MINERALOGY OF THE OH/IR SUPERWIND

R. LOMBAERT
B.L. DE VRIES
L. DECIN
S. HONY
M. MAERCKER
T. KHOURI
J. MENU
M. HILLEN
T. VERHOELST
M. MIN
P. ROYER

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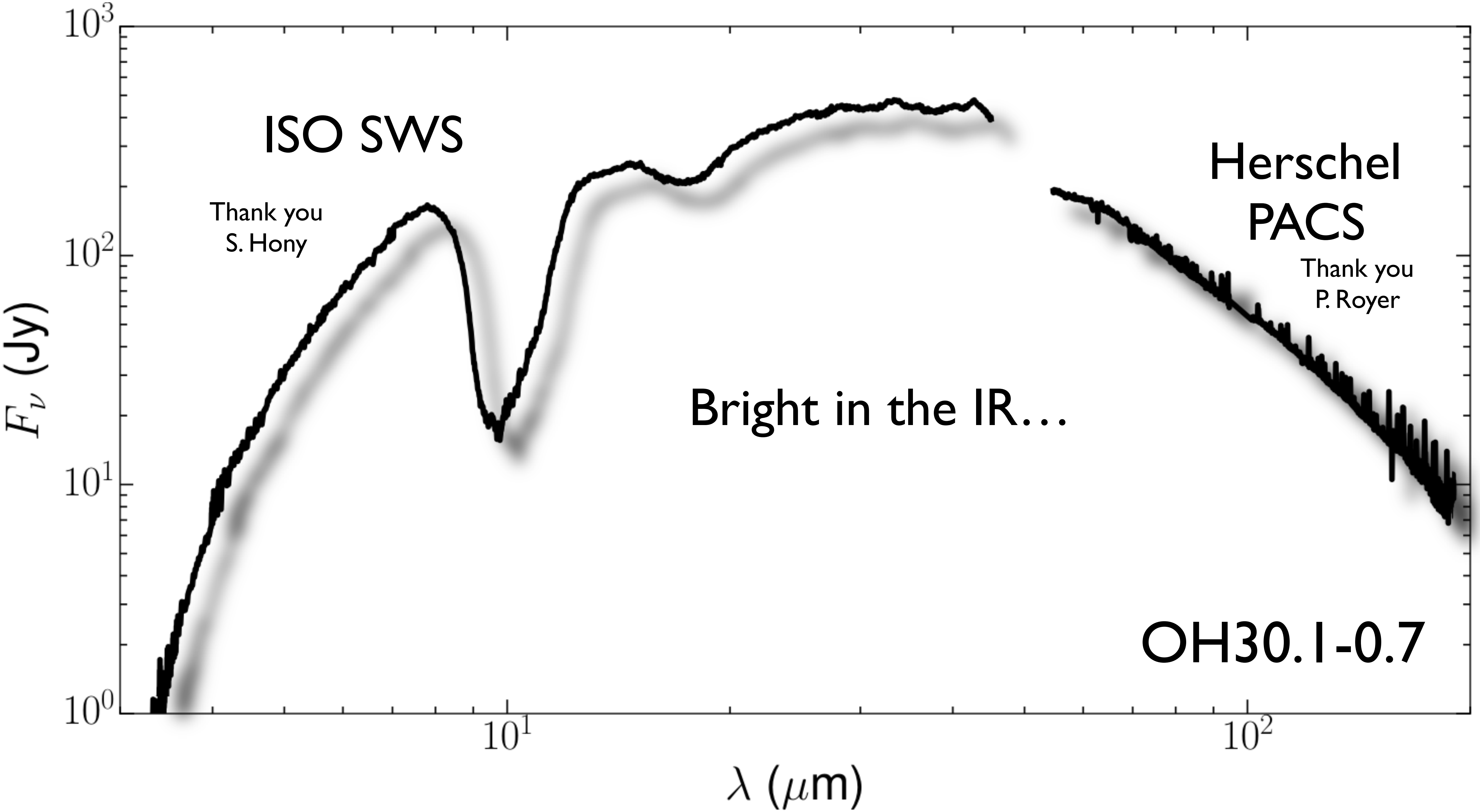
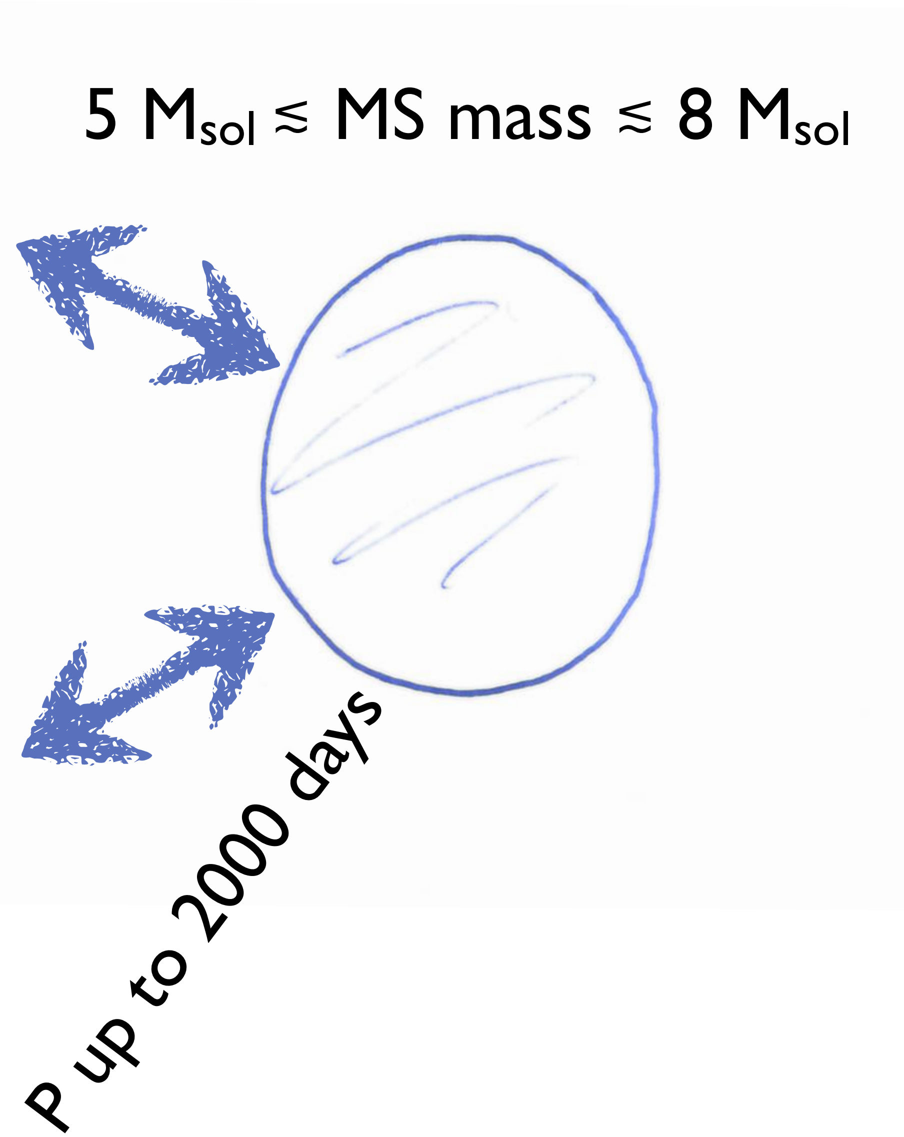
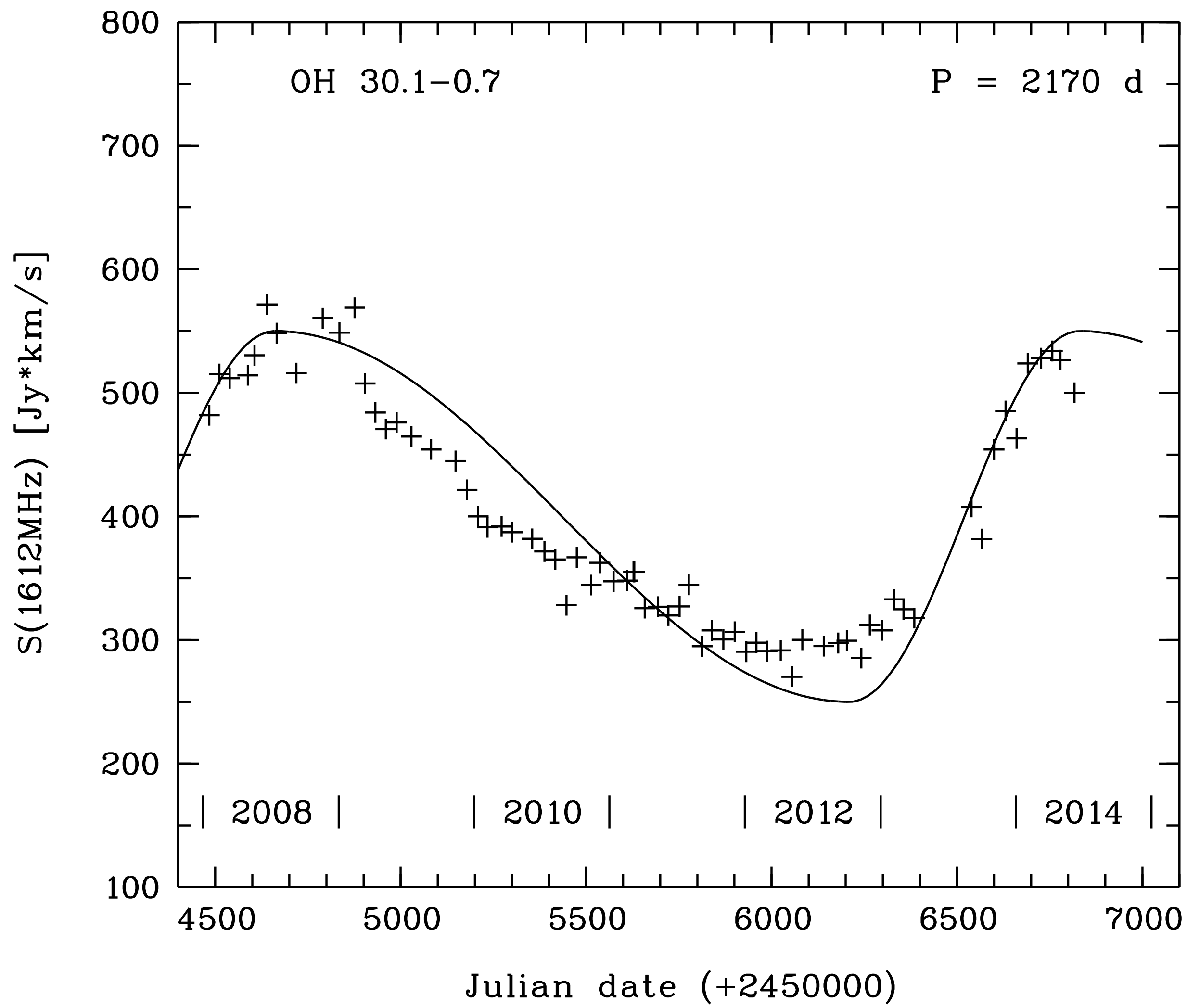
OH/IR STARS



