Fitting a snowline at 40AU at V883Ori

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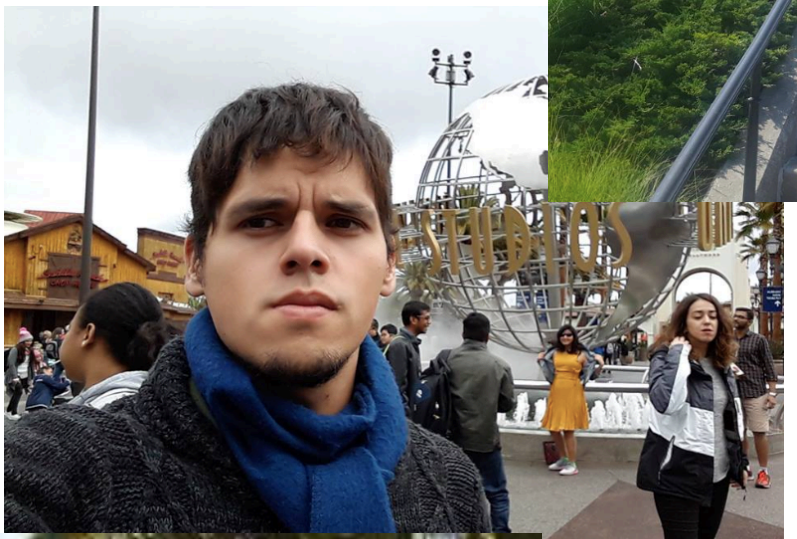
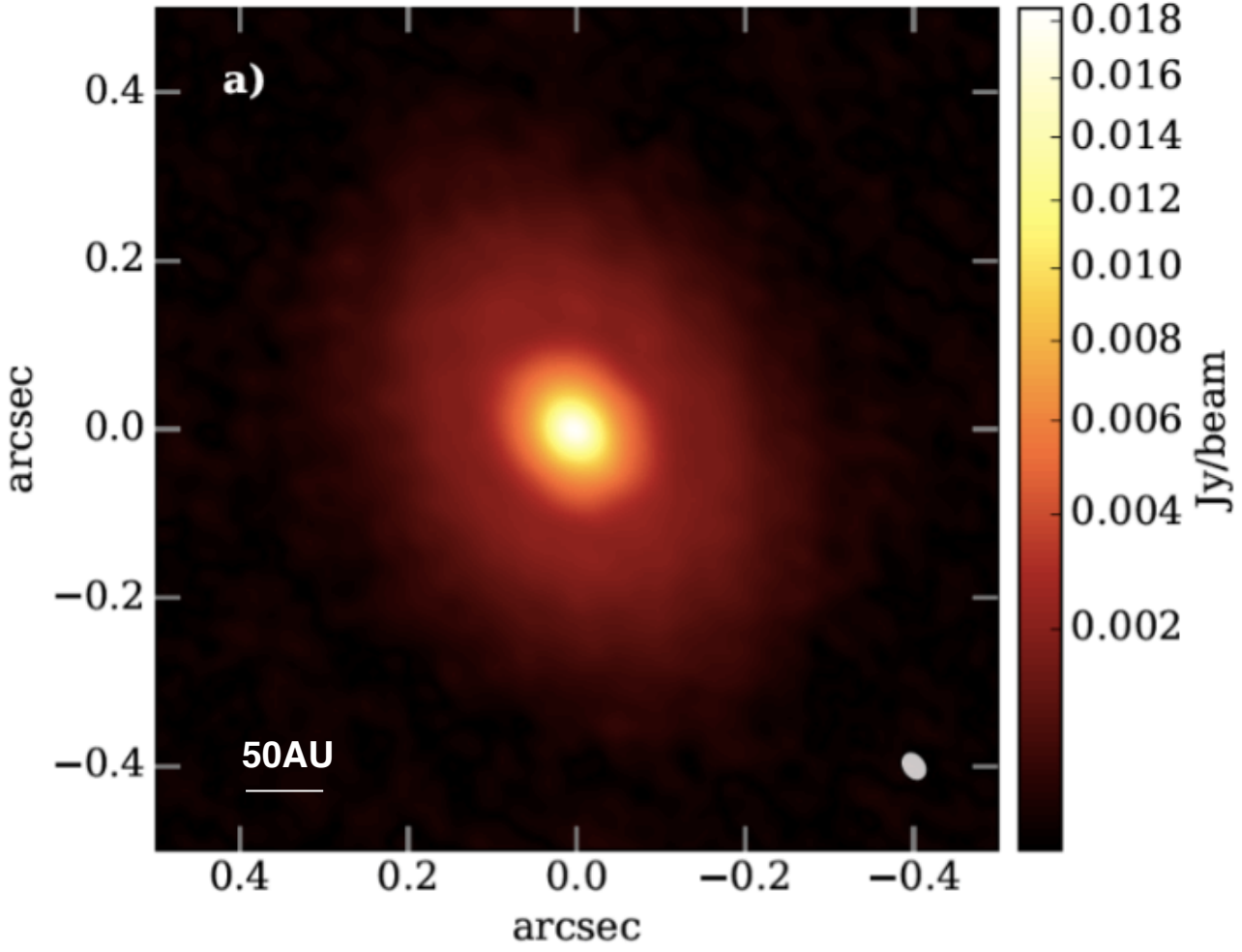
Felipe Alarcon



