Constraining the Physical Structure and Dust Opacities Towards B335

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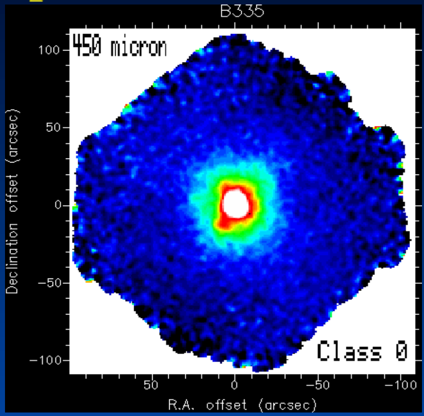
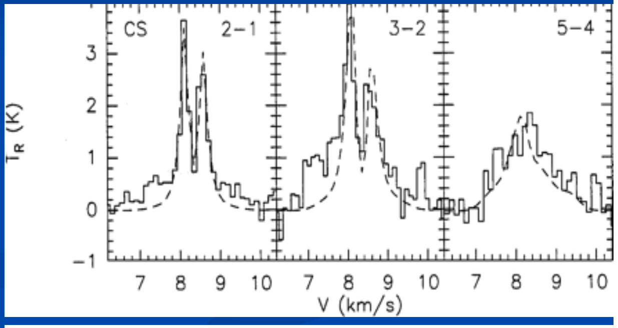
B335
E
D
C
B
A
F
G
Galfalk & Olofsson et al. 2007

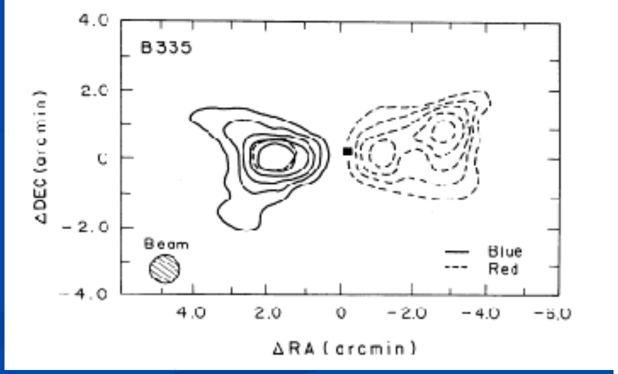
B335 – A Detailed Example



- B335 is a Bok globule harboring a single deeply embedded Class 0 protostar



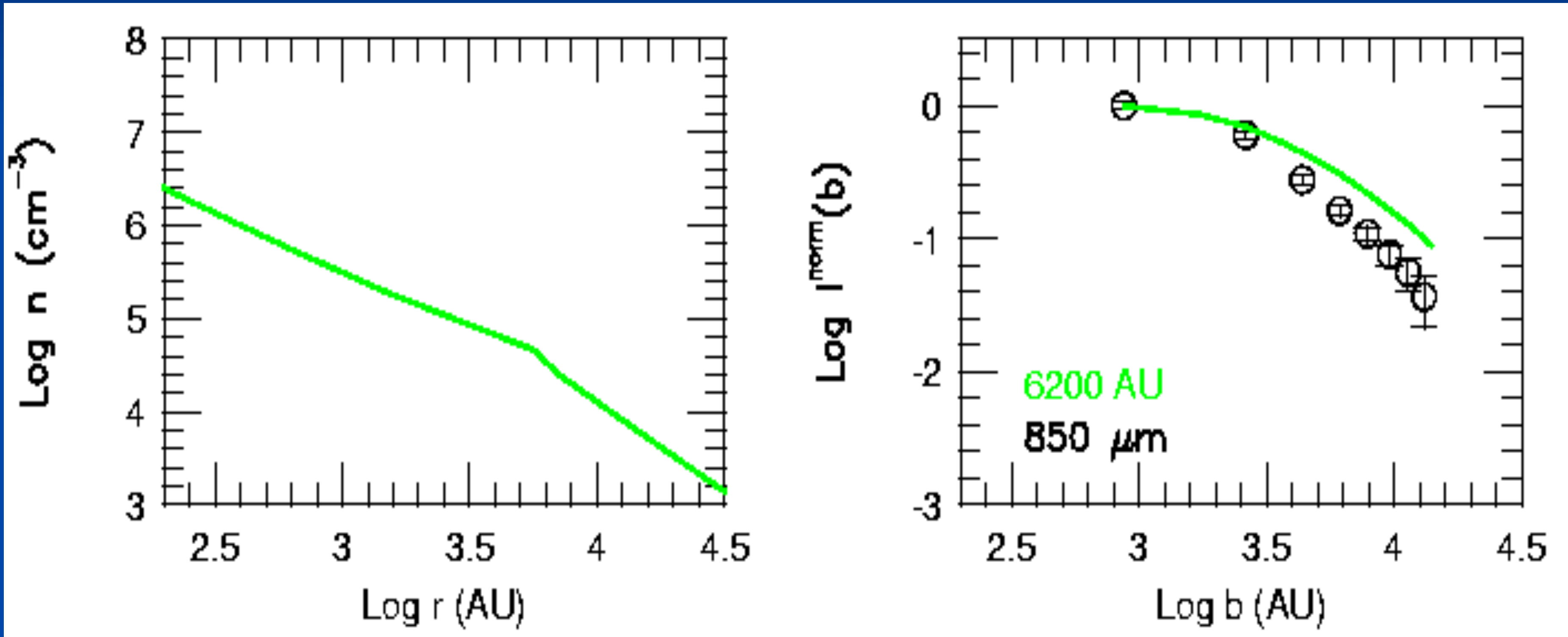
- Molecular lines show collapse signature



- Physical parameters
  - Distance 100 - 150 pc
  - Outflow in E-W directio
    - estimated age of < 10^5 yrs
  - Slow rotation across core
  - Mass of dense core ~ 1 M_{sun}
  - Luminosity ~ 2 L_{sun}
- An excellent test object for theories of isolated low-mass star formation