ISO SWS
Thank you
S. Hony
Herschel
PACS
Thank you
P. Royer
Bright in the IR…
OH30.1-0.7
10^3
10^2
10^1
10^0
F_ν (Jy)
10^1
10^2
λ (μm)

MIRA & LONG-P PULSATIONS

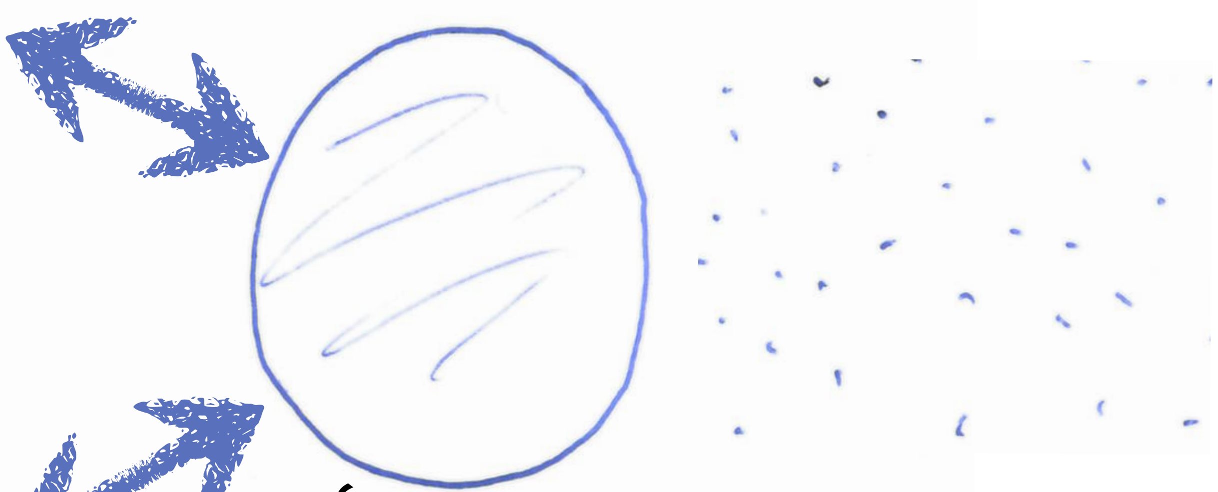




ENGELS ET AL. 2015

INTERMEDIATE INITIAL-MASS STARS

$5\ M_{sol} \lesssim$ MS mass $\lesssim 8\ M_{sol}$

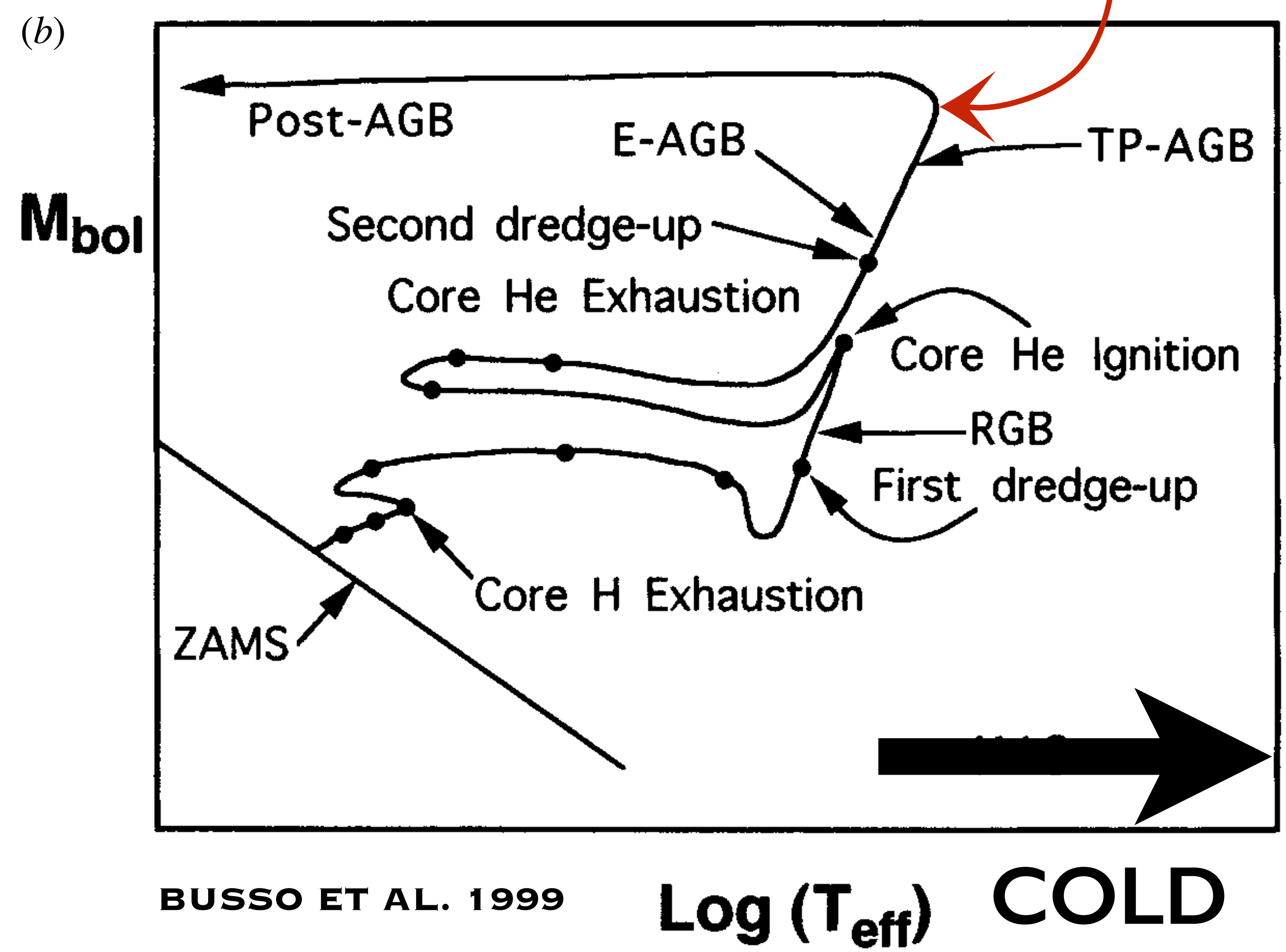


P up to 2000 days

L★ up to ~5x10^4 L_{sol}

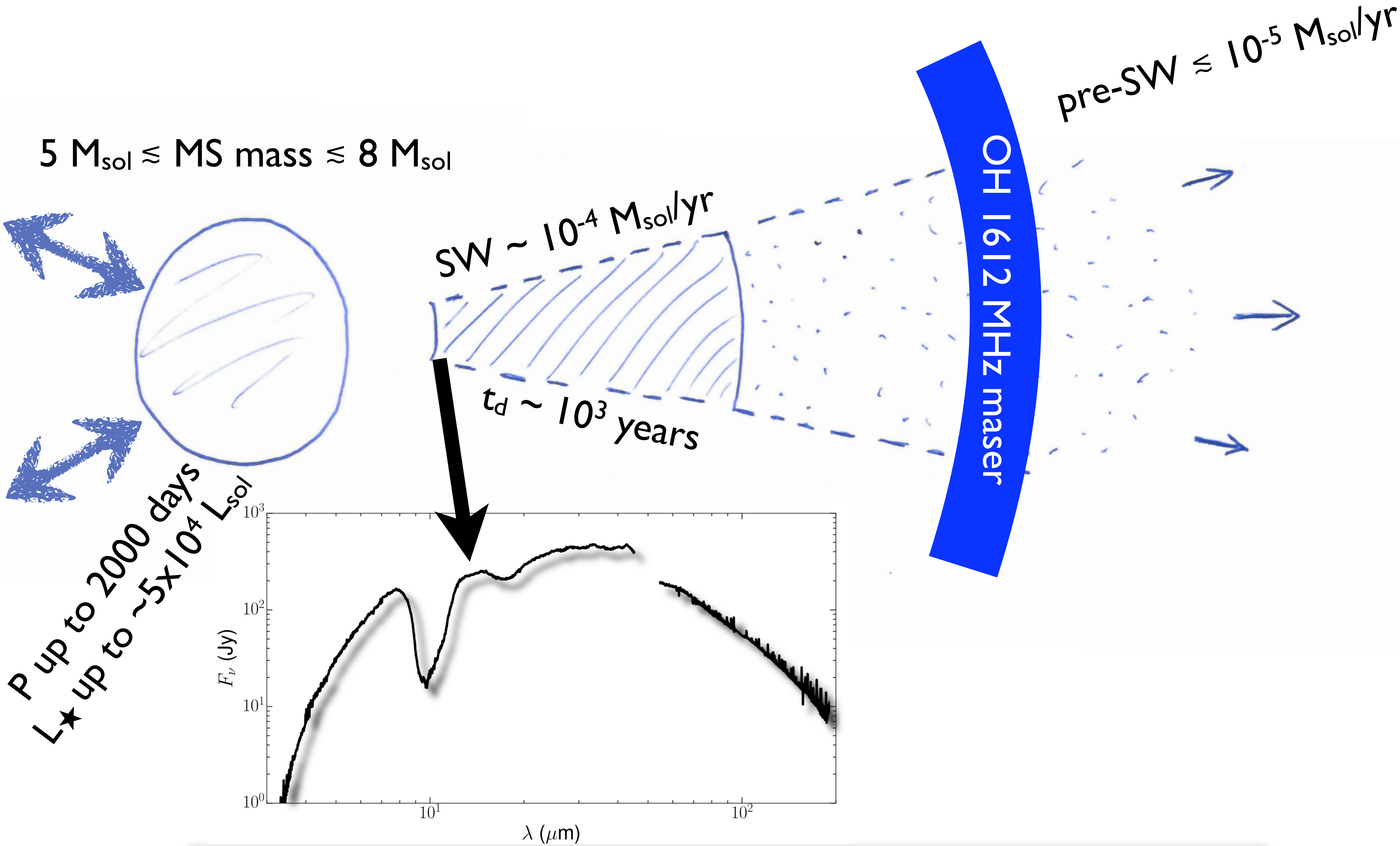
Dust forms

Evolution on the AGB



BUSSO ET AL. 1999

SUPERWIND: SHORT DURATION



SUPERWINDS: WHAT WE DON'T KNOW

1. Superwind duration: short

   Losing another 3 M_{sol}

2. How is a superwind driven?

   Grain size and role of scattering, dust properties

3. Effect of asymmetries in the wind

   Assumption of 1D spherically symmetric winds still reasonable?

