Determining the systematic errors in fits of dust thermal emission

The role of laboratory data in upcoming models

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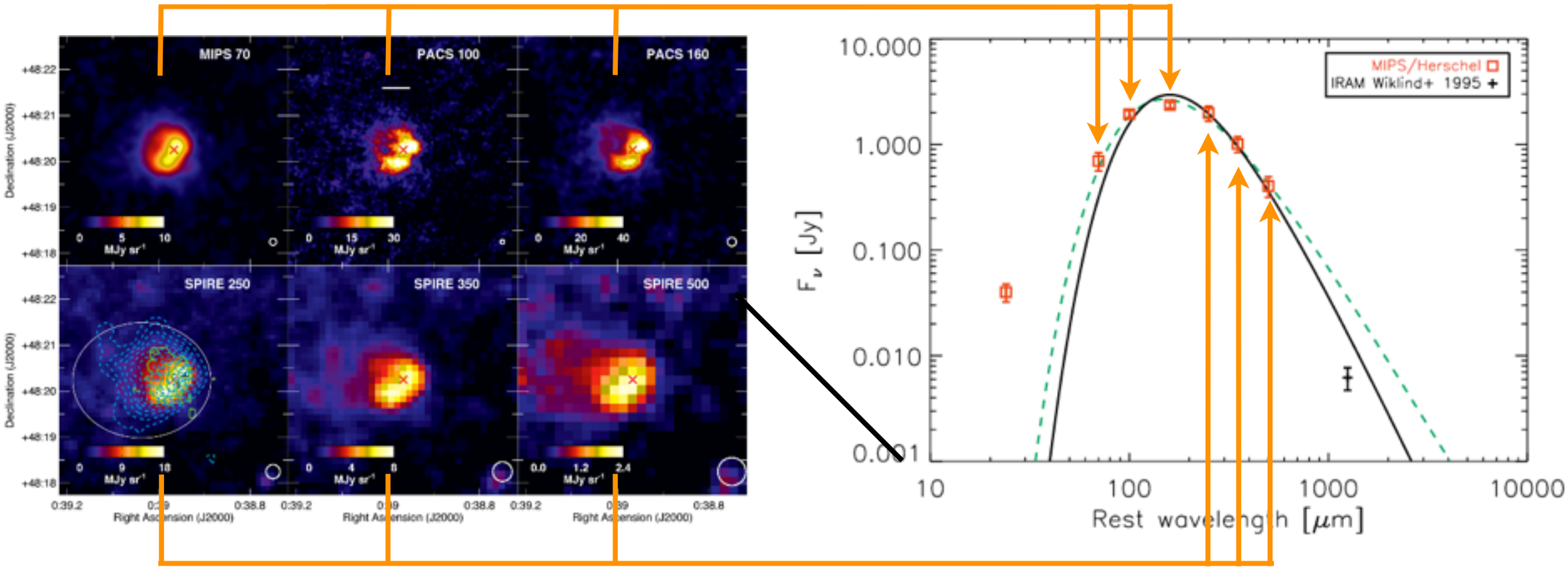
Seoul, Feb 1st 2018

Context: Dust masses from the SED

NGC 185 (De Looze+16)



Dust emission SED (multi-λ photometry) → Interpretation through model → Dust physical quantities: Mass, temperature...

FIR: 100 - 1000 μm

D/G: gas mass tracer?

Dust formation history at high z

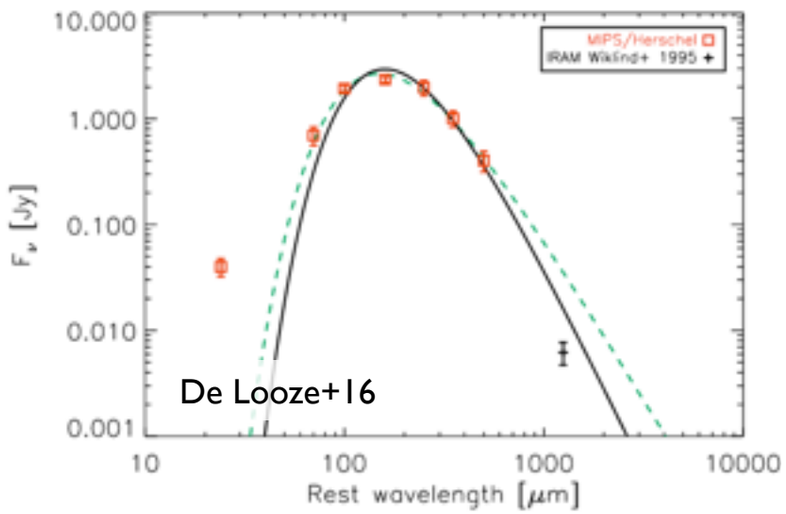
(Dust budget crisis)

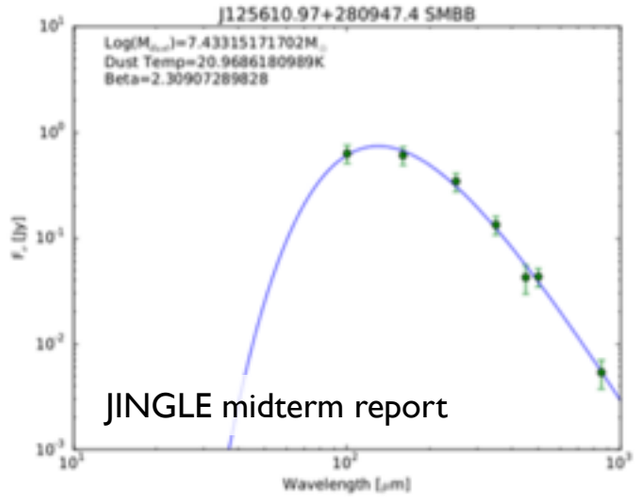
Context: Dust masses from the SED

Modified blackbody (MBB)

Issues:

- Parameter degeneracy
- No single T
- No constant β / simple power law
- κ_λ depends on many things:
  - Temperature
  - Composition
  - Grain shape





Alternative forms of κ_λ:

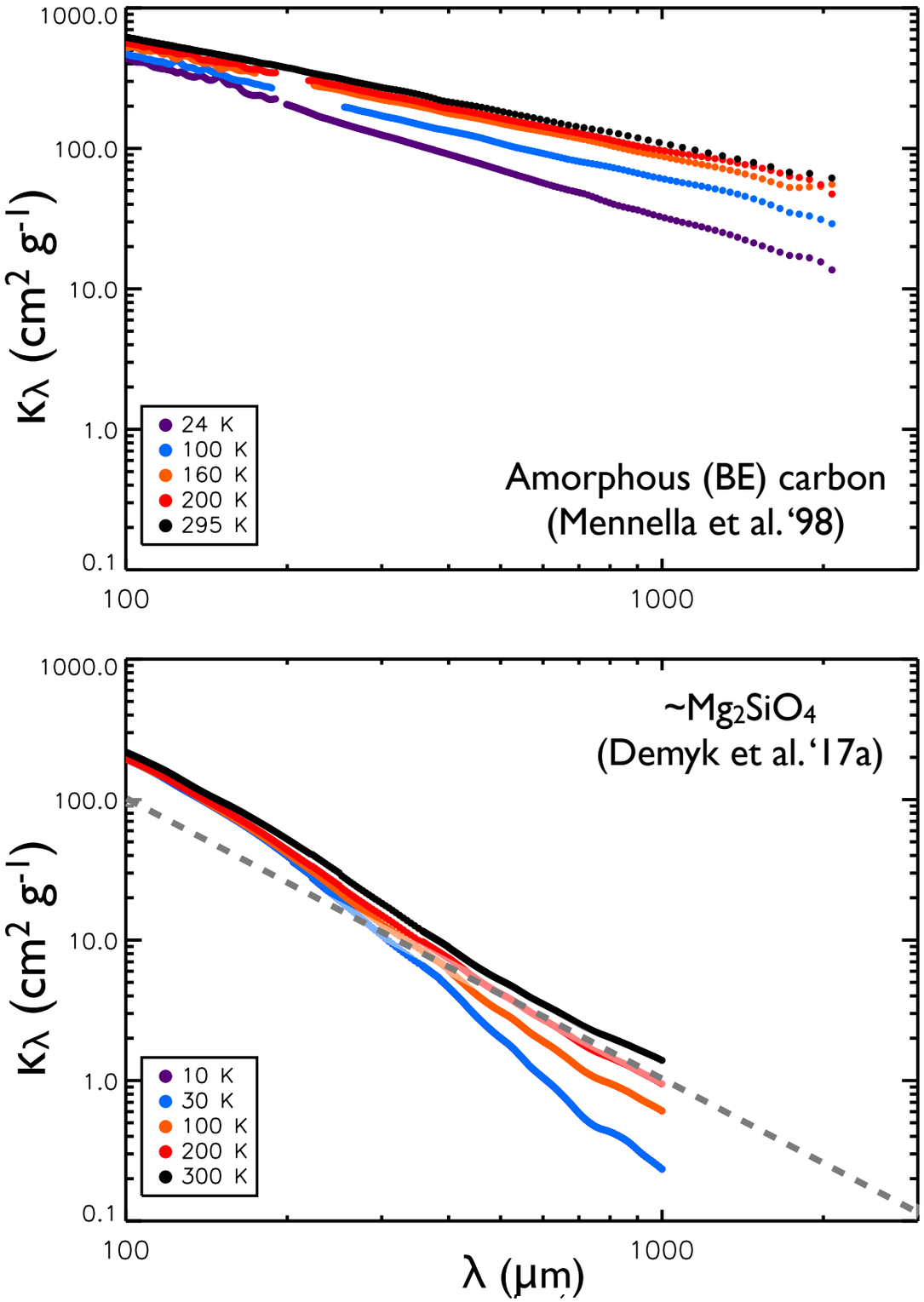
- Observational (e.g., Draine)
  - No info on actual dust properties
- Laboratory measurements

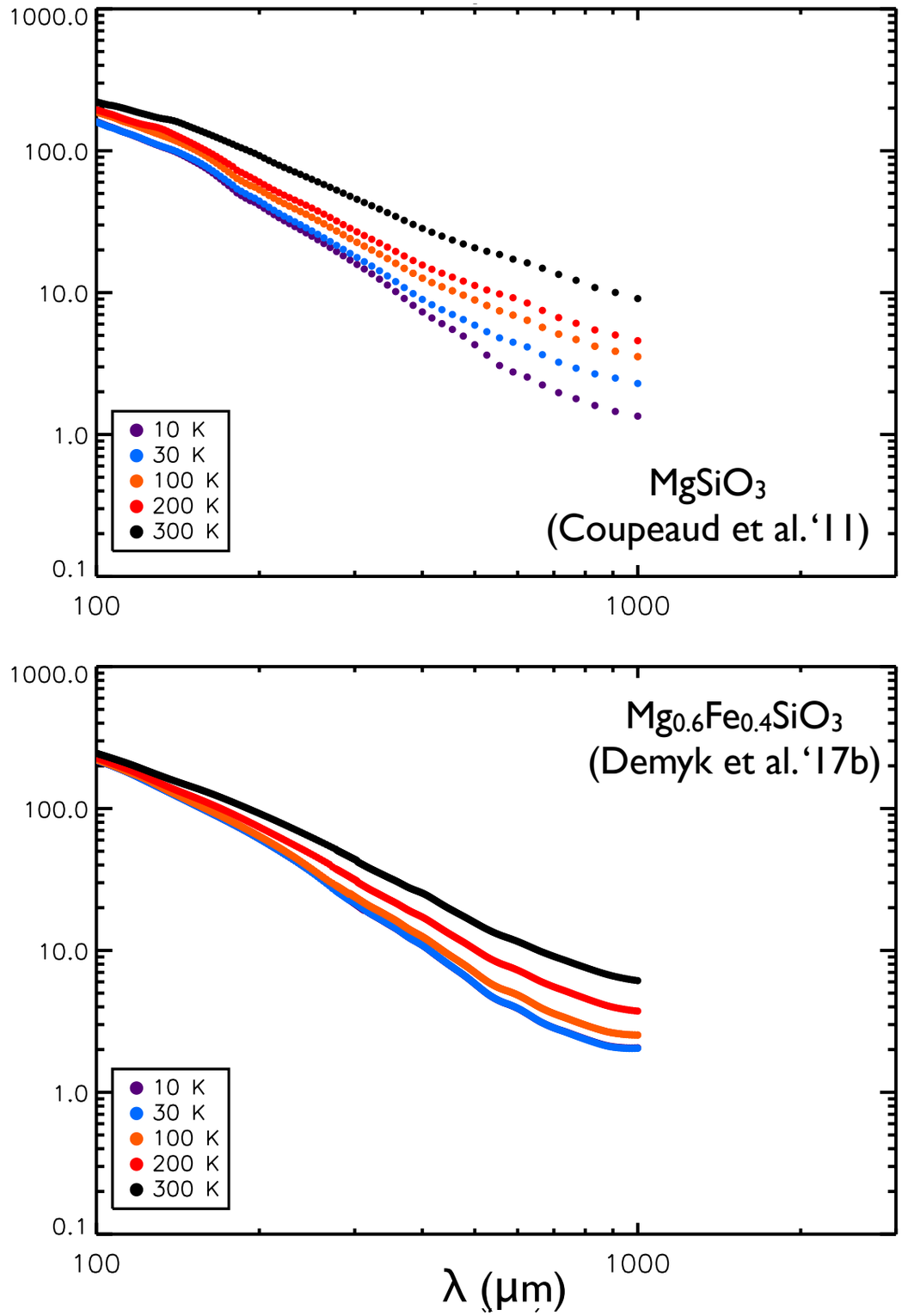
$$F_\lambda = \overbrace{M_{d,surf} \times \underbrace{\kappa_\lambda}_{\kappa_0 \times (\lambda/\lambda_0)^{-\beta}}}^{\tau_\lambda} \times B_\lambda(T)$$