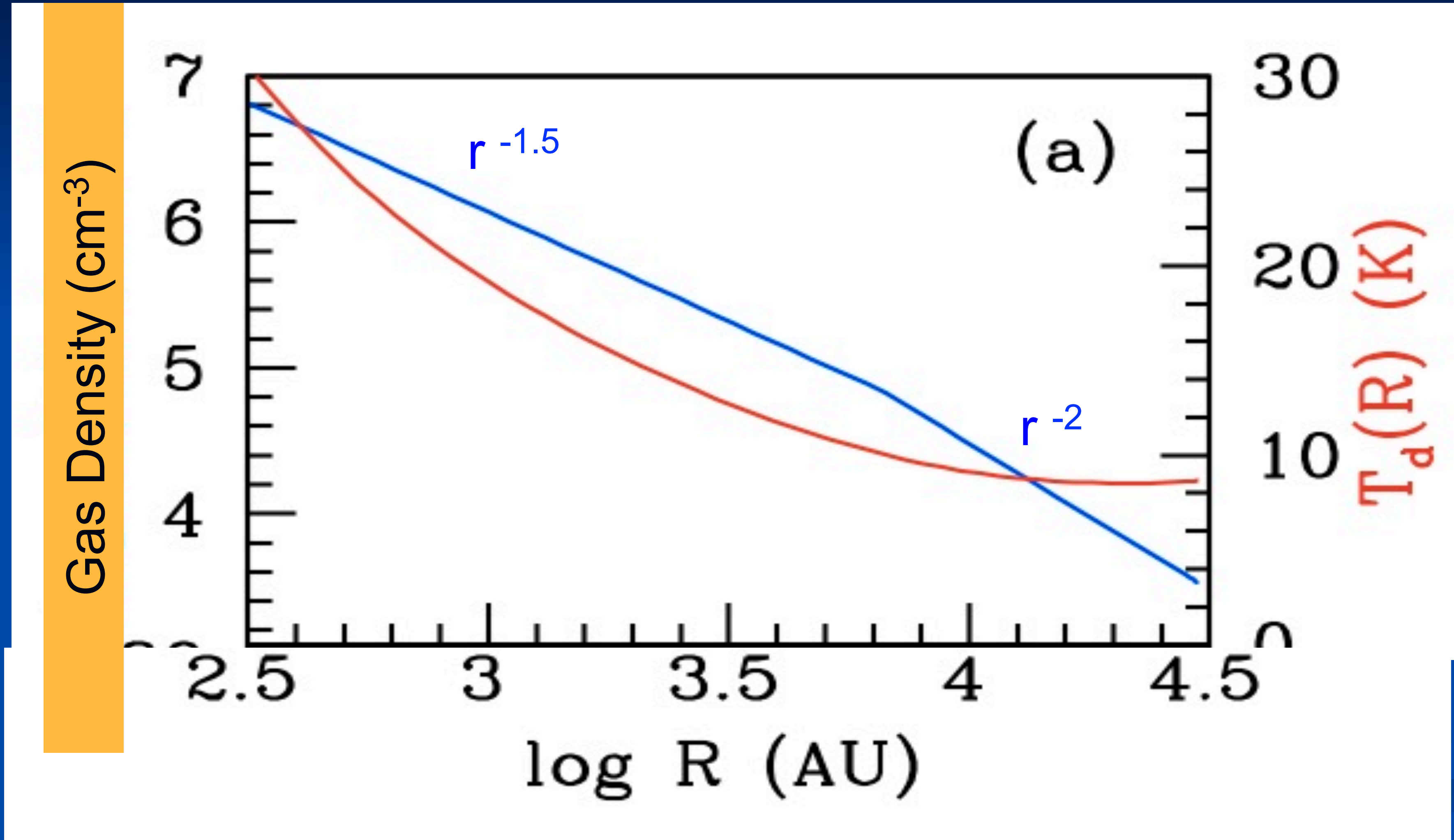
B335 – Dust & Gas Modeling DO NOT AGREE

- Best fit gas infall profile does NOT fit dust continuum



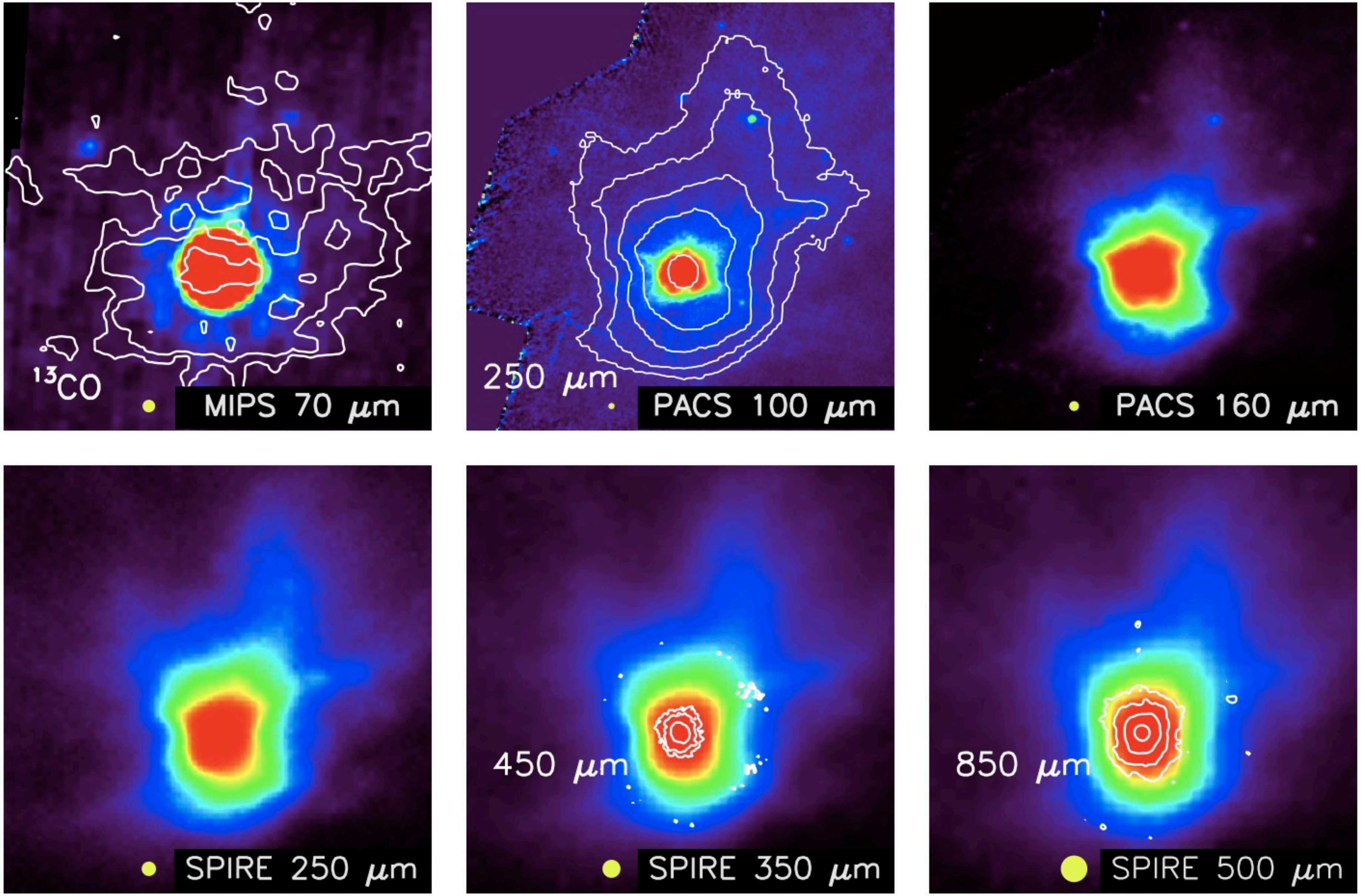
Shirley et al. 2002, Evans et al. 2005, Doty et al. 2010