One way to provide constraints:

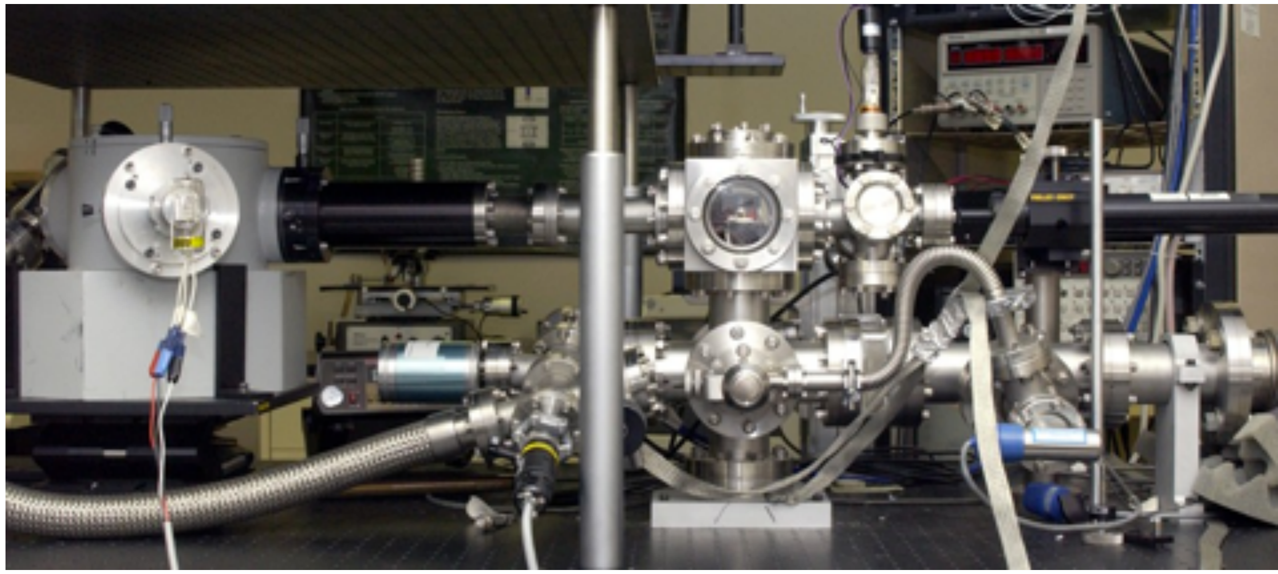
Mineralogy.

(in 1D)