$$\downarrow$$

$$\boxed{T,\ \beta,\ \tau_0\ [\kappa_0]}$$

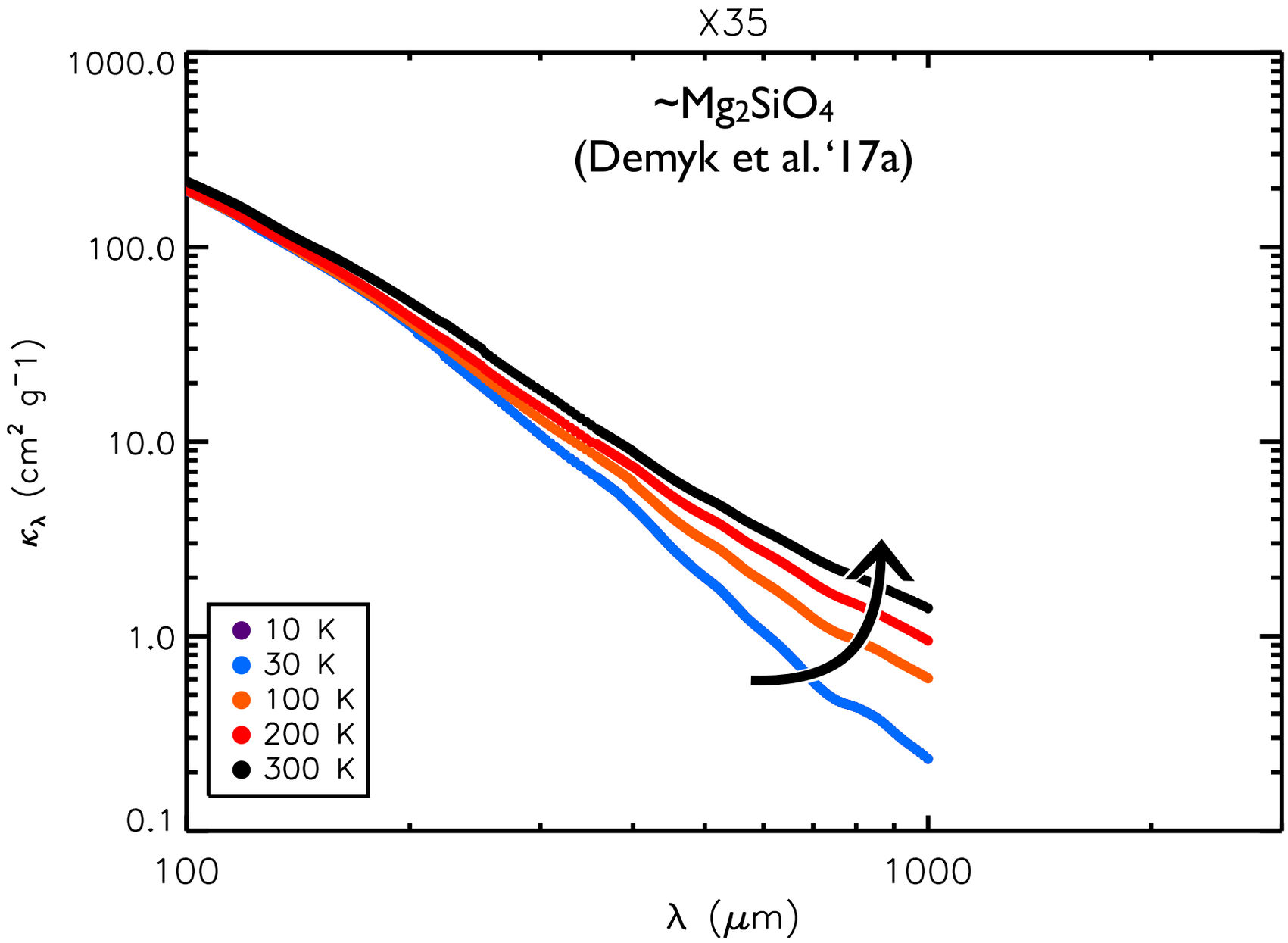
Laboratory dust opacities





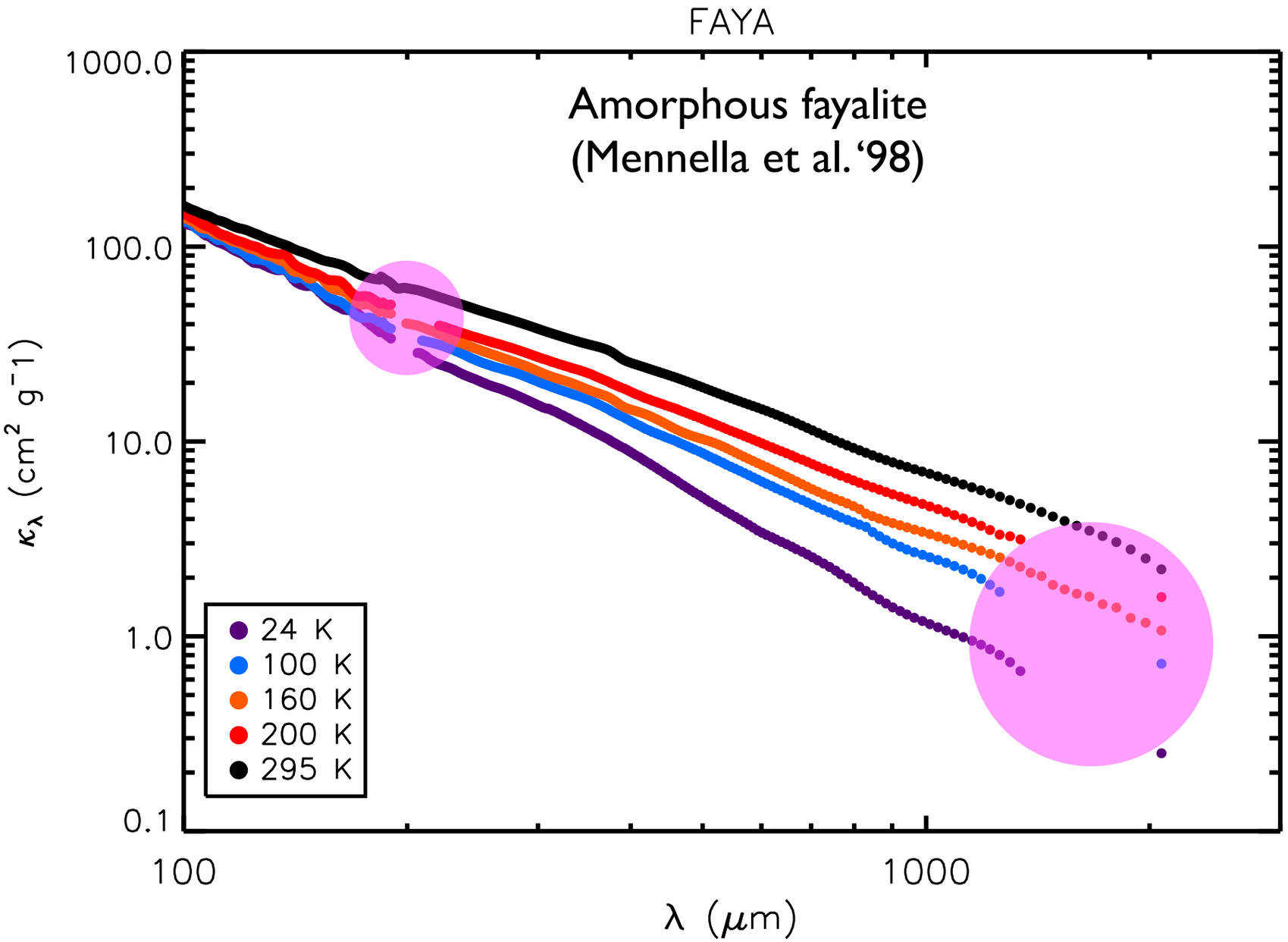
Laboratory dust opacities

- Interpolation on T



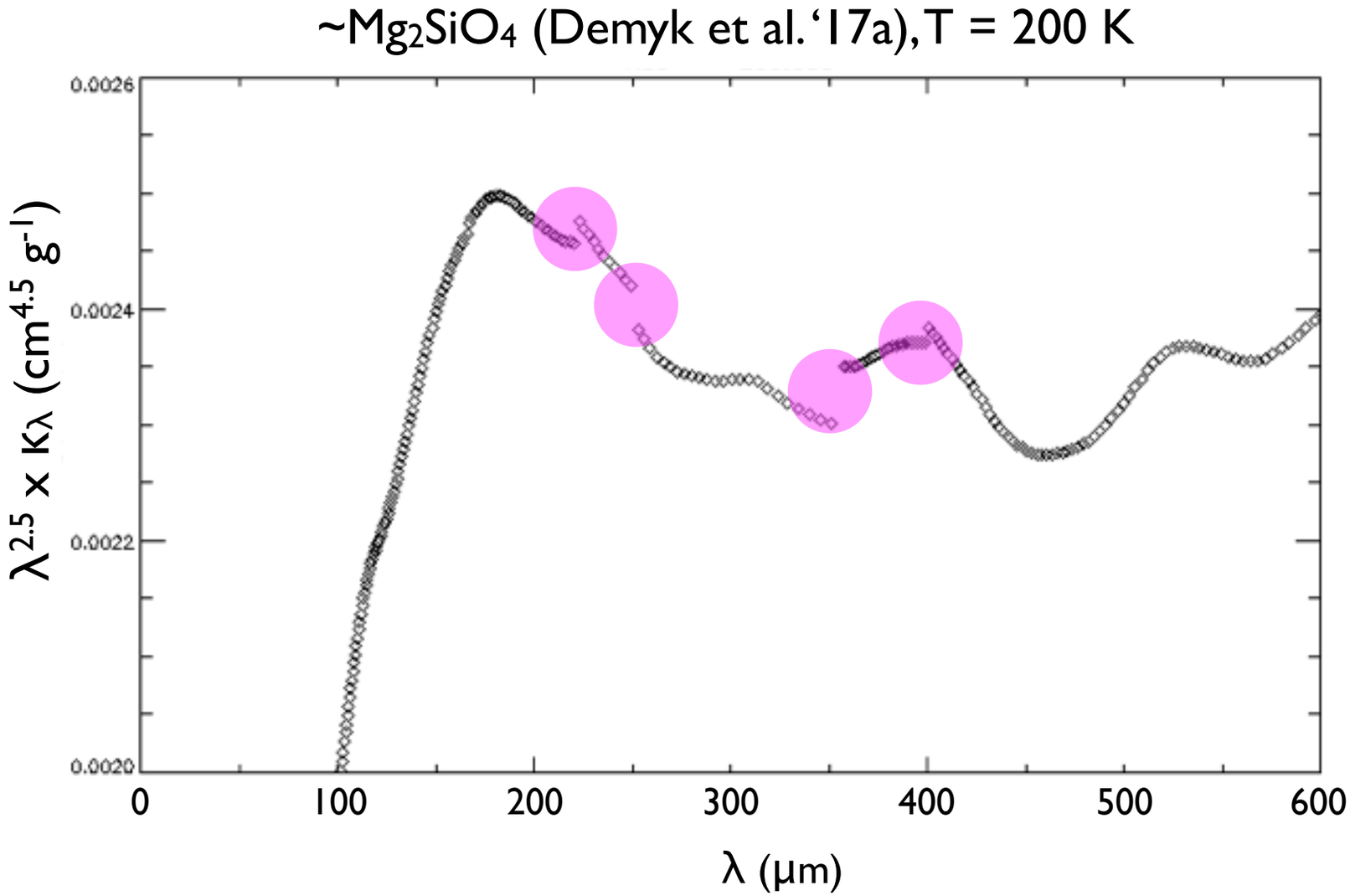
Laboratory dust opacities

- Interpolation on T
- Interpolation on λ
  - 2D interpolation



Laboratory dust opacities

- Interpolation on T
- Interpolation on λ
  - 2D interpolation
- Smooth (if necessary)
- Correct for artifacts