B335 – Best-fit Dust Continuum Model



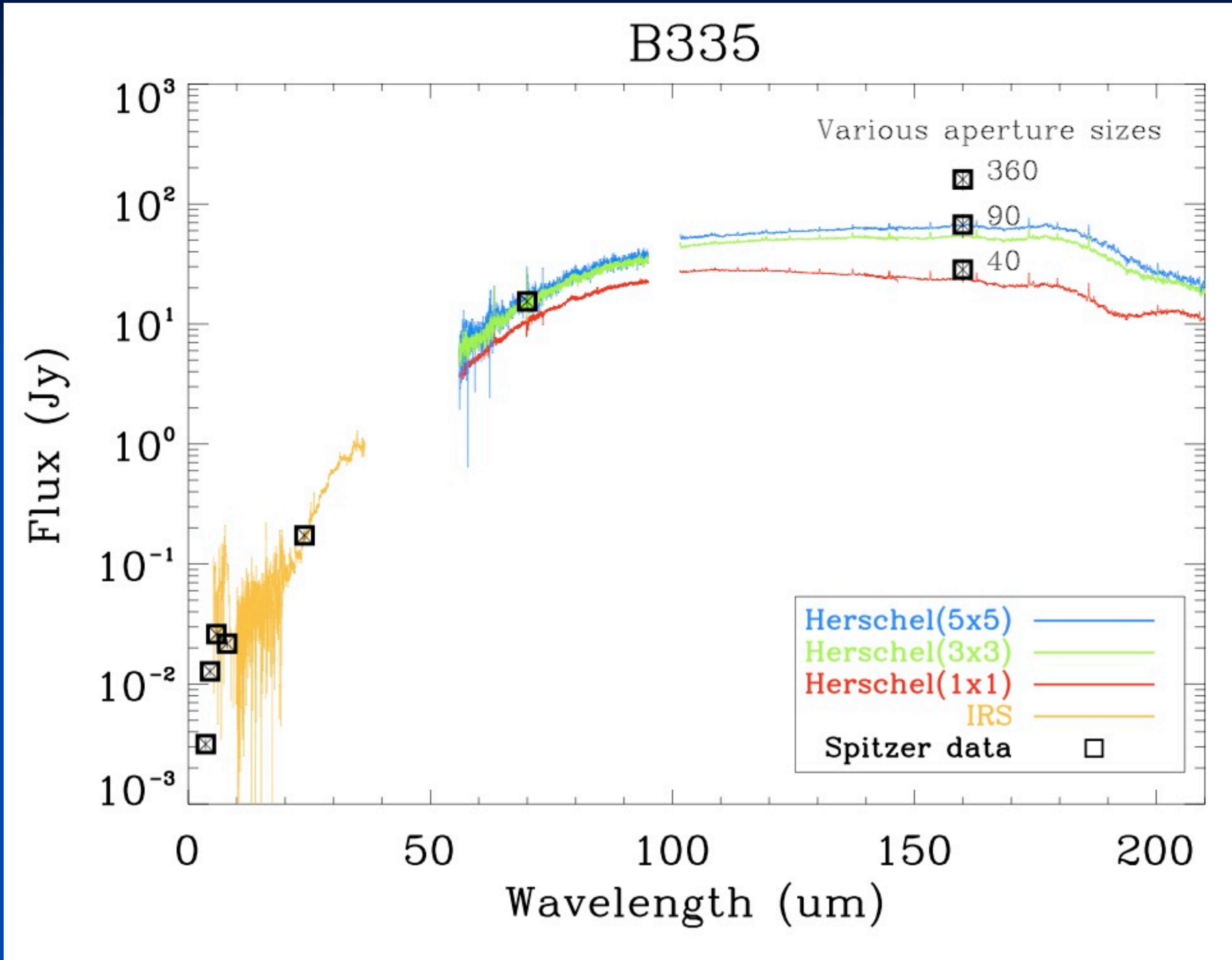
Shirley et al. 2011b

Herschel/Spitzer Observations of B335



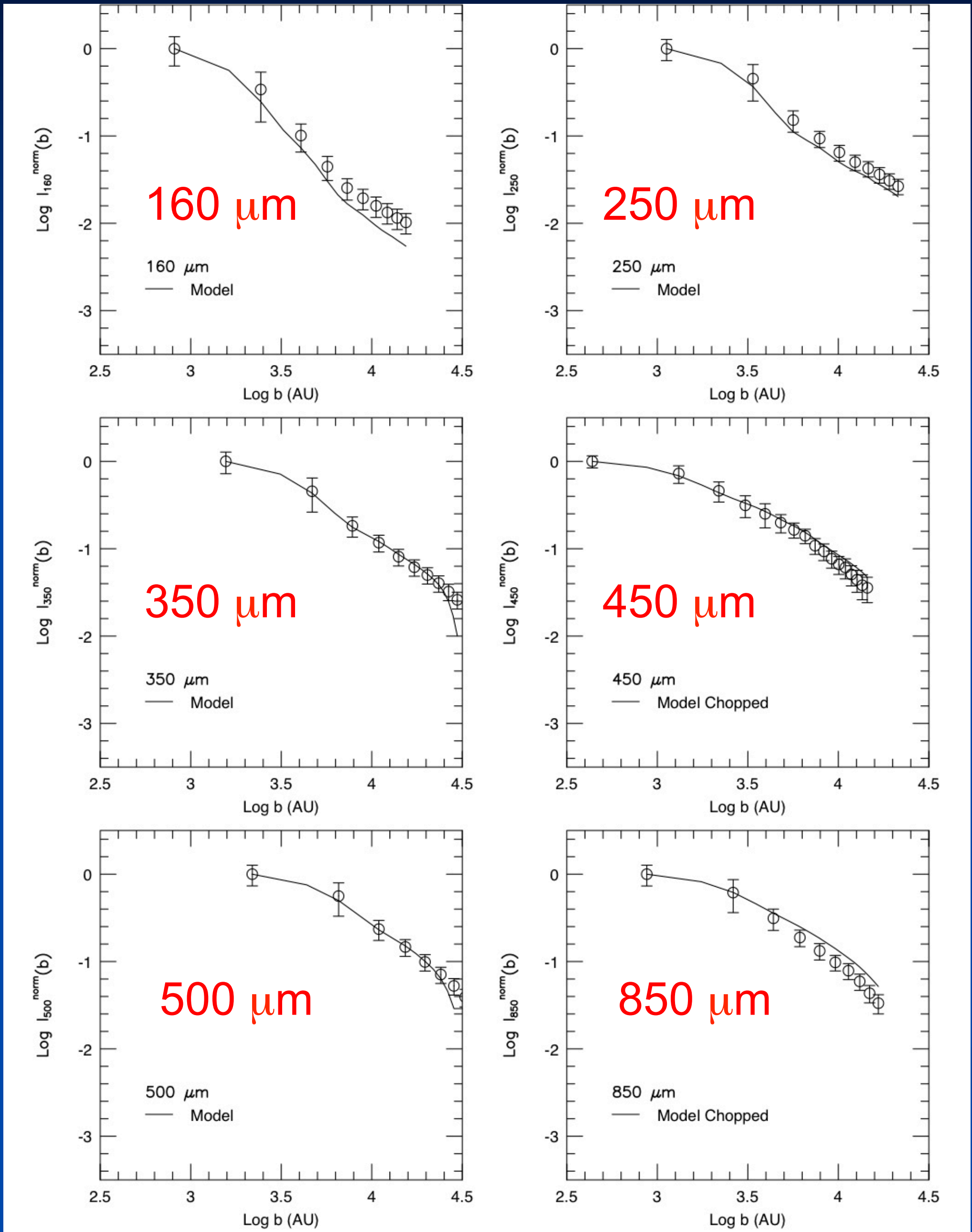
Courtesy Amy Stutz, Ralf Launhardt,, Oliver Krause; Stutz et al., in prep.

B335 Far-IR Herschel SED



Courtesy DIGIT Team from Evans, Lee, et al.