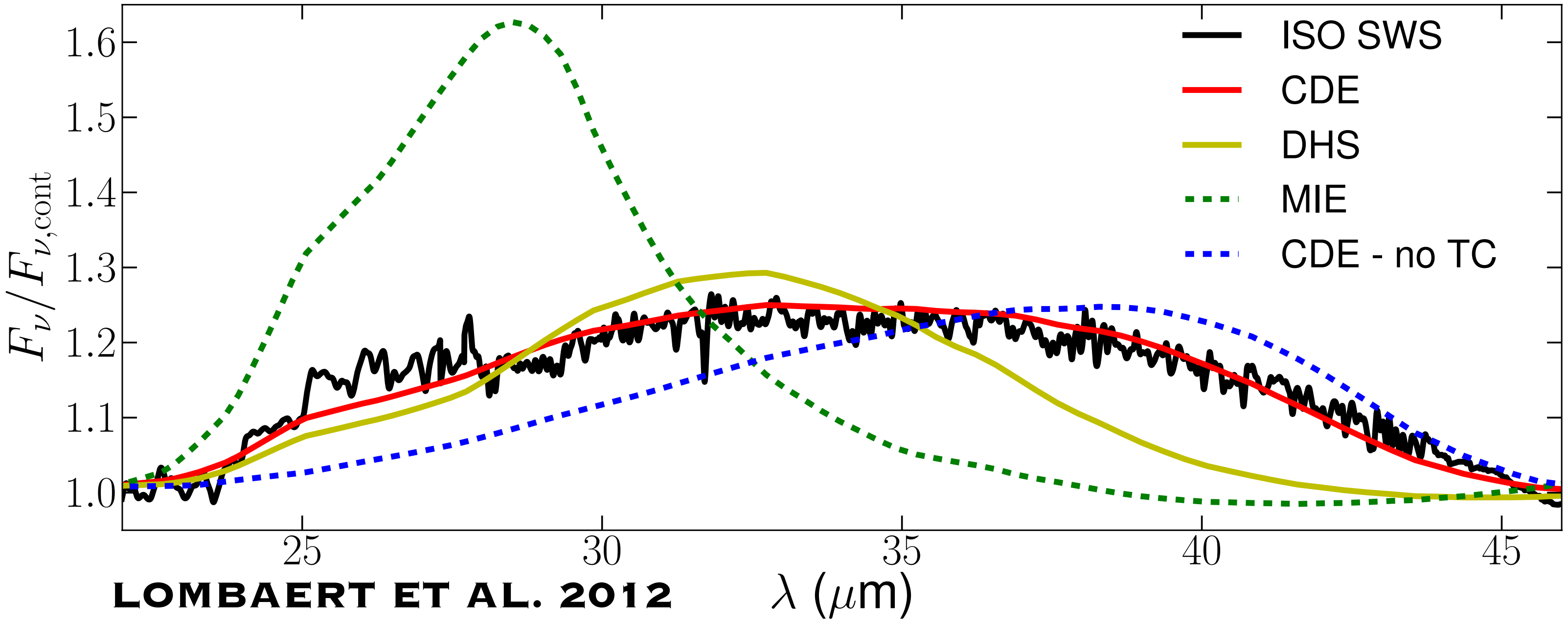
DUST RADIATIVE TRANSFER

1) Monte Carlo radiative transfer code

2) Dust optical properties



3) Dust shape model & grain size distribution



LOMBAERT ET AL. 2012

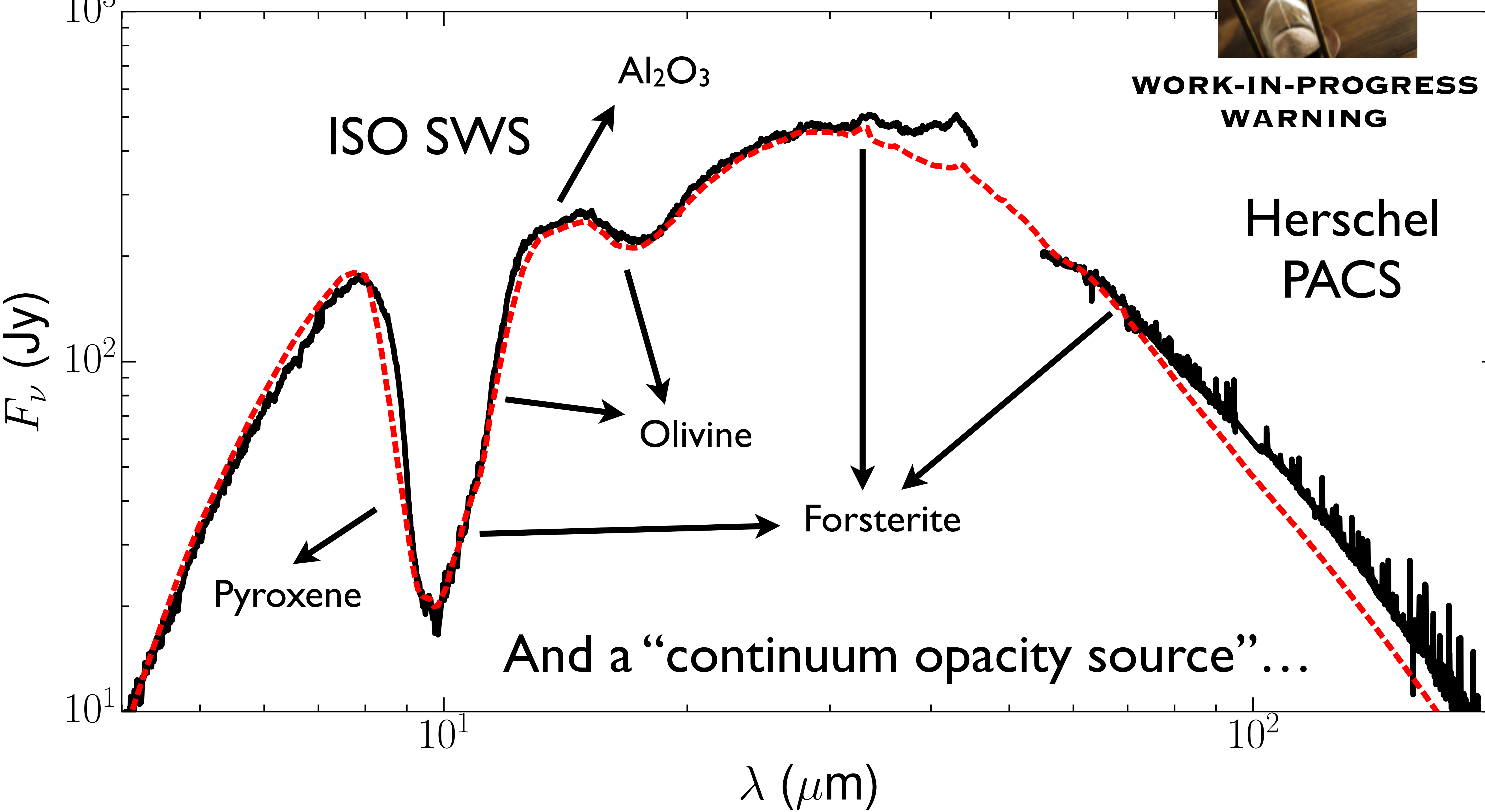
4) And a number of caveats…

- 1D spherically symmetric
- Phase dependence
- Interstellar reddening
- ISO SWS data reduction
- Short superwind duration
- …

MINERALOGY: DOWN THE RABBIT HOLE

Mineralogy must be understood to constrain the superwind properties **reliably** from SEDs