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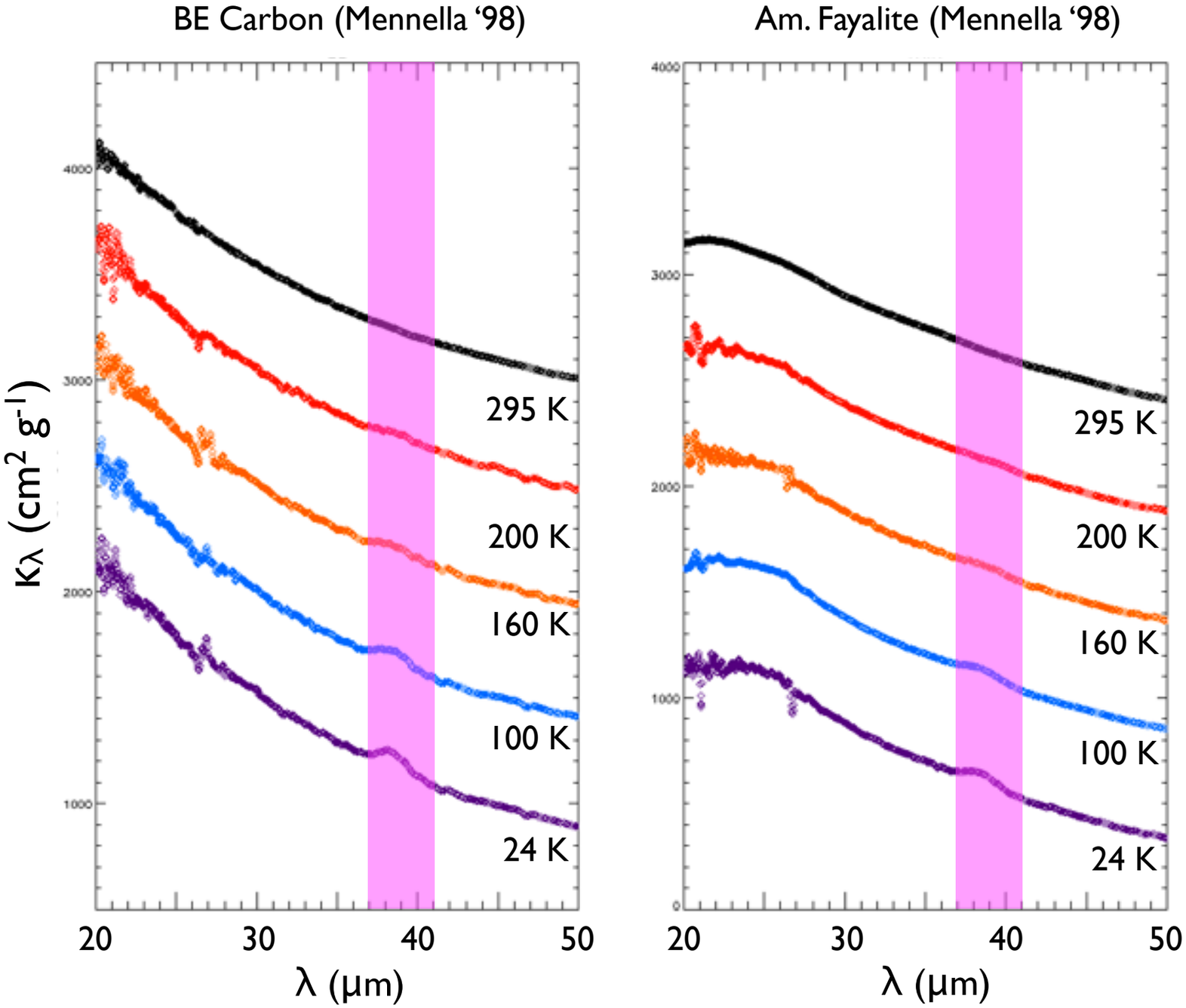
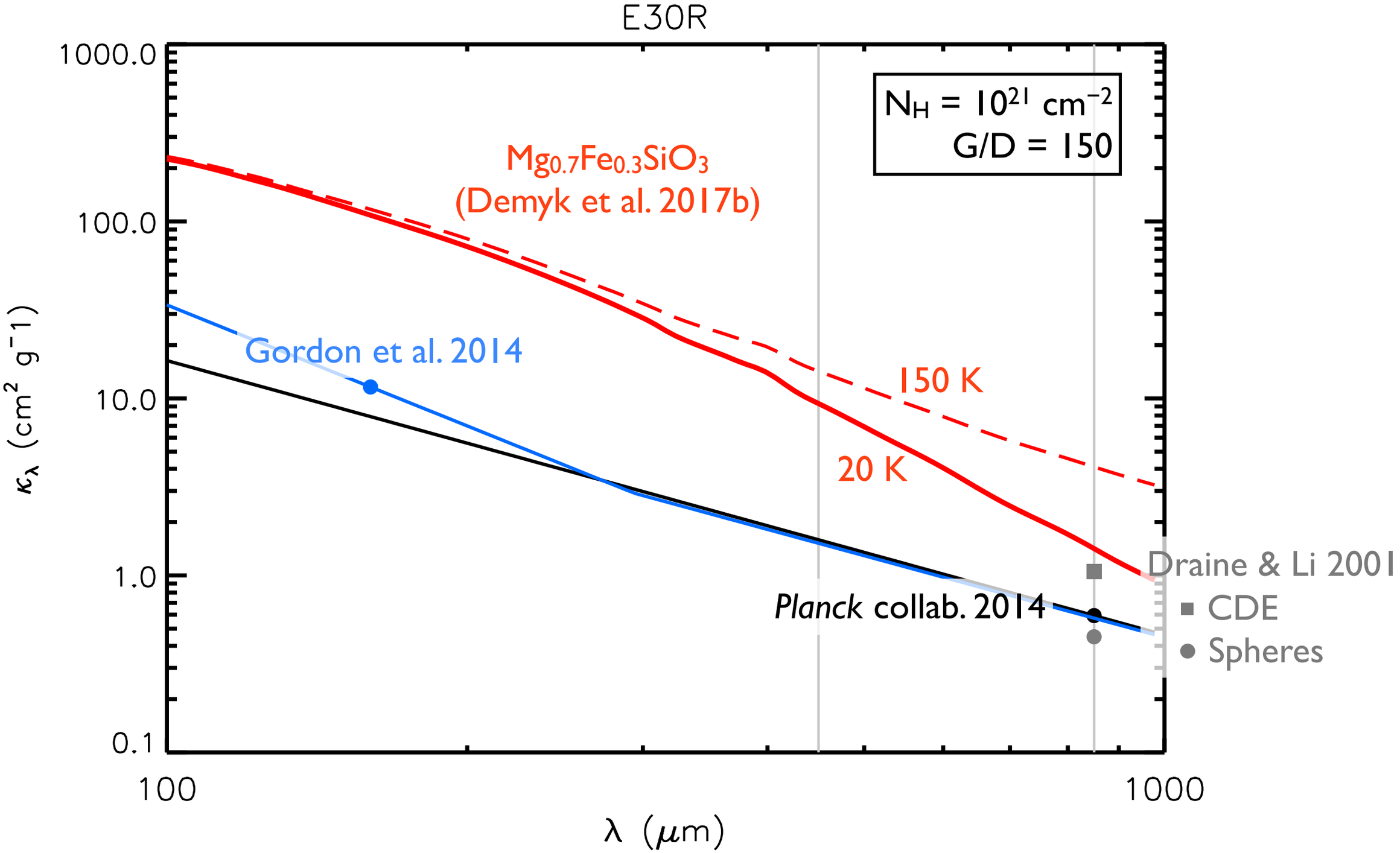
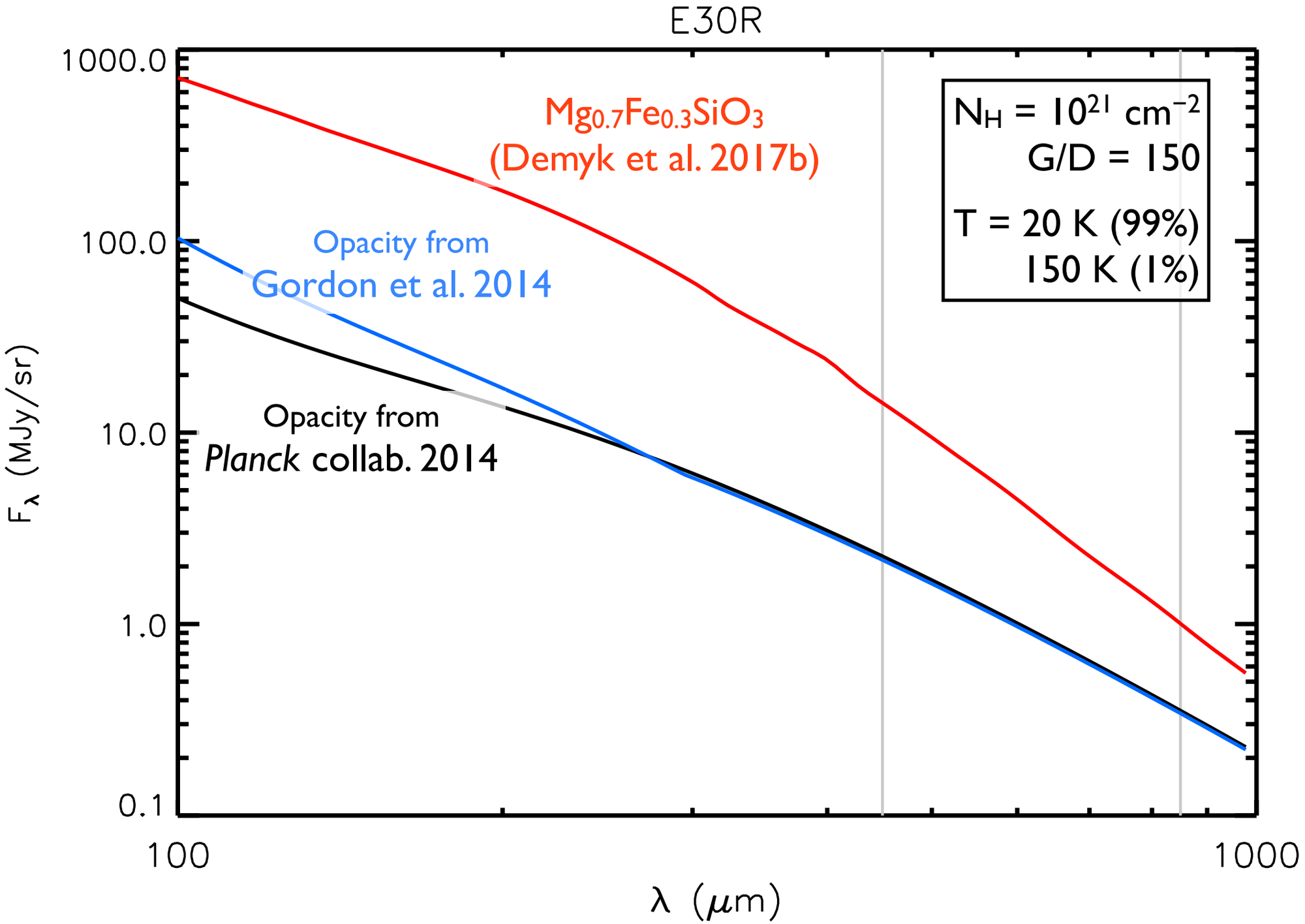