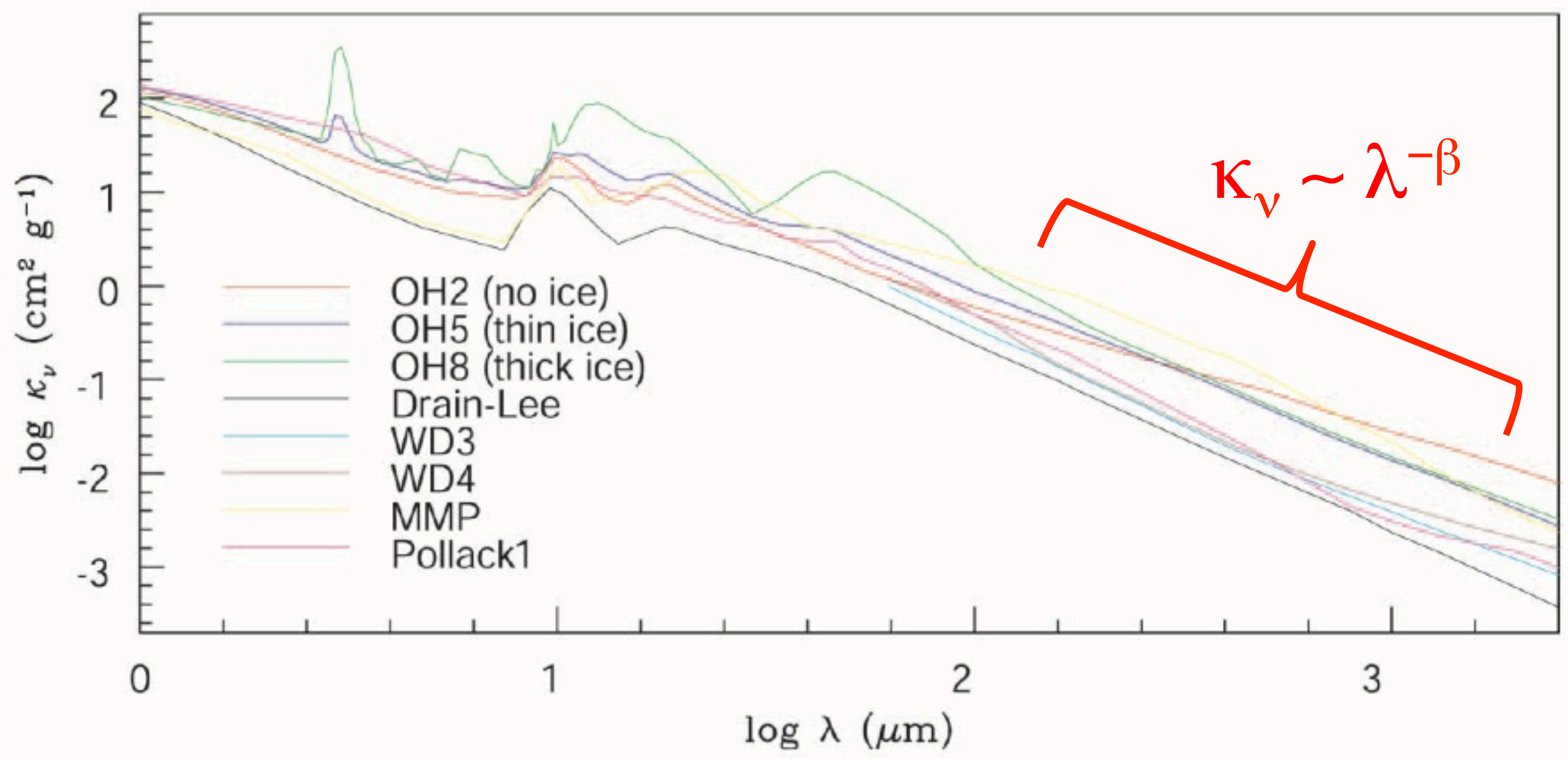
B335 – Problems w/ the dust model



- Smooth transition observed in dust intensity slope from 160 μm to 850 μm
- Illustrates need for inclusion of disk/inner envelope opacity variations which can only be probed with interferometer

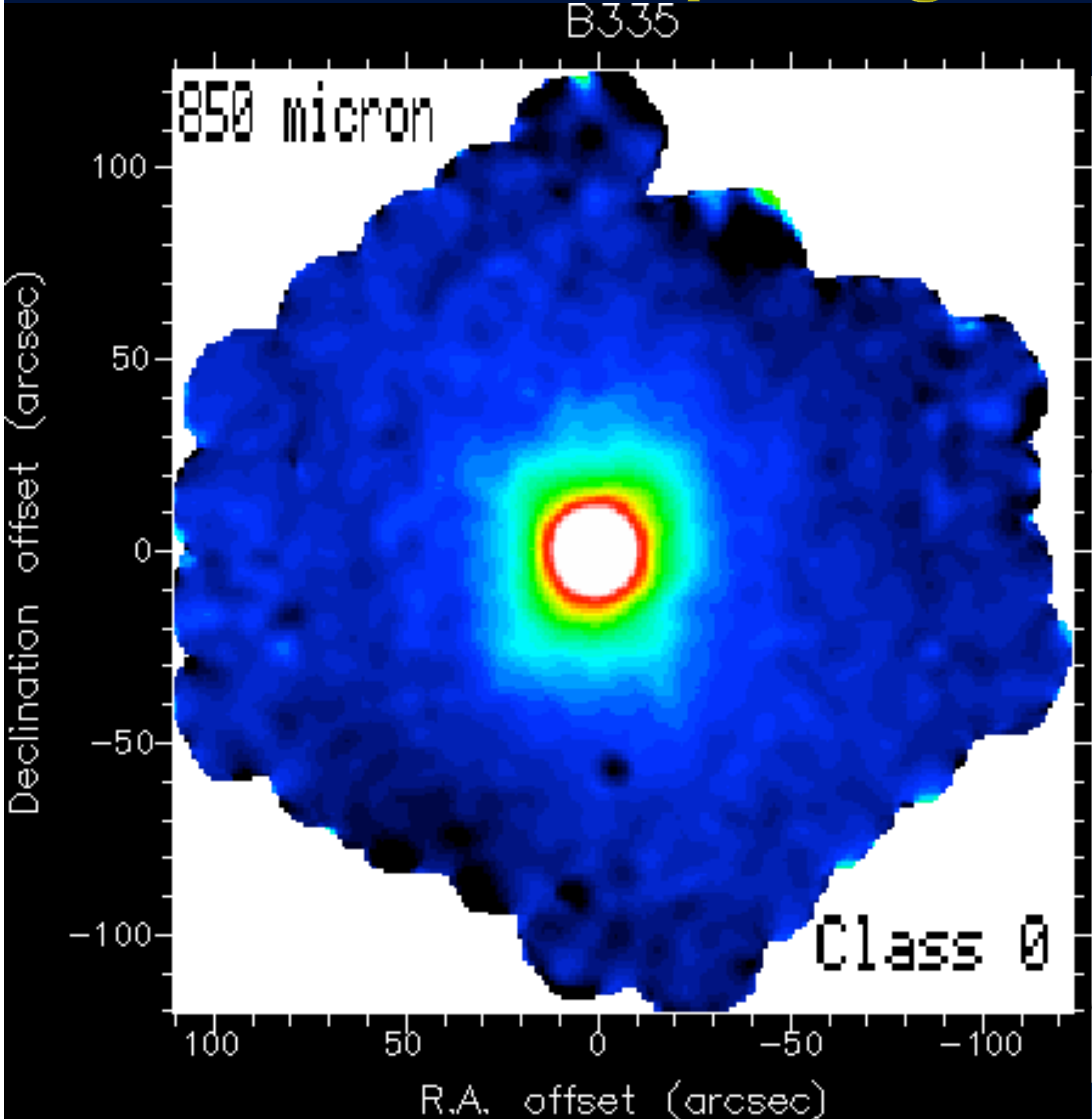
Stutz et al. / Shirley et al. in prep.