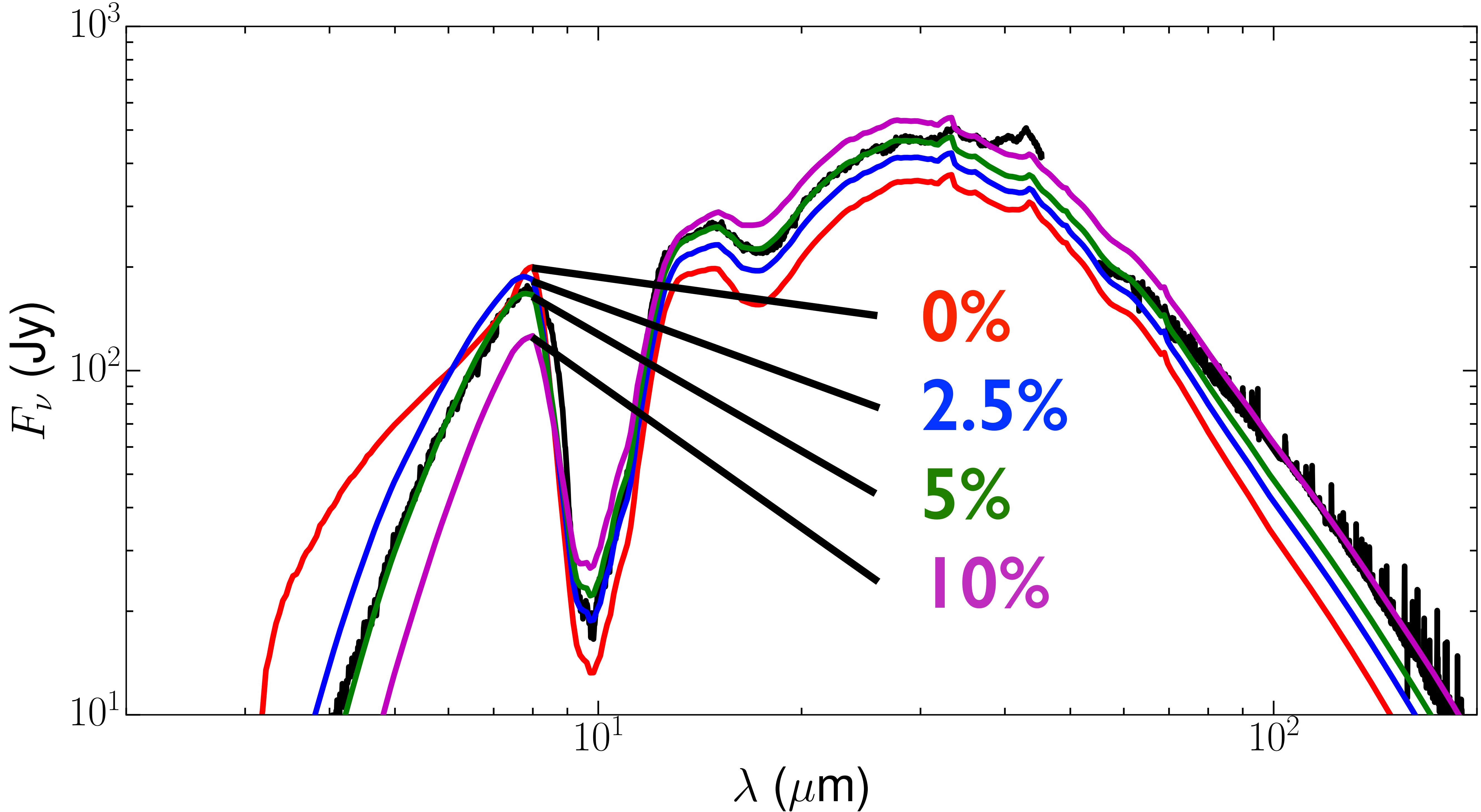
WORK-IN-PROGRESS WARNING



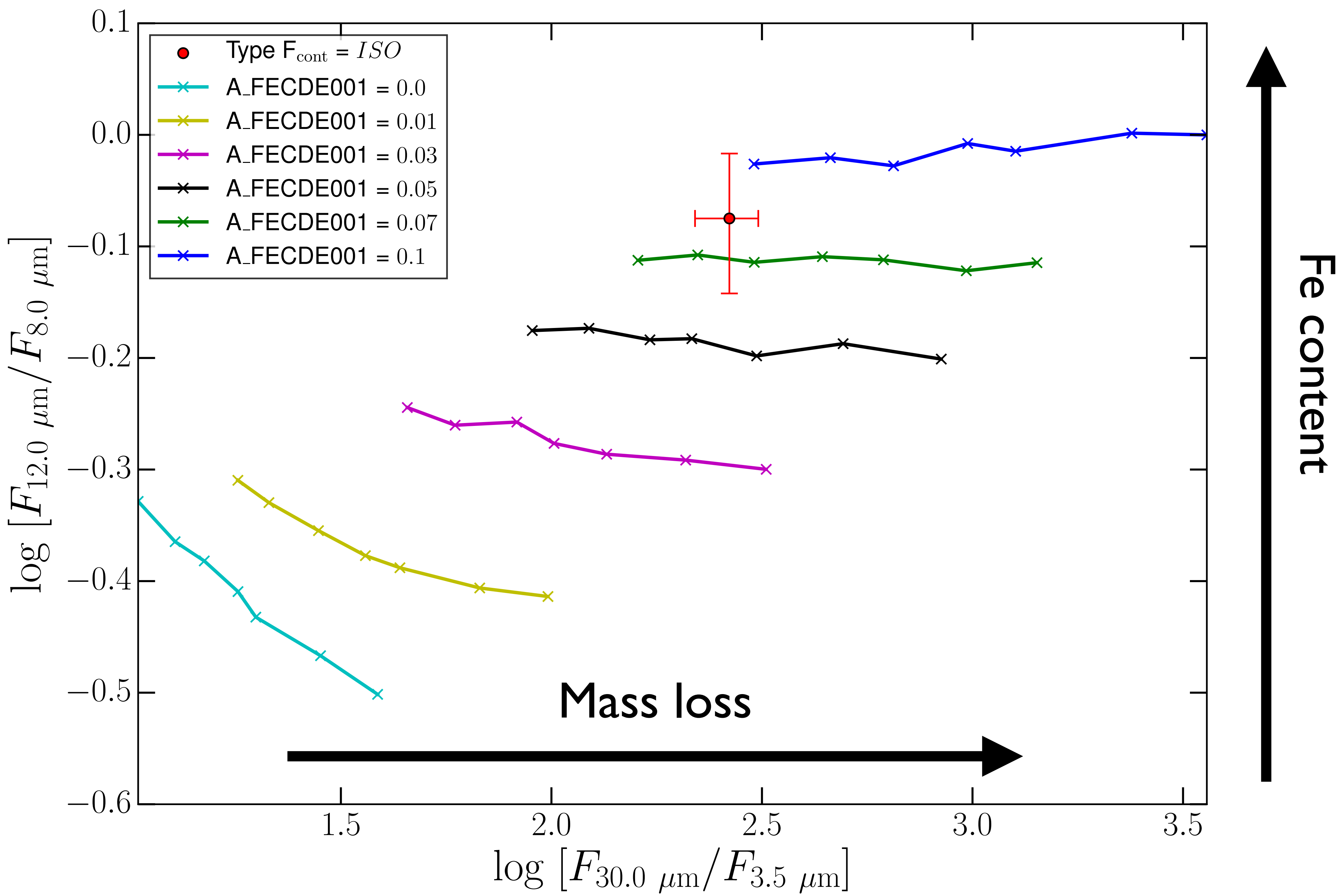
MINERALOGY: METALLIC IRON

(SEE ALSO KEMPER ET AL. 2002)

Metallic Fe contribution to
“continuum opacity source”

