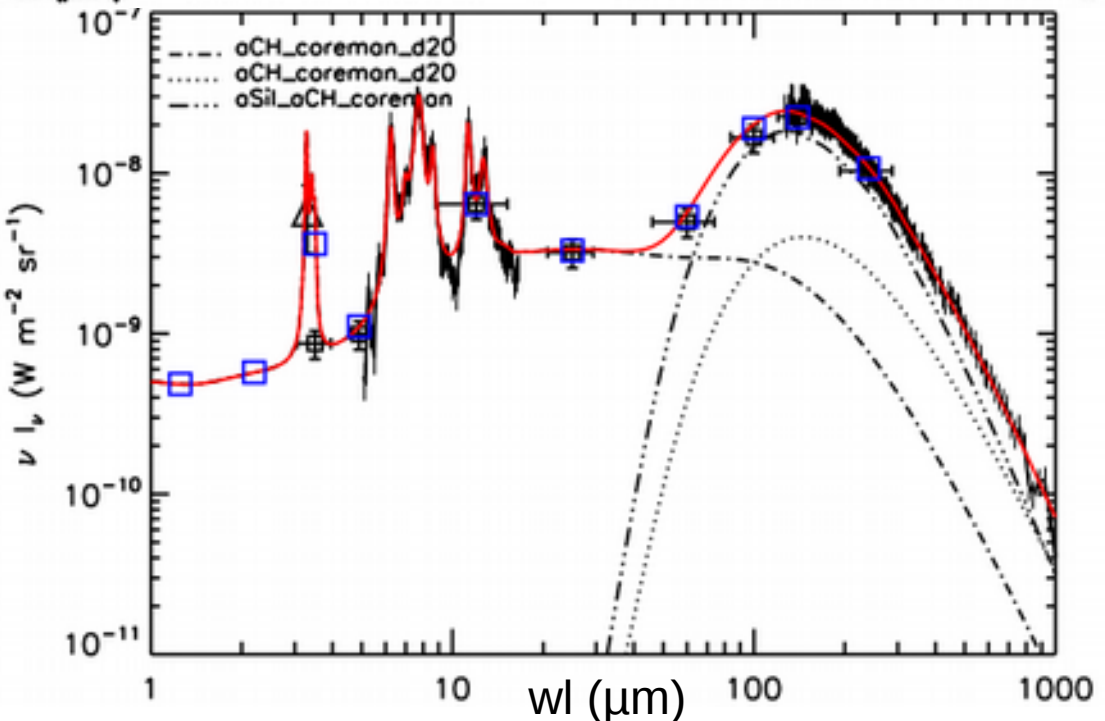


Jones+ 2013

A model developed for the ISM







Jones+ 2013

Make the grid

- Blackbody
- T = 11000 K
- L = 36 Lsol

G0

- completely constrained by C / H atoms ratio
- drives grain density
- drives kind of bonding