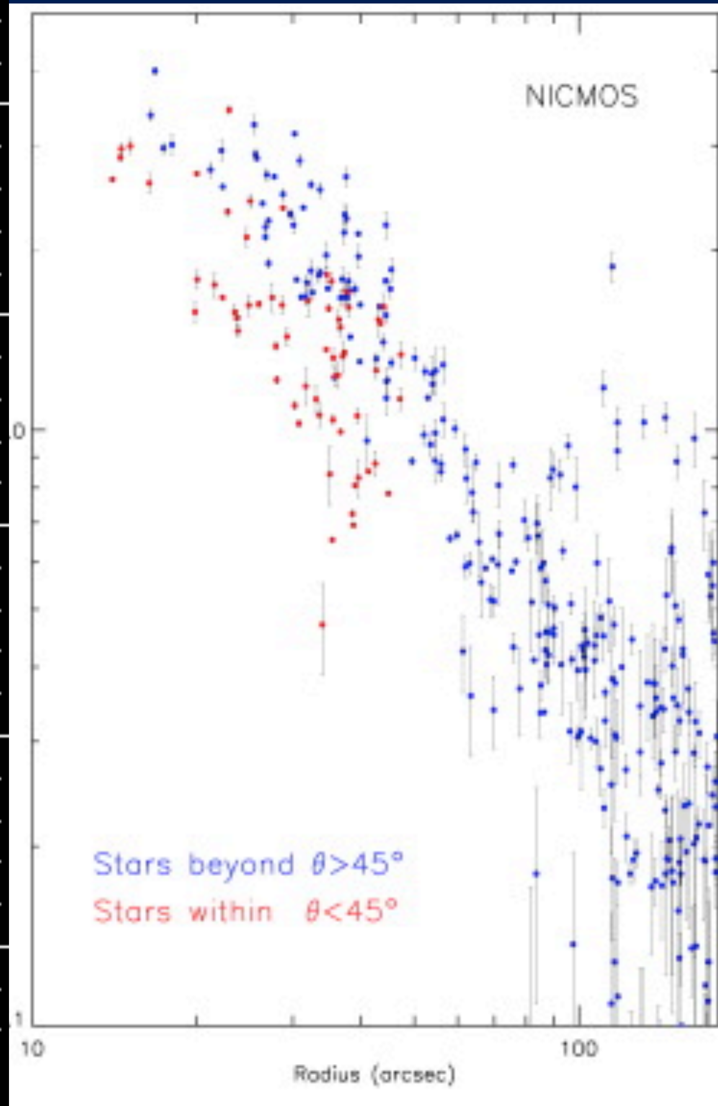
Theoretical Dust Opacity Curves



Shirley et al. 2005

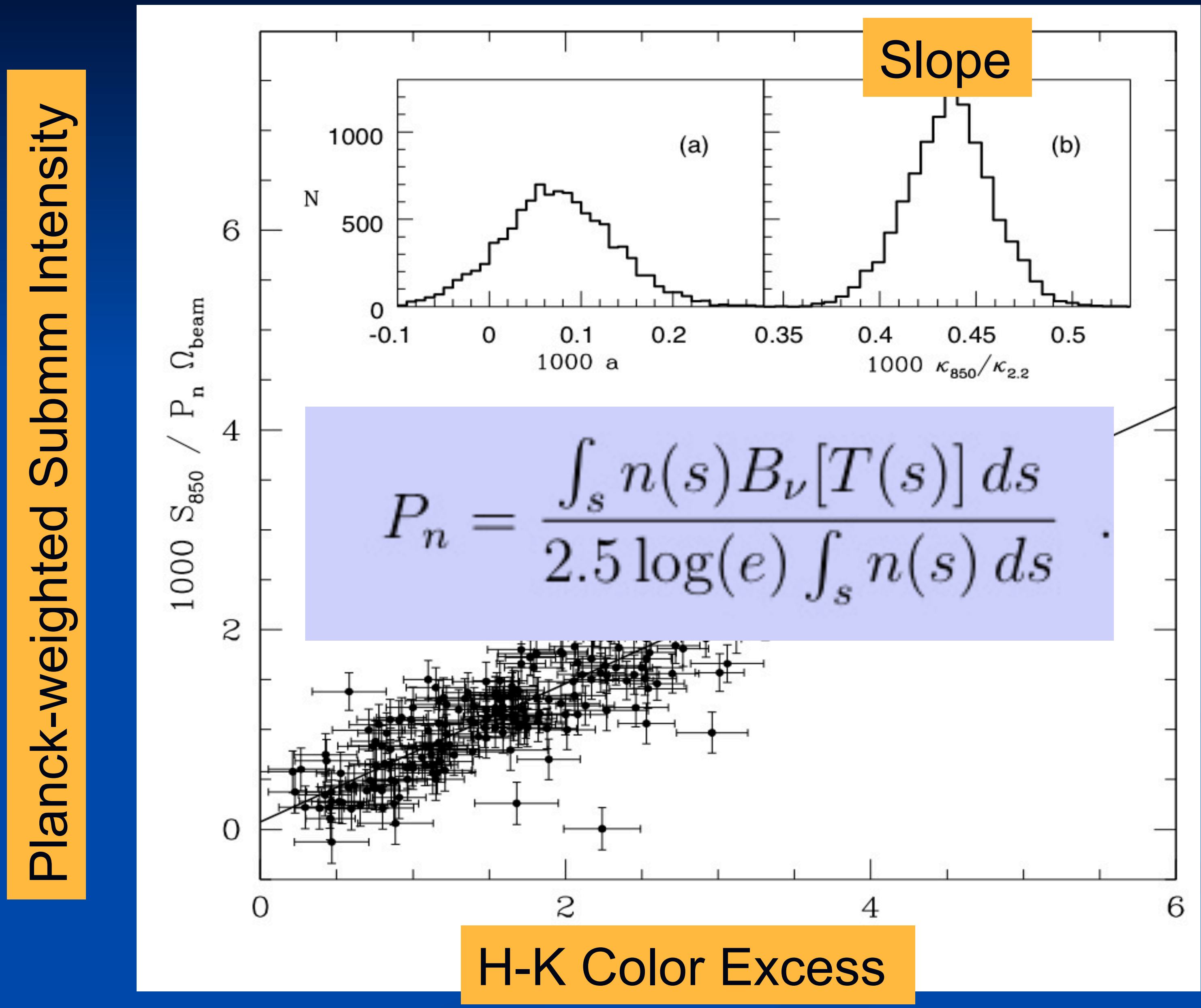
B335: Comparing NIR - Submm





Harvey et al. 2001/Shirley et al. 2000