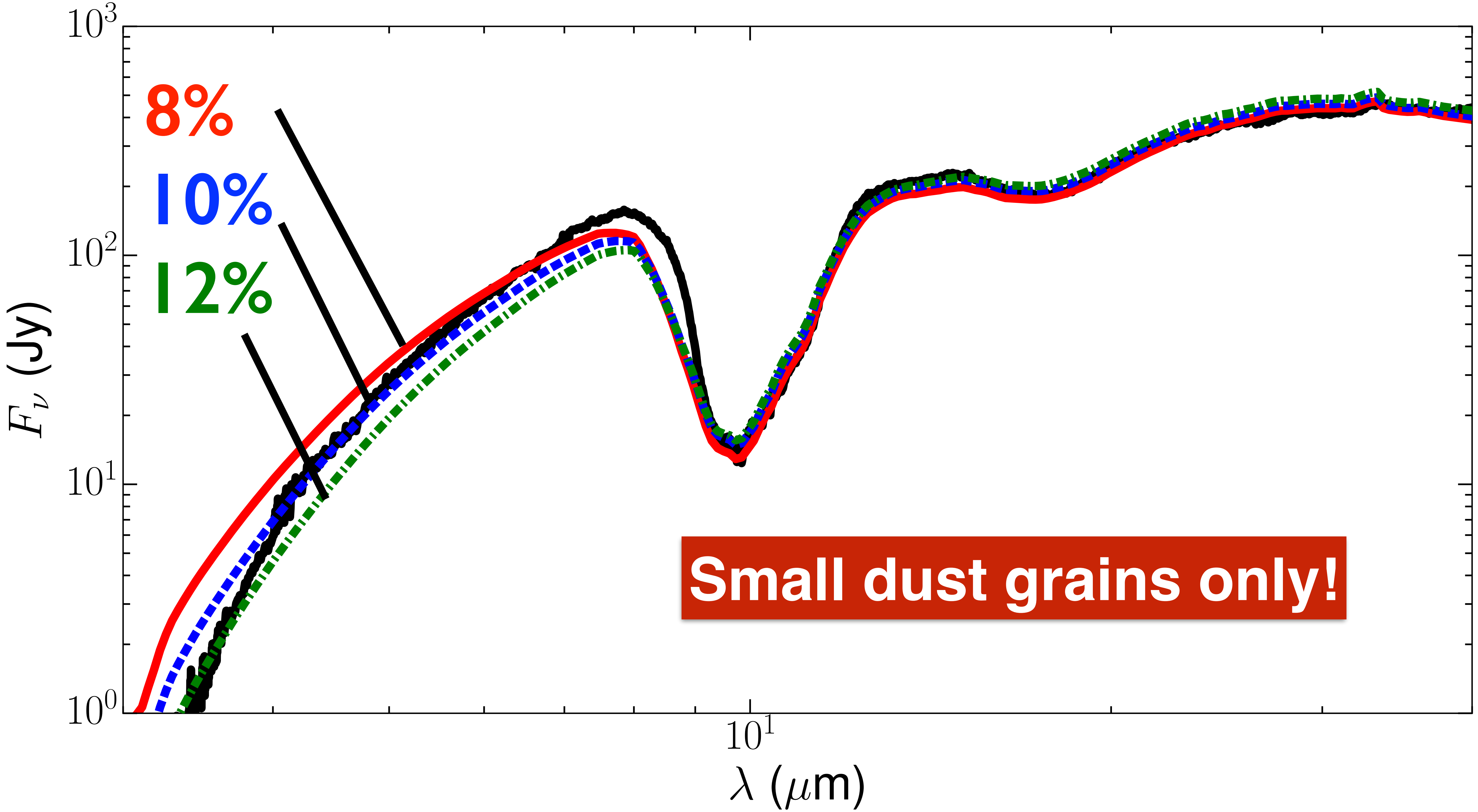


METALLIC IRON VS. MASS LOSS



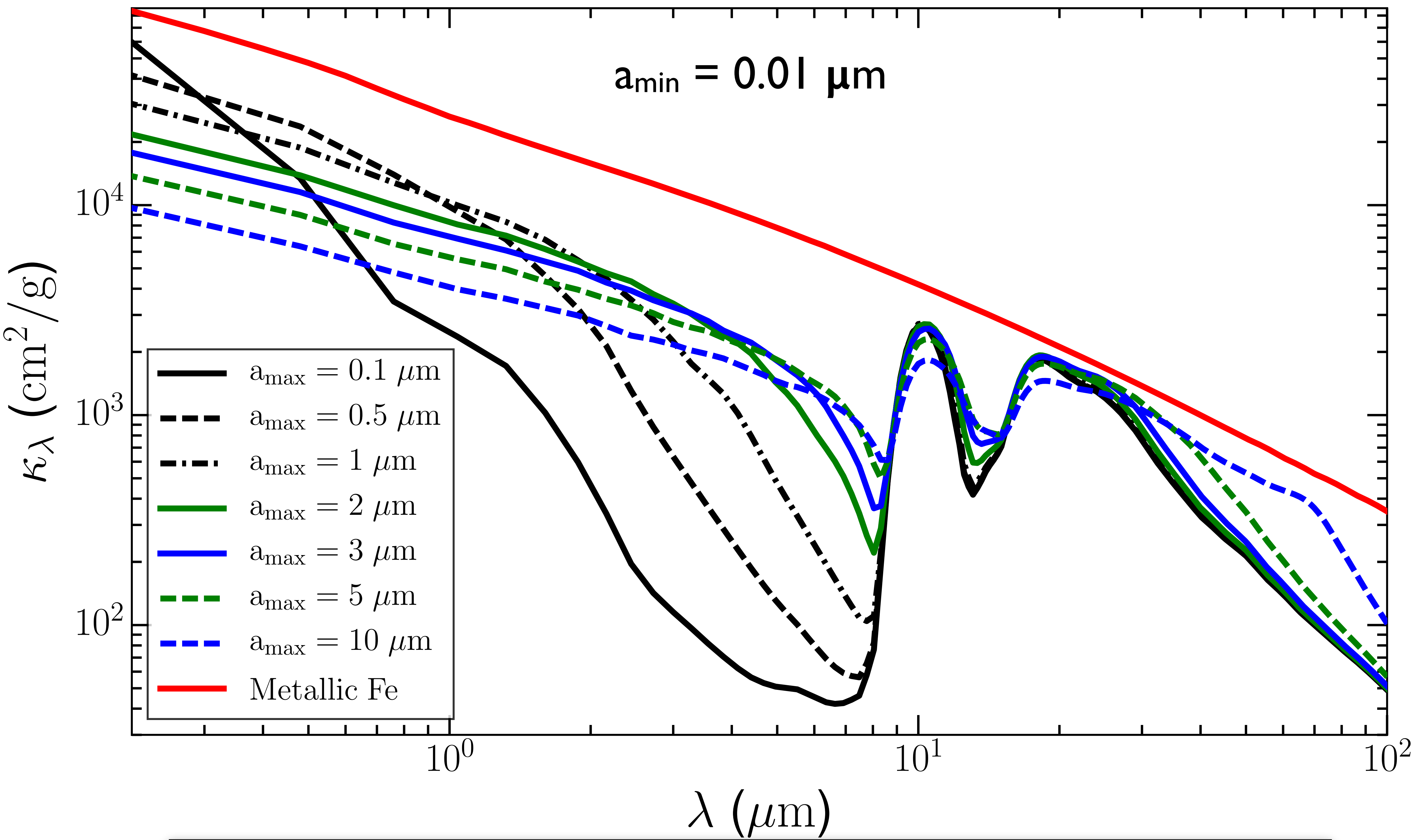
MINERALOGY: METALLIC IRON

Metallic Fe: only a single opacity "slope"