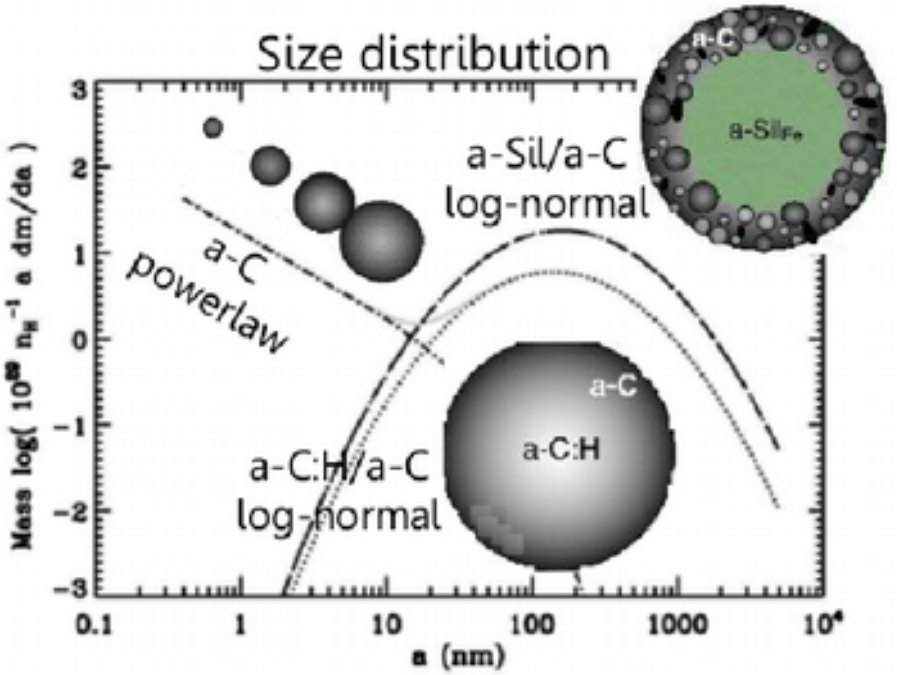
Eg_mantle

DUSTEM

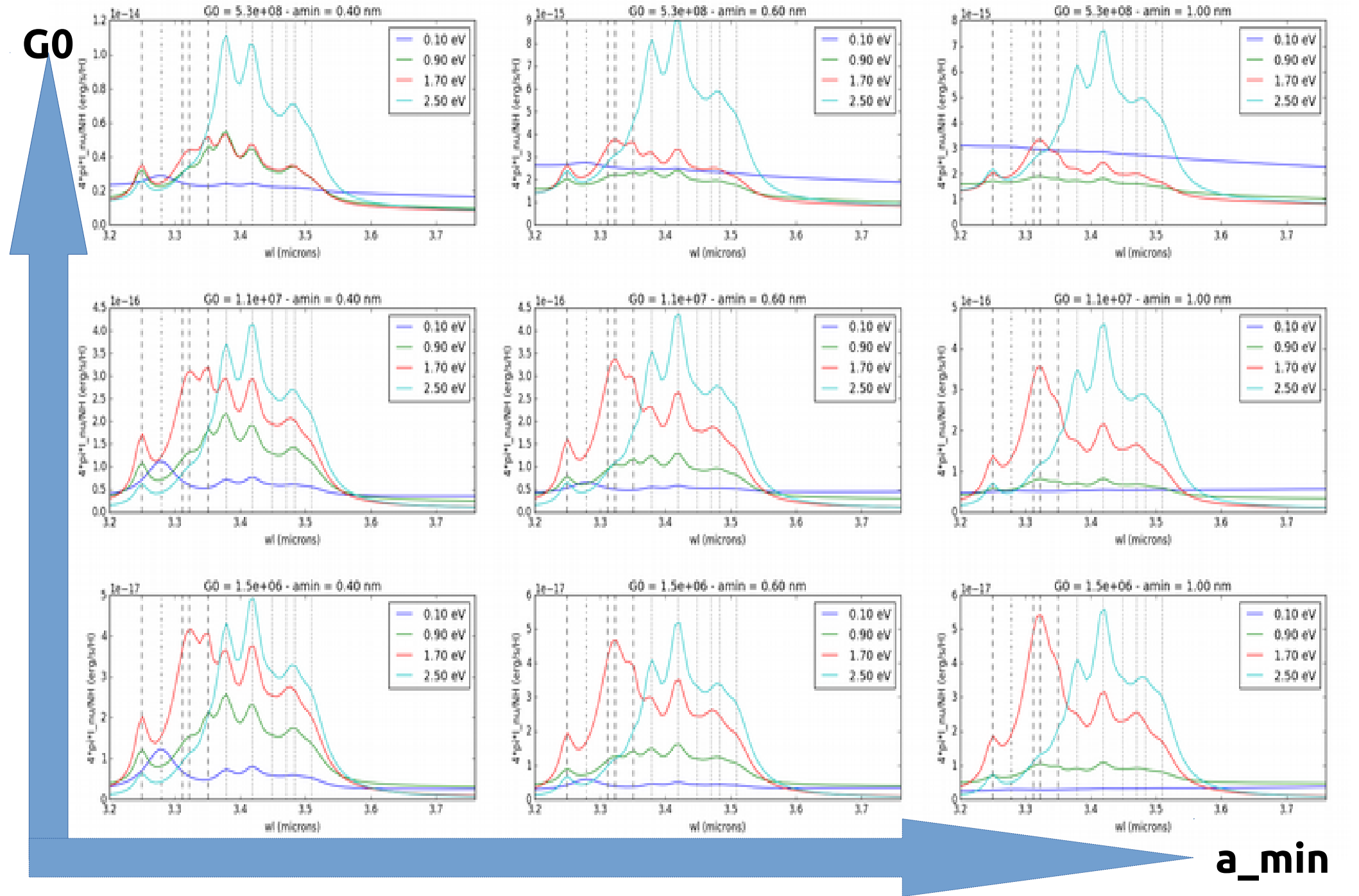
Dustprop

a_min

DUSTEM

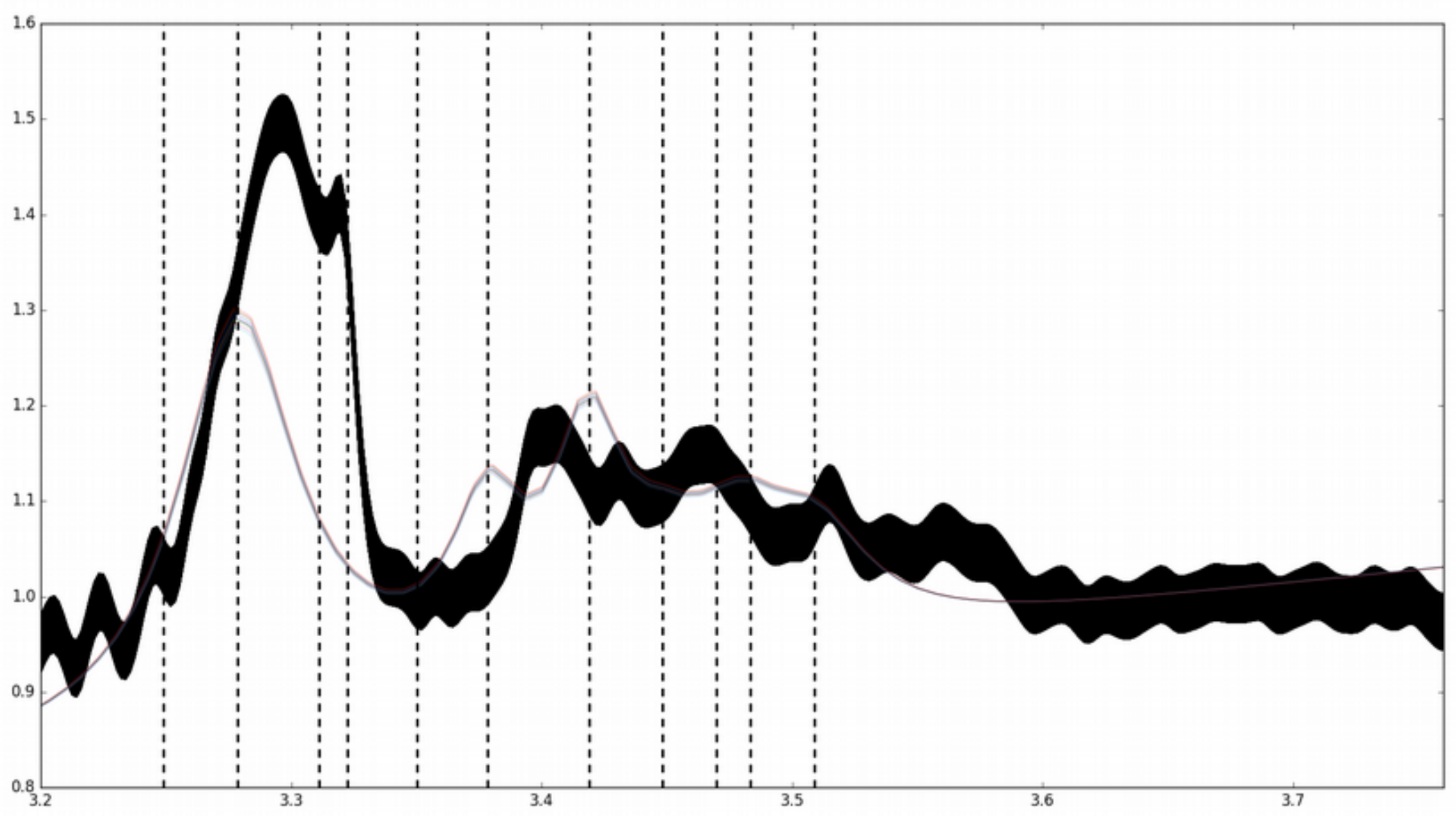


Grid exploration

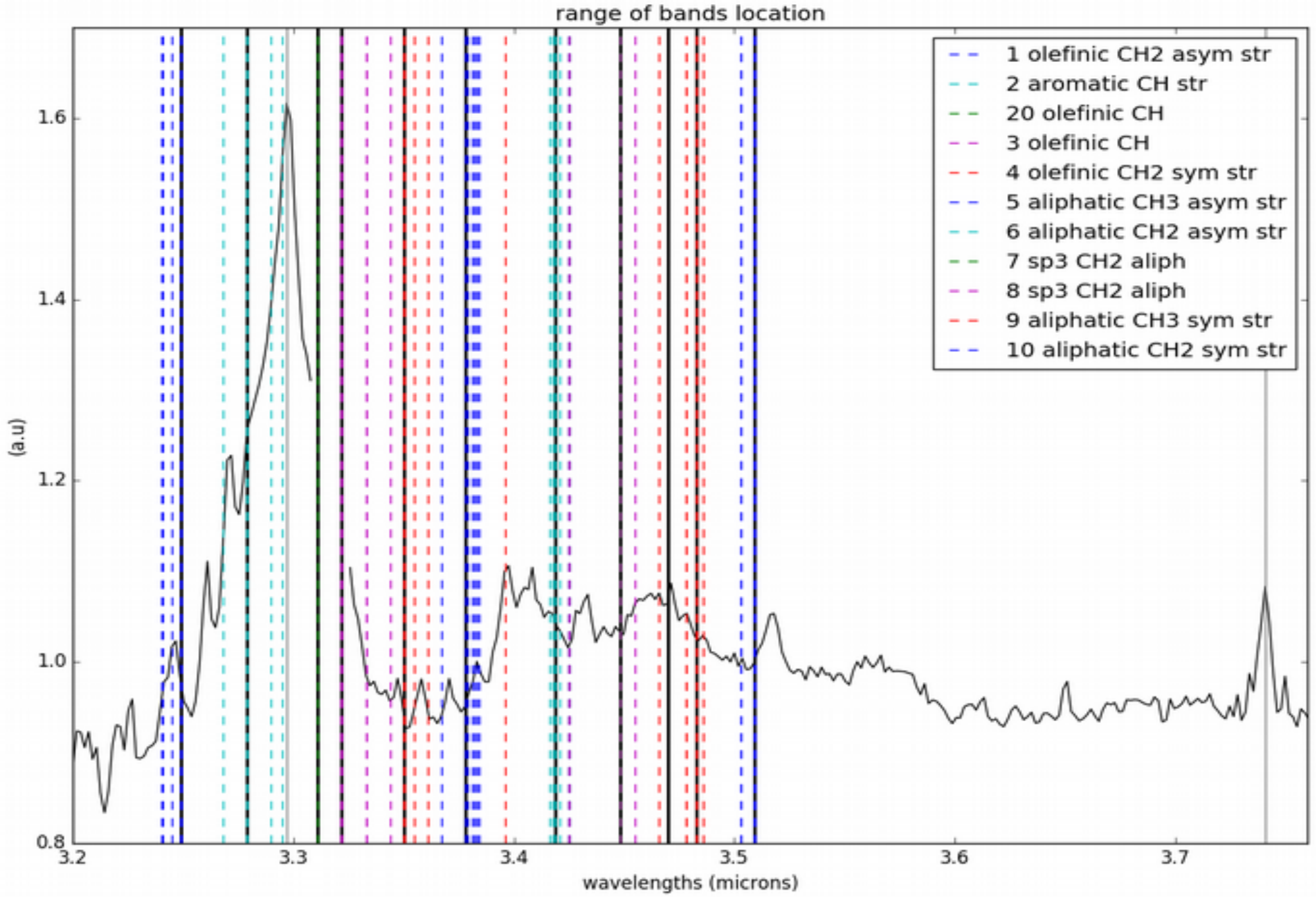


Model VS observations

> khi2 method
> two-modelled-spectra melting



Conclusions and perspectives



Dartois+ 2004,2005, Robertson 1986, Ristein+ 1998, Pino+ 2008, Dischler+ 1987

Conclusions and perspectives

> Spatially resolved spectra show an evolution of the signatures away from the star

> Aromatics features at 3.3 µm and aliphatics at 3.4 µm sound to be correlated

> Maybe there are diamonds in HD 100546

> Conditions in the disk are different from the ISM and require to consider the physical processes at work

Forthcoming

> To consider carbonaceous feature variations in DUSTEM
> To implement diamonds in the model

Thank you for your attention !