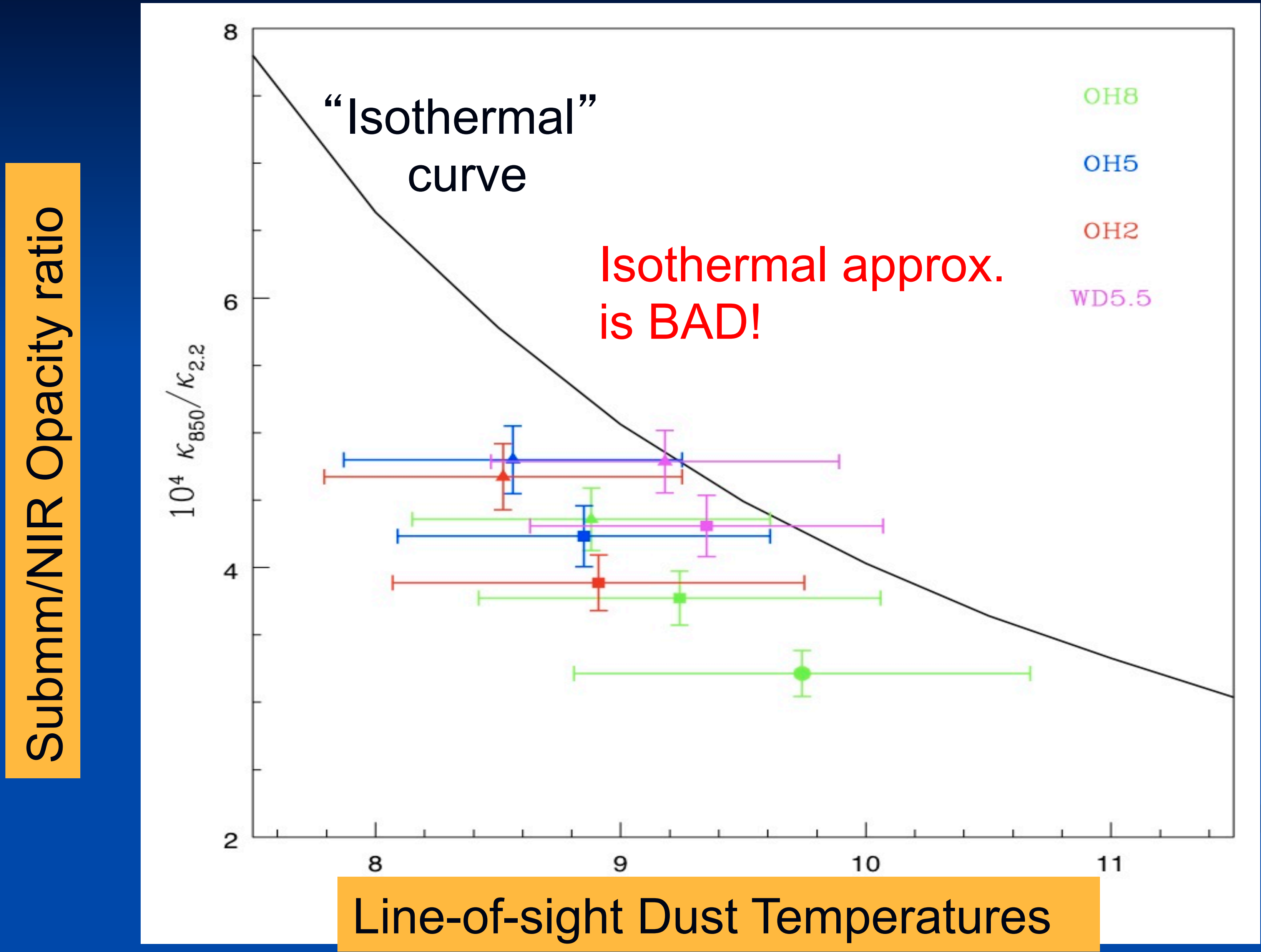
Constraints on opacity ratio



$$P_n = \frac{\int_s n(s) B_\nu[T(s)]\, ds}{2.5 \log(e) \int_s n(s)\, ds}.$$

Shirley et al. 2011b

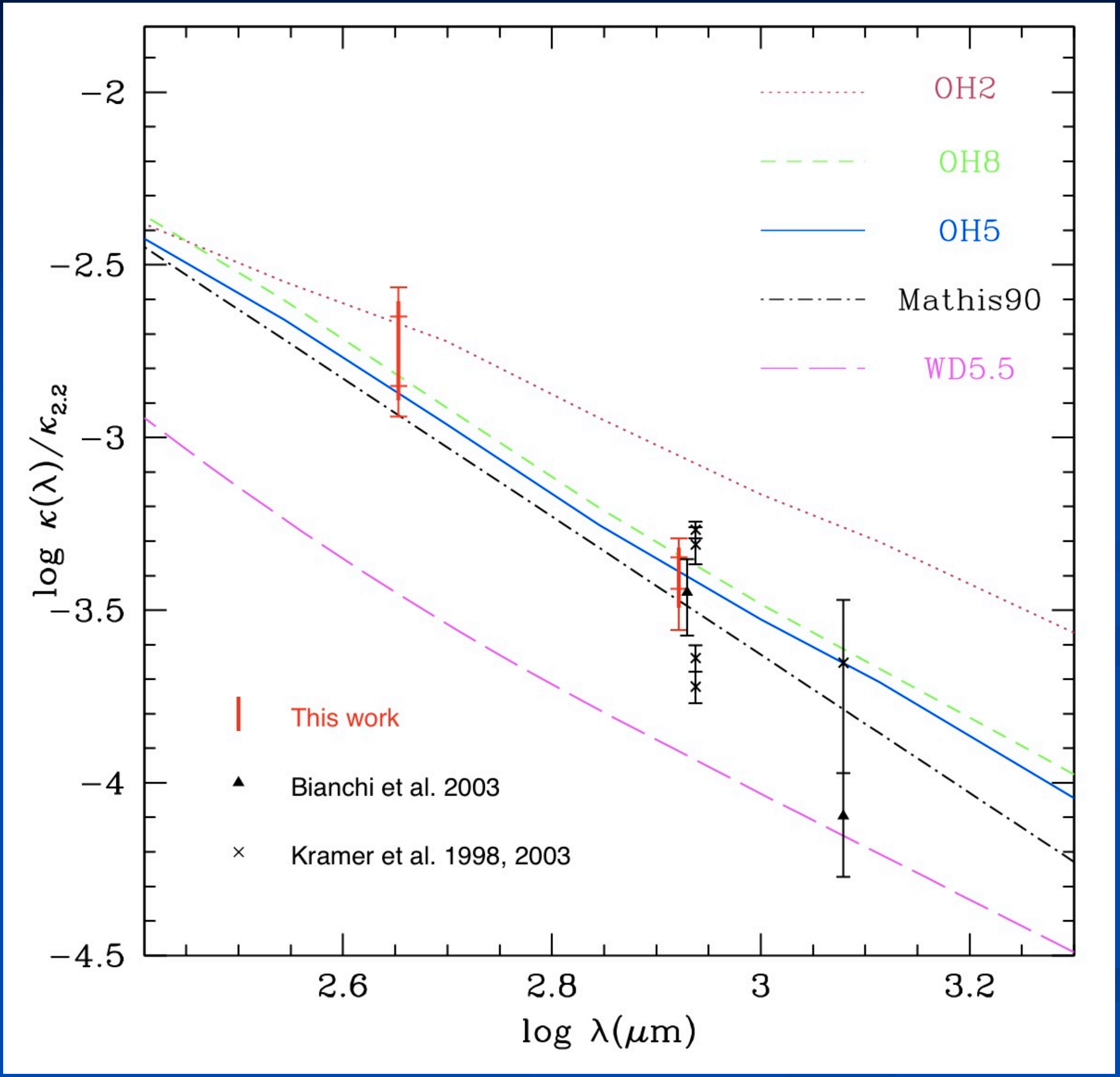
The importance of using T(r)