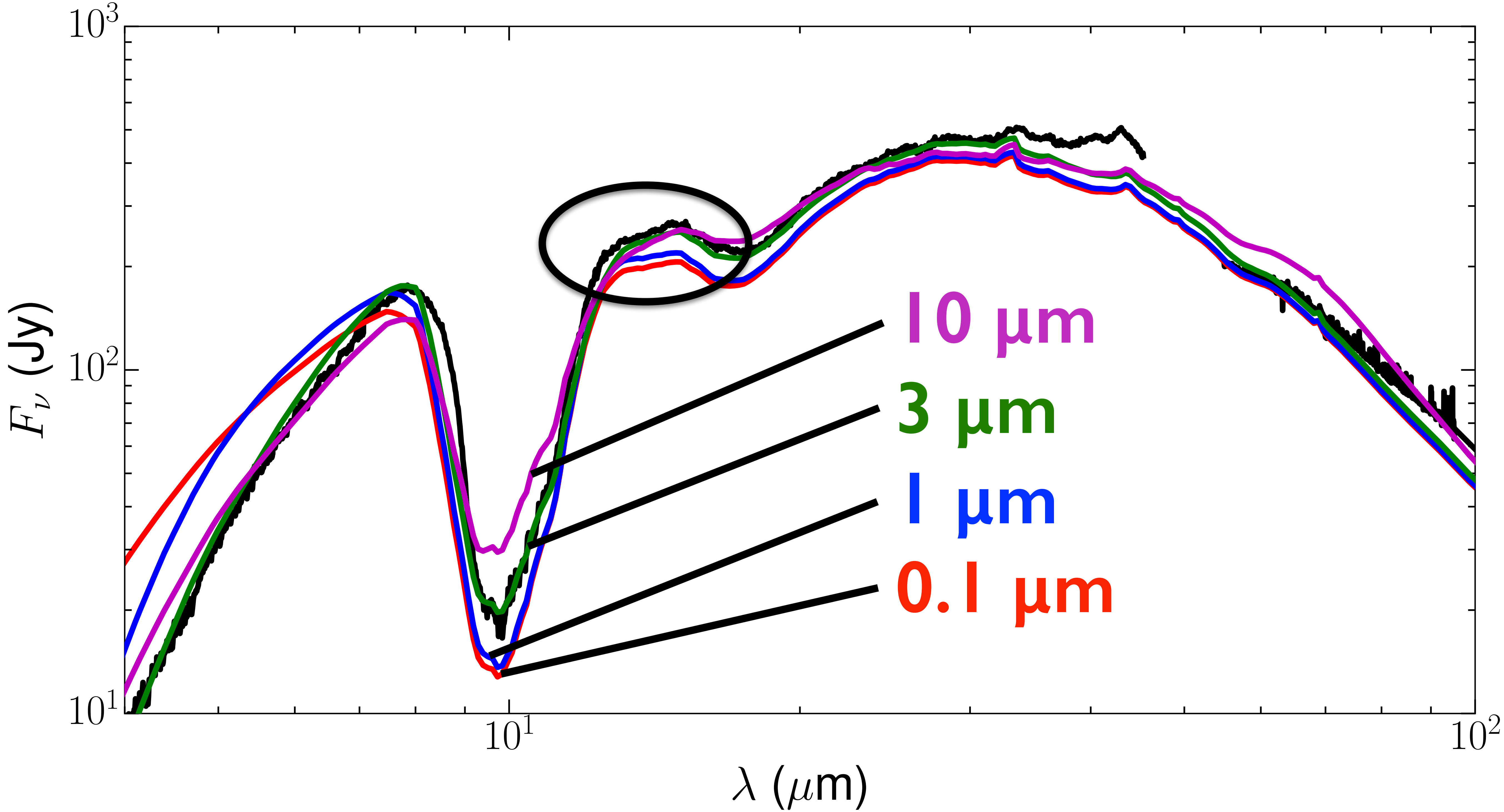
MINERALOGY: GRAIN SIZE DISTRIBUTION

$$\frac{dn_g}{da} = A n_{\mathrm{H}} a^{-3.5}, \quad a_{\min} < a < a_{\max}$$



MINERALOGY: GRAIN SIZE

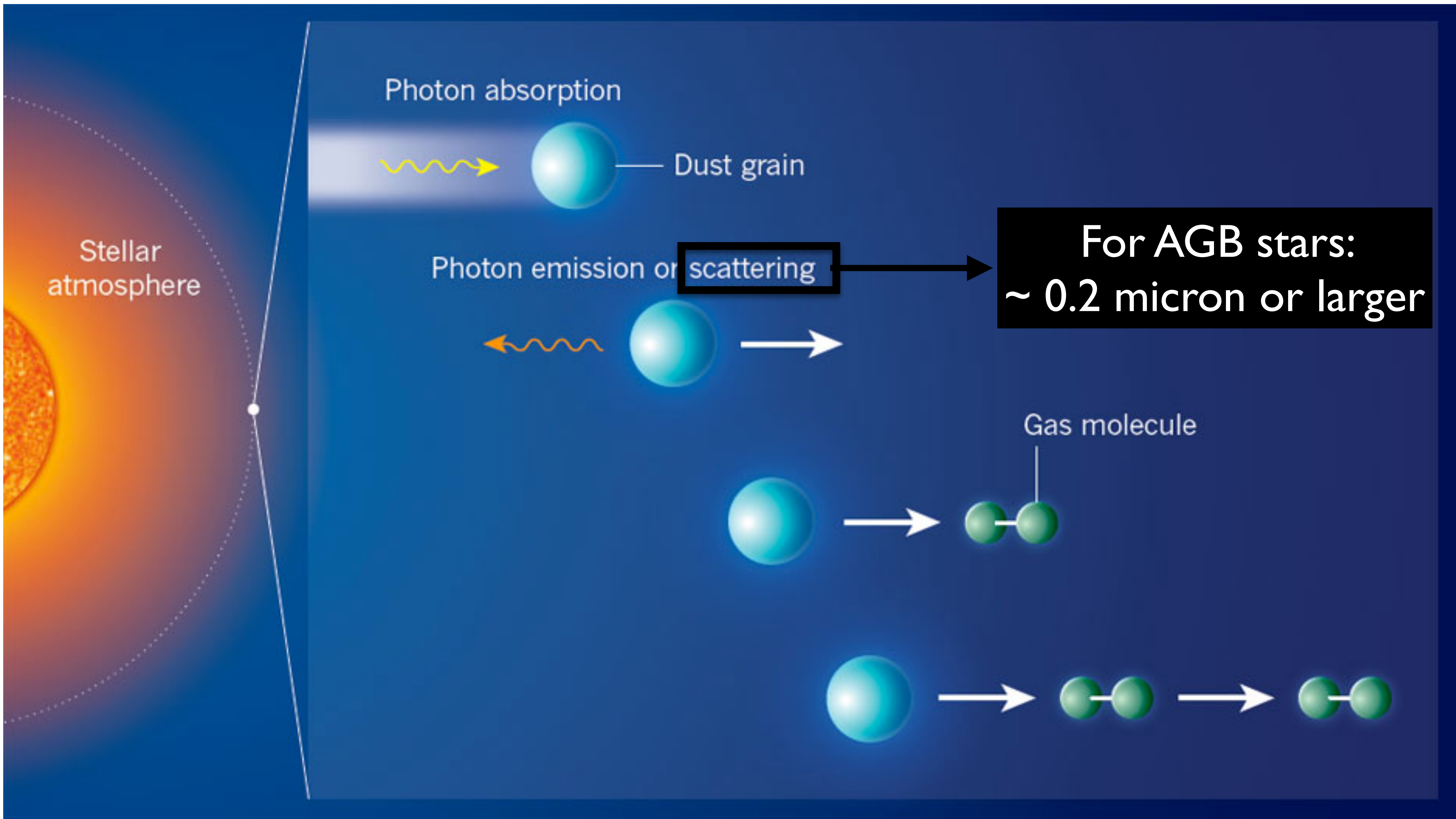
Micron-size grains contribution to
"continuum opacity source"



MINERALOGY: GRAIN SIZE

Scattering on grains:
required to have enough momentum to drive the stellar wind

HÖFNER 2012



MINERALOGY: CONCLUSIONS
(PRELIMINARY!)

!! Under assumption of wind spherical symmetry !!

1. **Fe in continuum and in olivine**
   Small abundance of pure Mg olivine needed for mid-IR fit

2. **(Sub-) Micron-size dust grains required**
   Important contribution to the "continuum opacity source"

3. **Require near 100% condensation of Fe, Mg, and Si**
   Assuming Solar abundance

4. **No alumina or other signs of early dust formation**
   They may still function as seed grains, but no sign of them is visible in present-day mass loss

5. **Pyroxene required**
   Agrees with dust formation sequence and finding Fe in the silicate