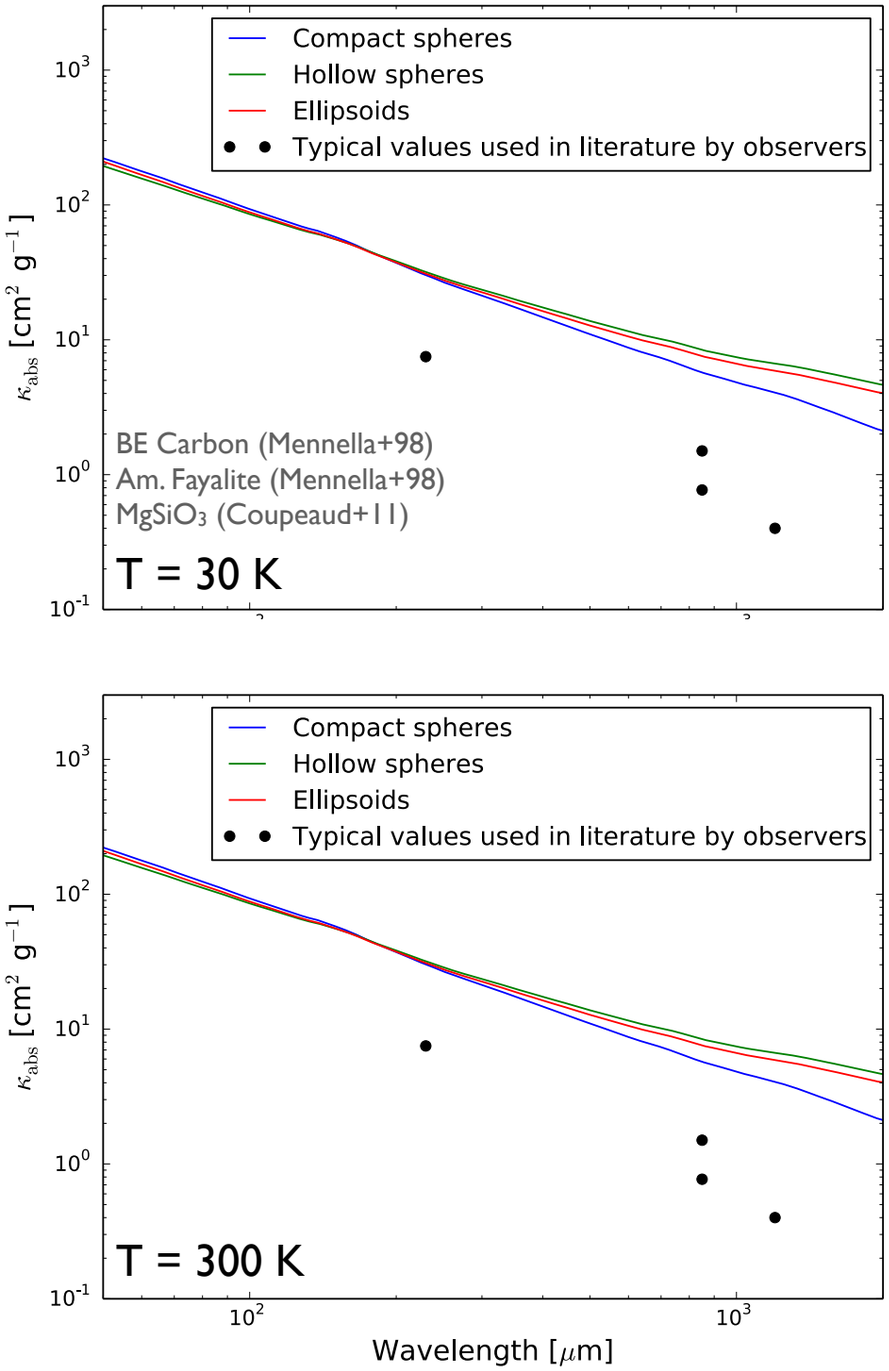
Lab results vs. observations

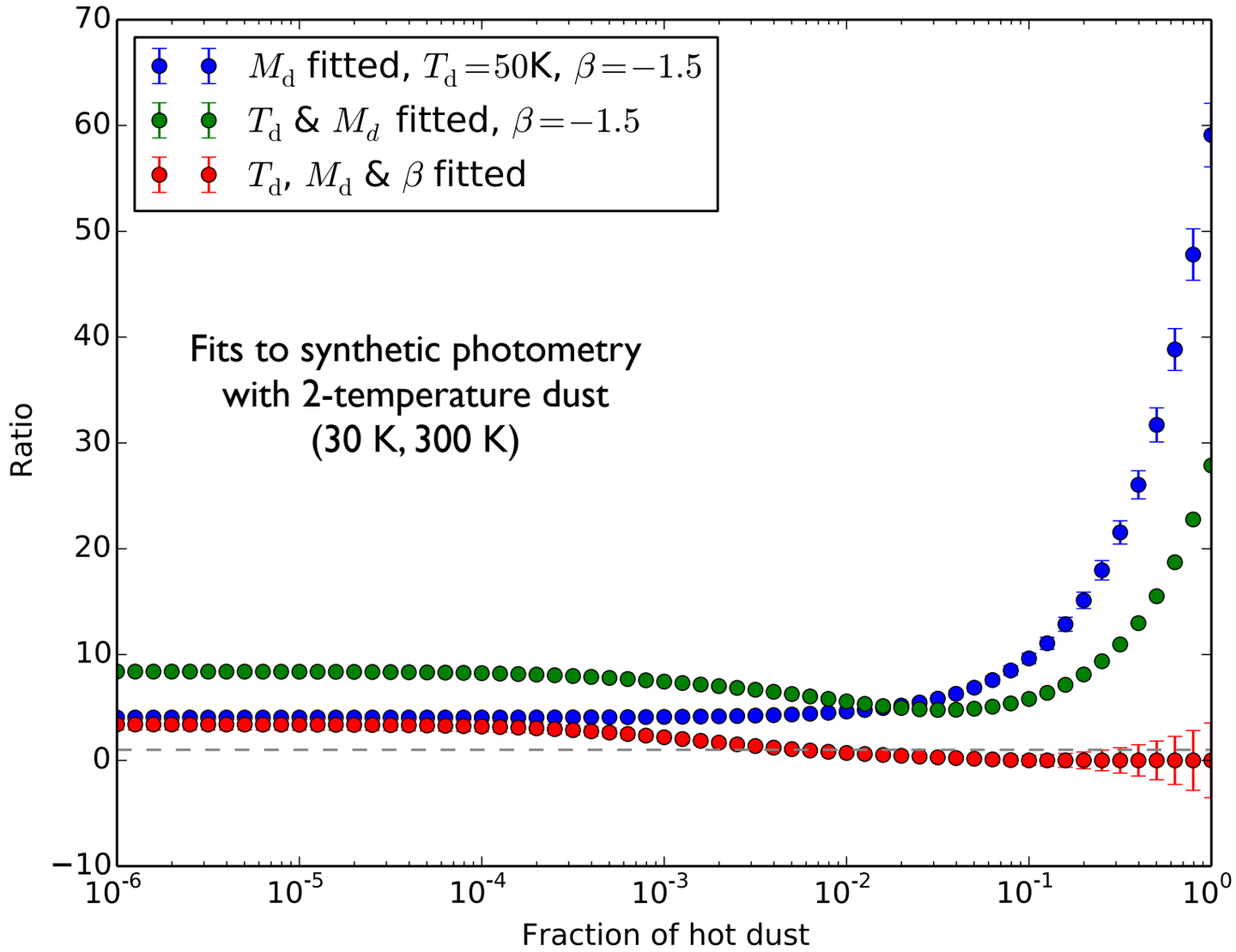


Lab results vs. (synthetic) observations



Bias estimation (Work by Peter Scicluna)





Conclusions

- Dust mass determination depends on choice of opacity
- Large differences between lab-derived and observation-derived opacities
  - Power law (single-β) model inadequate
  - Dependence on T
- Fits of synthetic photometry