Shirley et al. 2011b

Constraints on opacity ratio

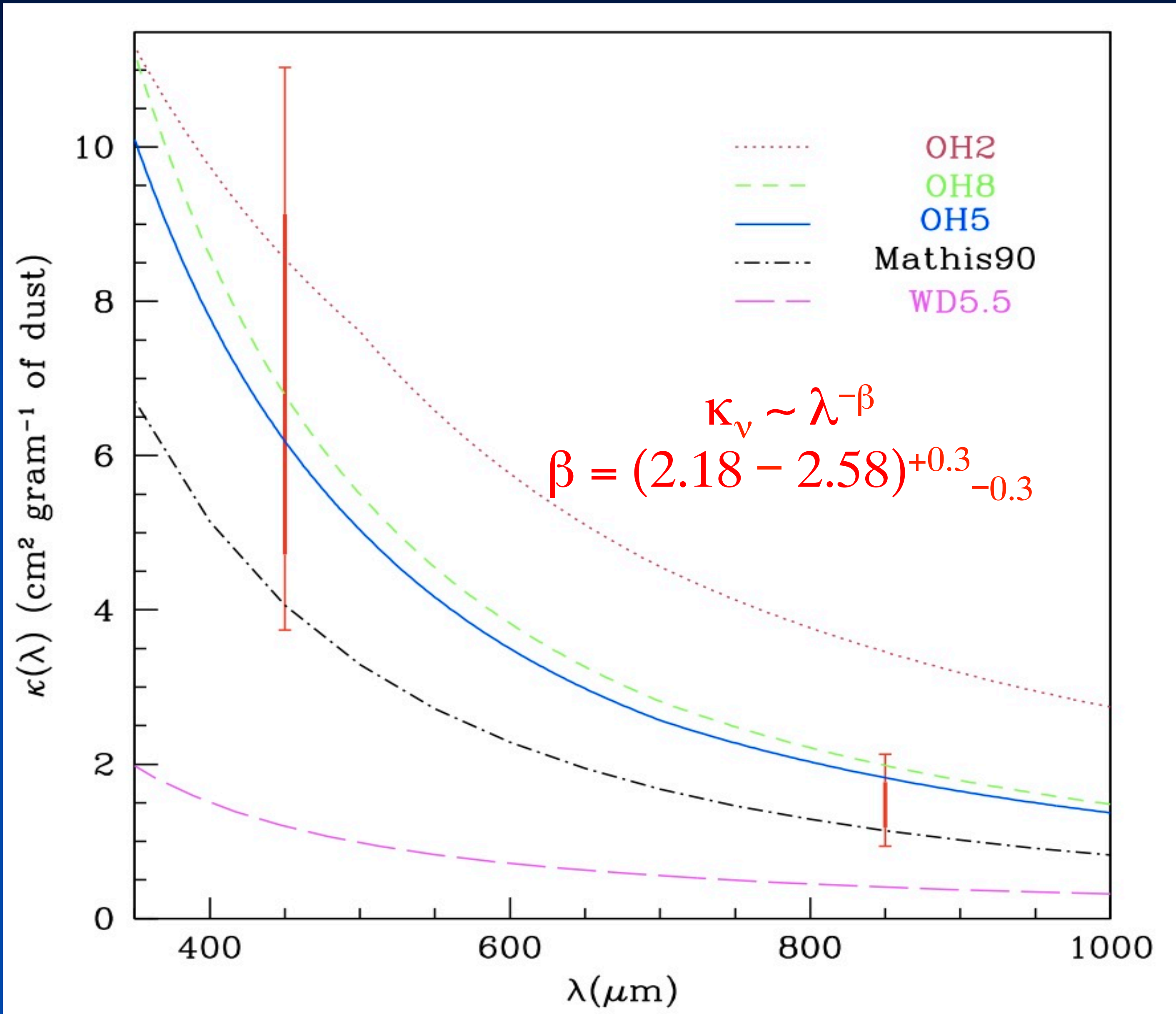
Submm/NIR Opacity ratio



Shirley et al. 2011b

Constraints on κ_ν & β

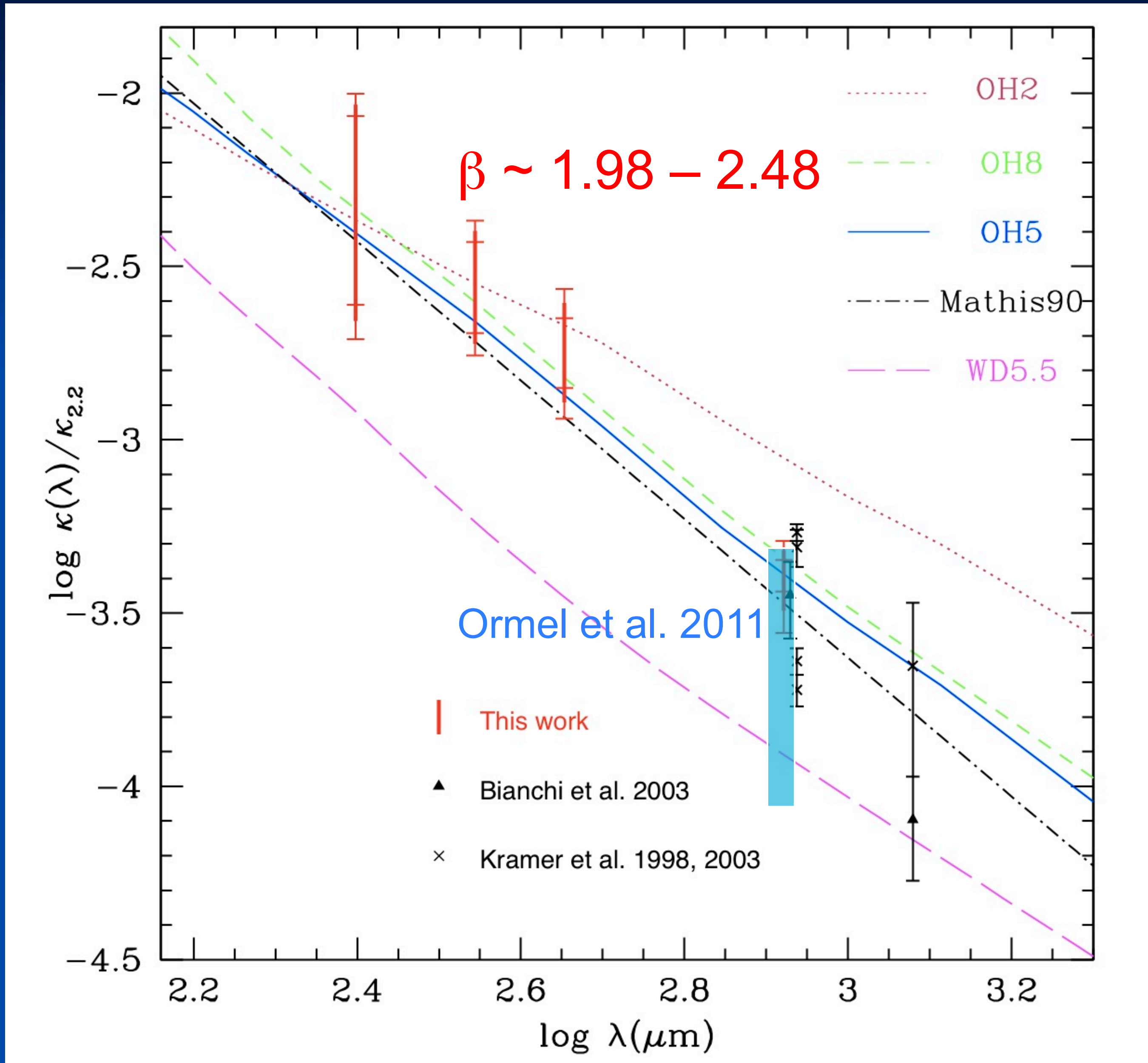
Submmm Opacity



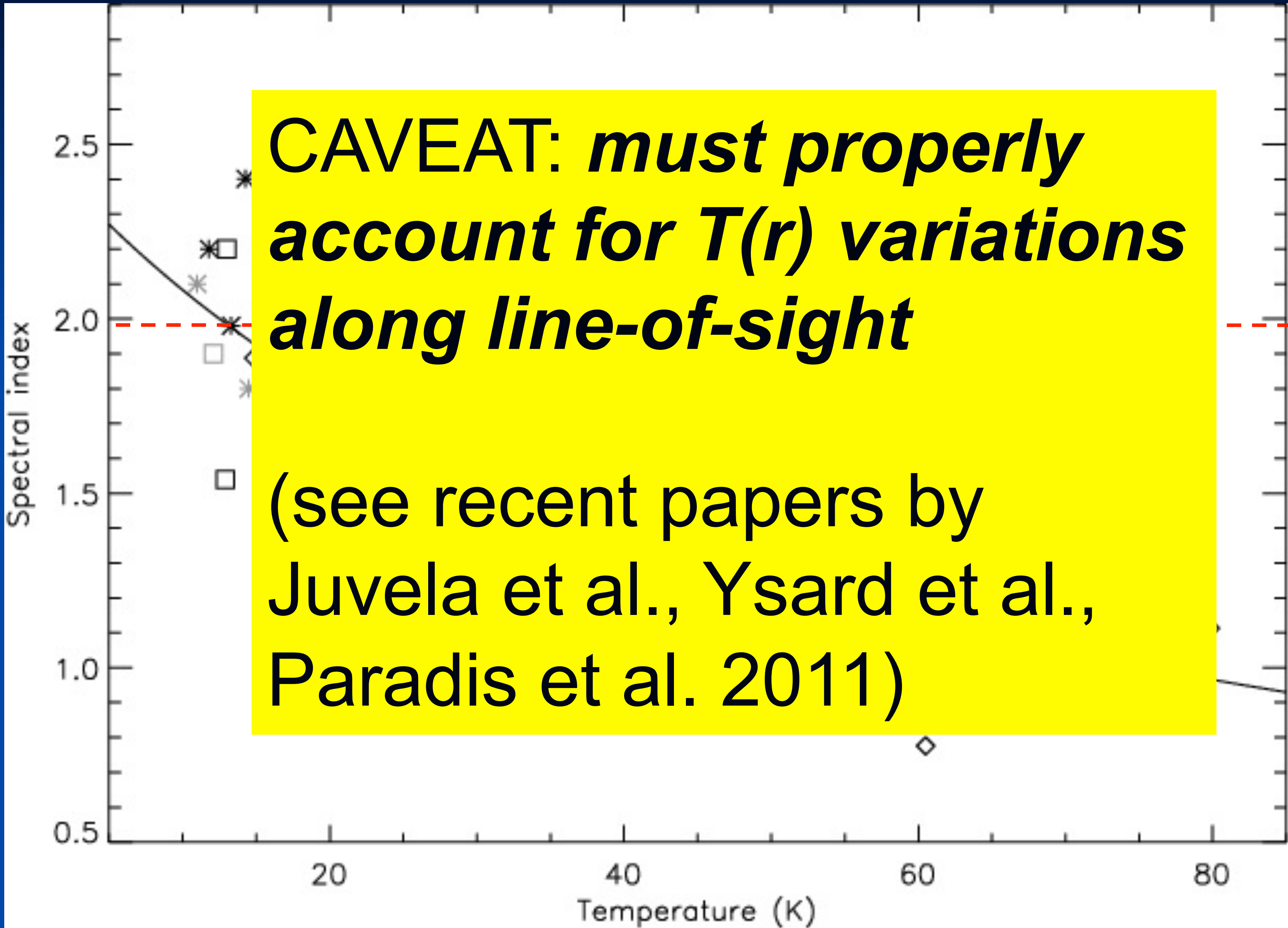
Shirley et al. 2011b

SPIRE Constraints on κ_ν & β

Submm/NIR Opacity ratio



Evidence for β > 2 ??



CAVEAT: ***must properly account for T(r) variations along line-of-sight***

(see recent papers by Juvela et al., Ysard et al., Paradis et al. 2011)

Dupac et al. 2003

Theoretical Evidence for β > 2 ??