  ➠ Mass overestimated by up to ~10x

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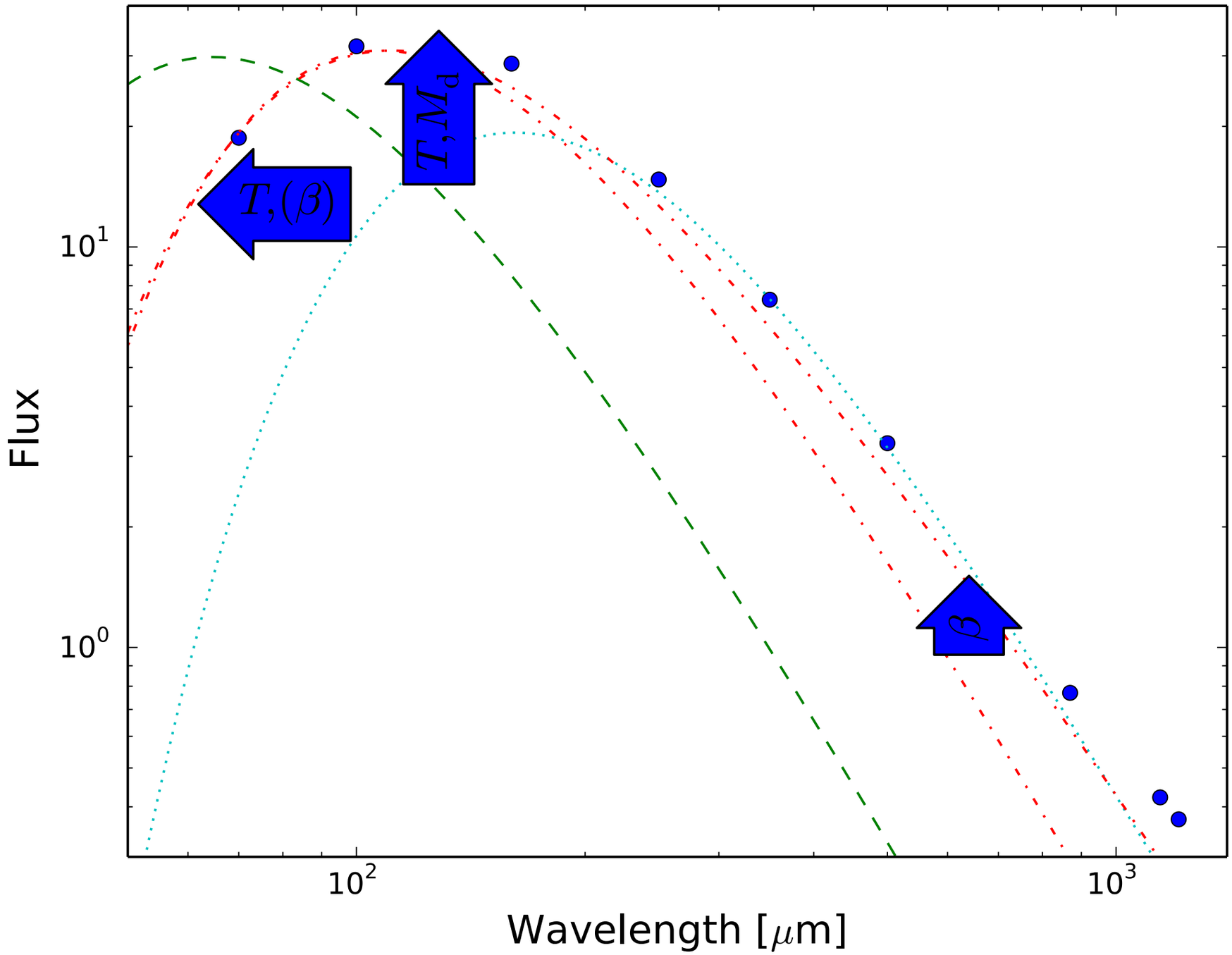
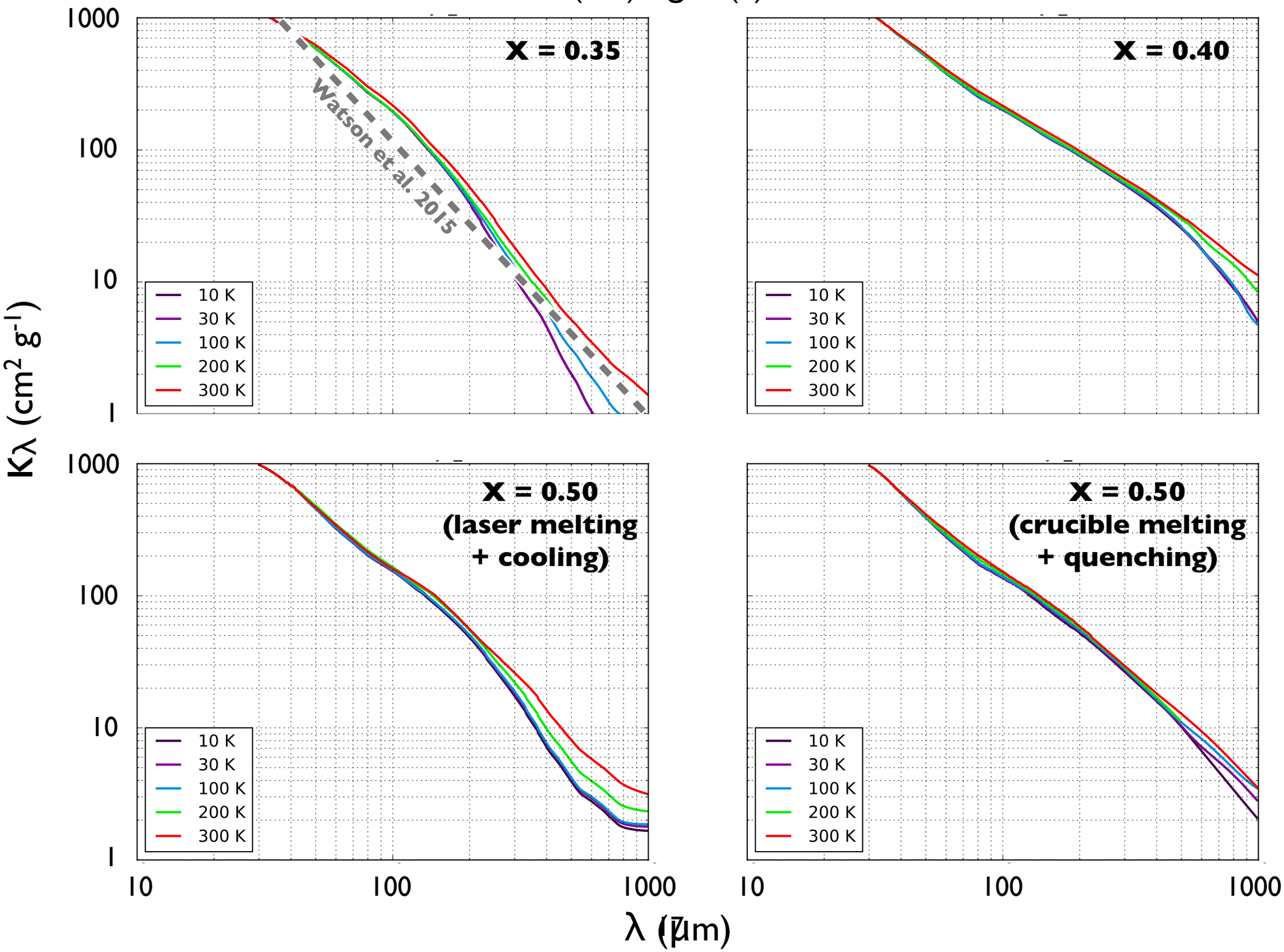
PRELIMINARY

Thank you for your attention!