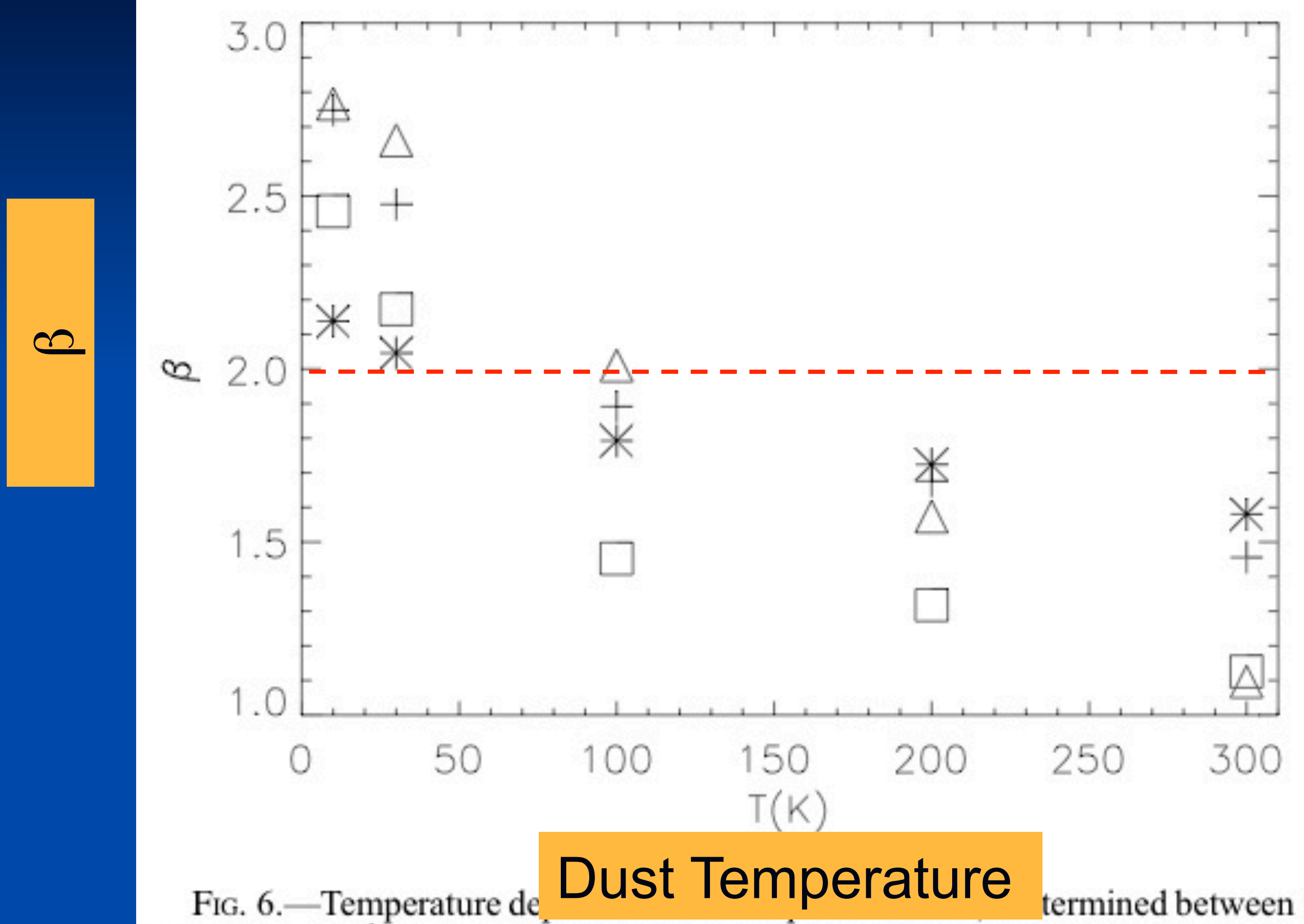
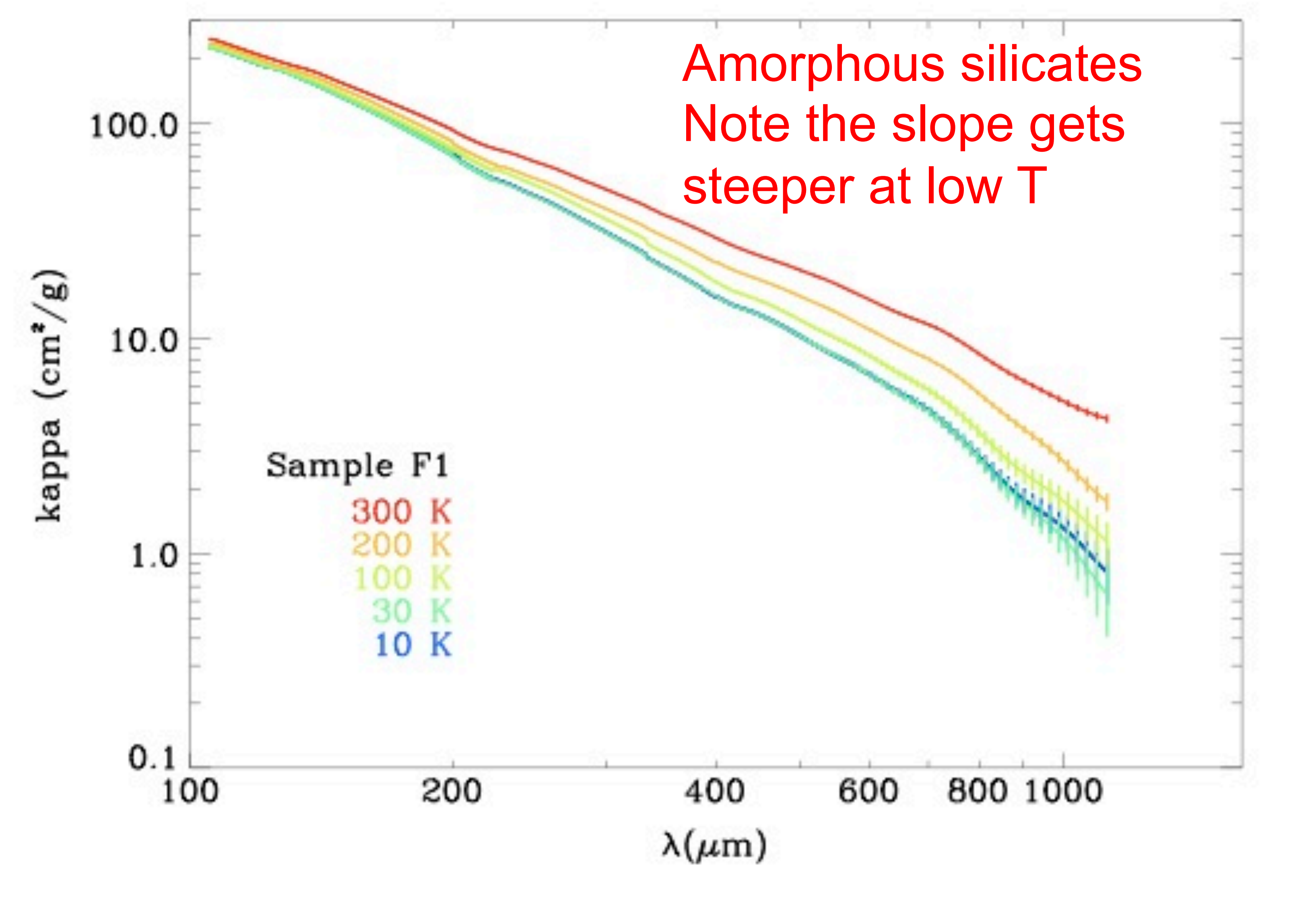


FIG. 6.—Temperature de[...]termined between 10 and 20 cm^{-1} by least-squares fits for $MgSiO_3$ sol-gel (*plus signs*), $MgSiO_3$ glass (*asterisks*), 1.5 μm monospheres (*triangles*), and fumed silica (*squares*).

Boudet et al. 2005

Theoretical Evidence for $\beta > 2$??



Coupeaud et al. 2011

Have we tamed submm Opacities ?

observer

submm opacities

Not yet…

Conclusions/Future Work

- Observe B335 envelope β at 350 μm – 850 μm that is > 2.0. This is consistent with recent reports of inverse β - T_d dependence, Schnee et al. 2009 starless core modeling, and solid state predictions.

- Kappa 850 μm consistent with OH5 opacities, but problems with OH opacities shape in far-IR and with β

- Requires interferometric multi-λ obs (ALMA) to disentangle opacity variations in disk + envelope emission.