T,$M_{\rm d}$
T,(β)
β
10^1
10^0
10^2
10^3
Flux
Wavelength [μm]

Kλ: Demyk et al. 2017



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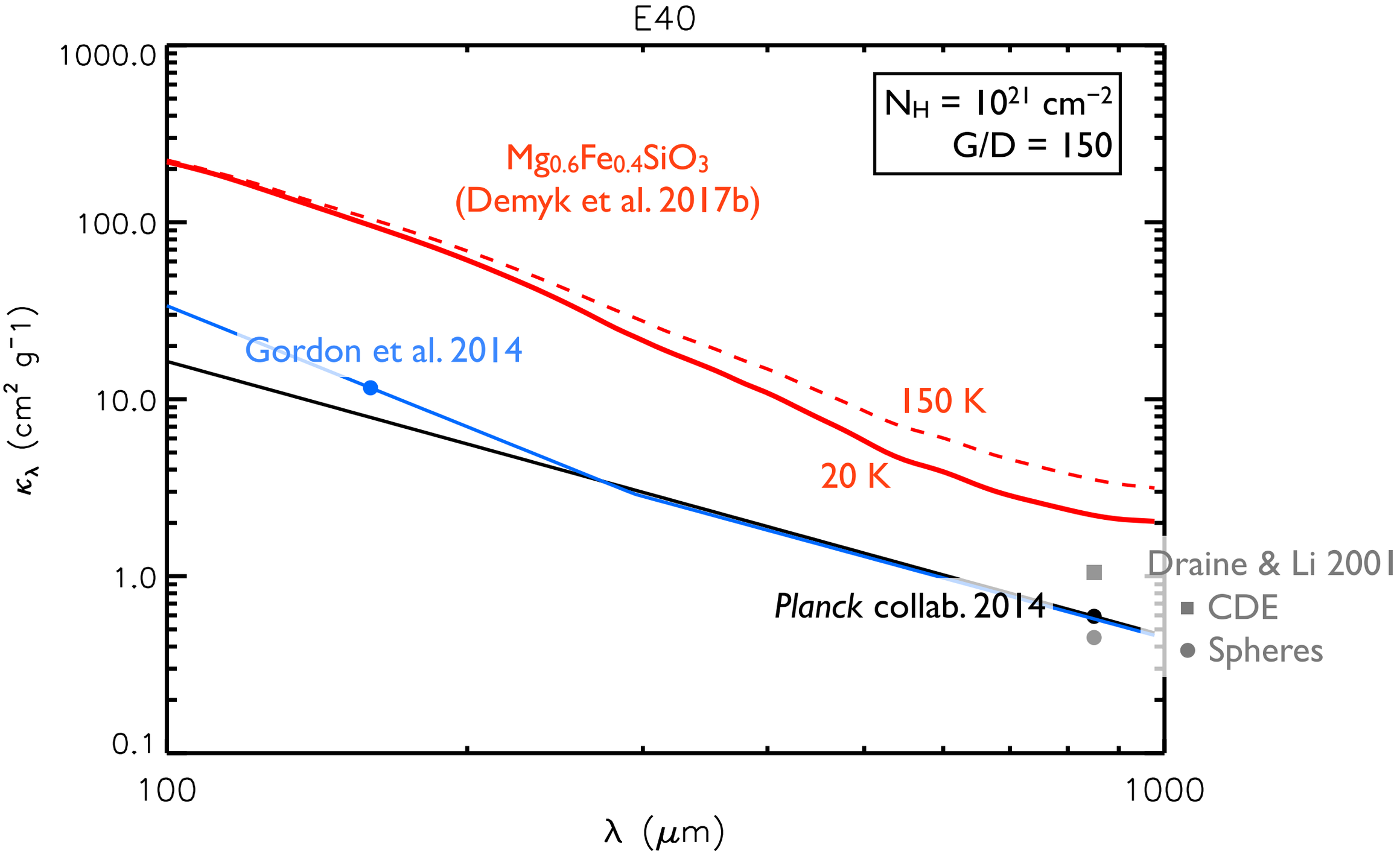

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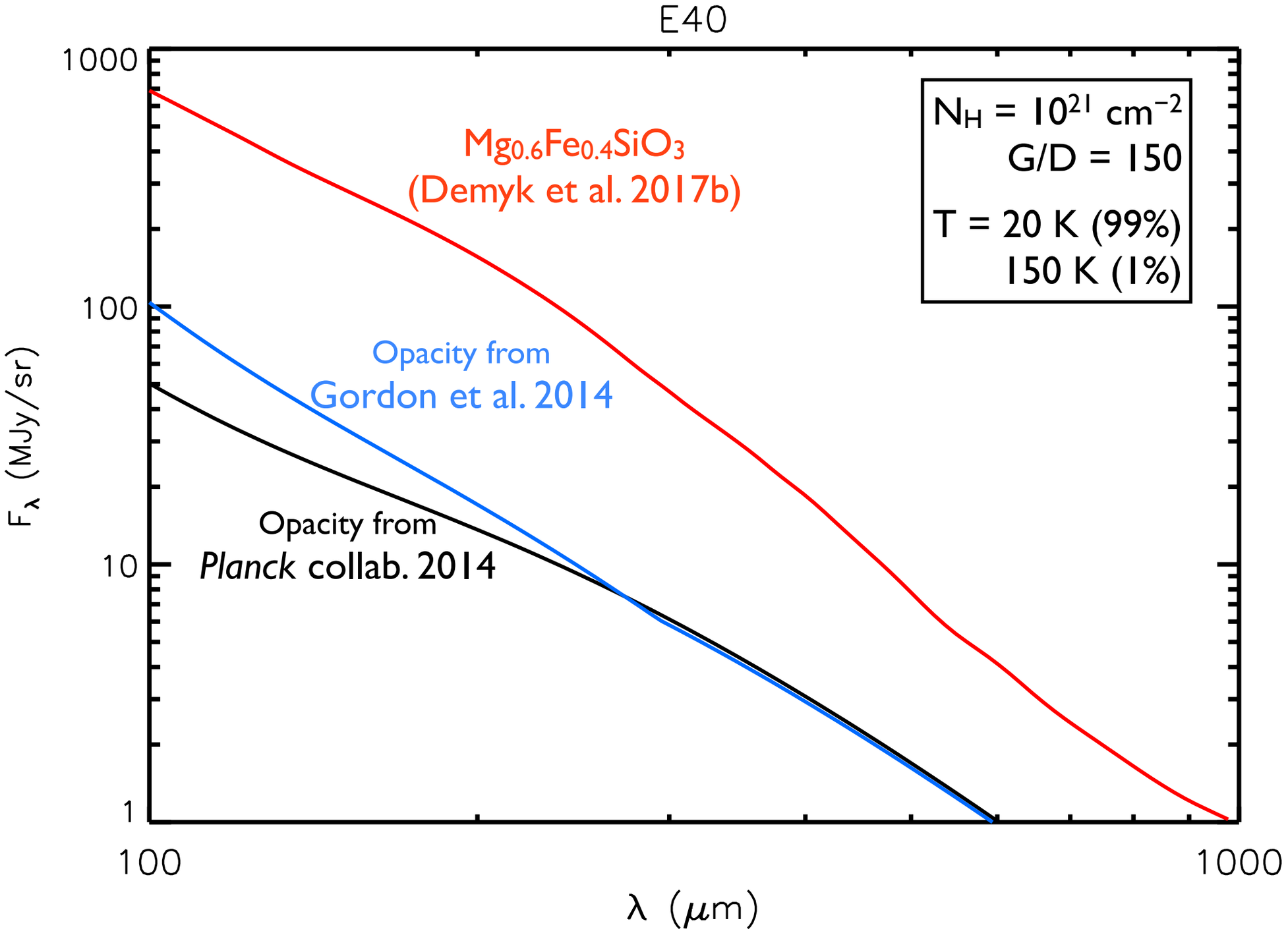

Work by Peter Scicluna, z = 1