V883Ori

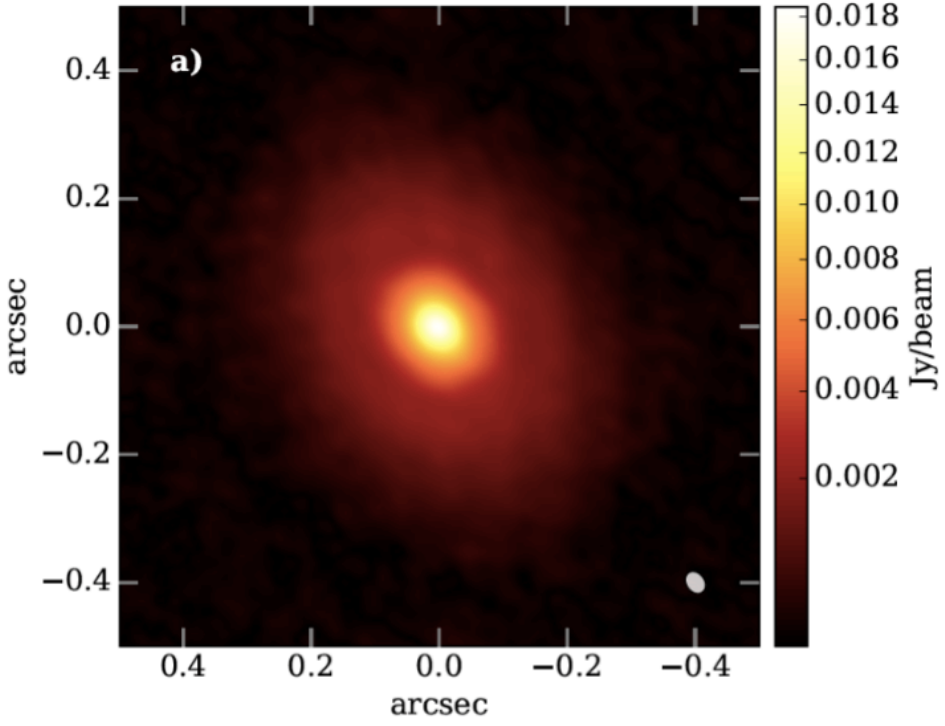


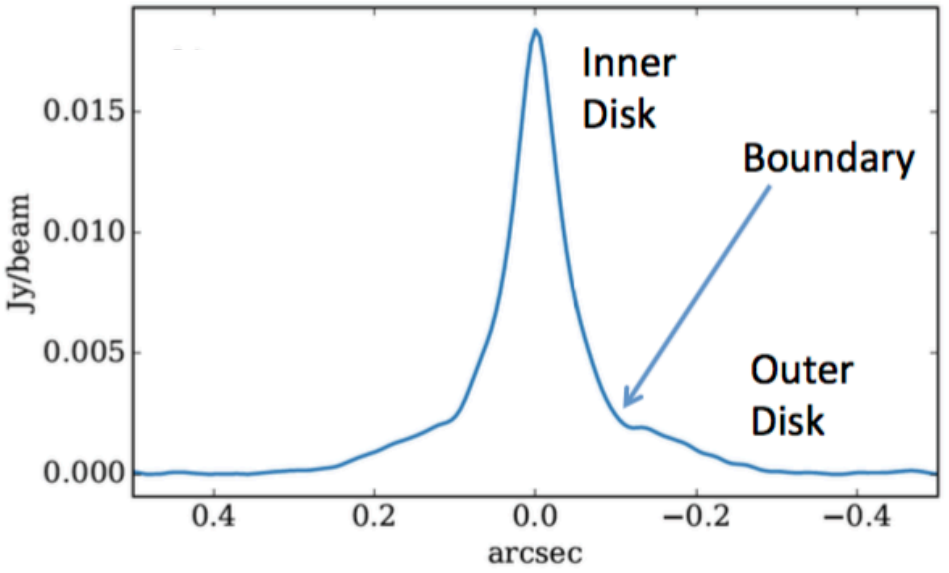
Class I protostar
(Age ~0.5 Myr)
(L_* ~ 6 L_{sun}*)*

M_* = 1.3 +/- 0.1 M_{sun}
M_{disk} ~ 0.3 M_{sun}
d = 414 +/-7 pc
Ldisk = 400 L_{sun}

Cieza et al. (2016)

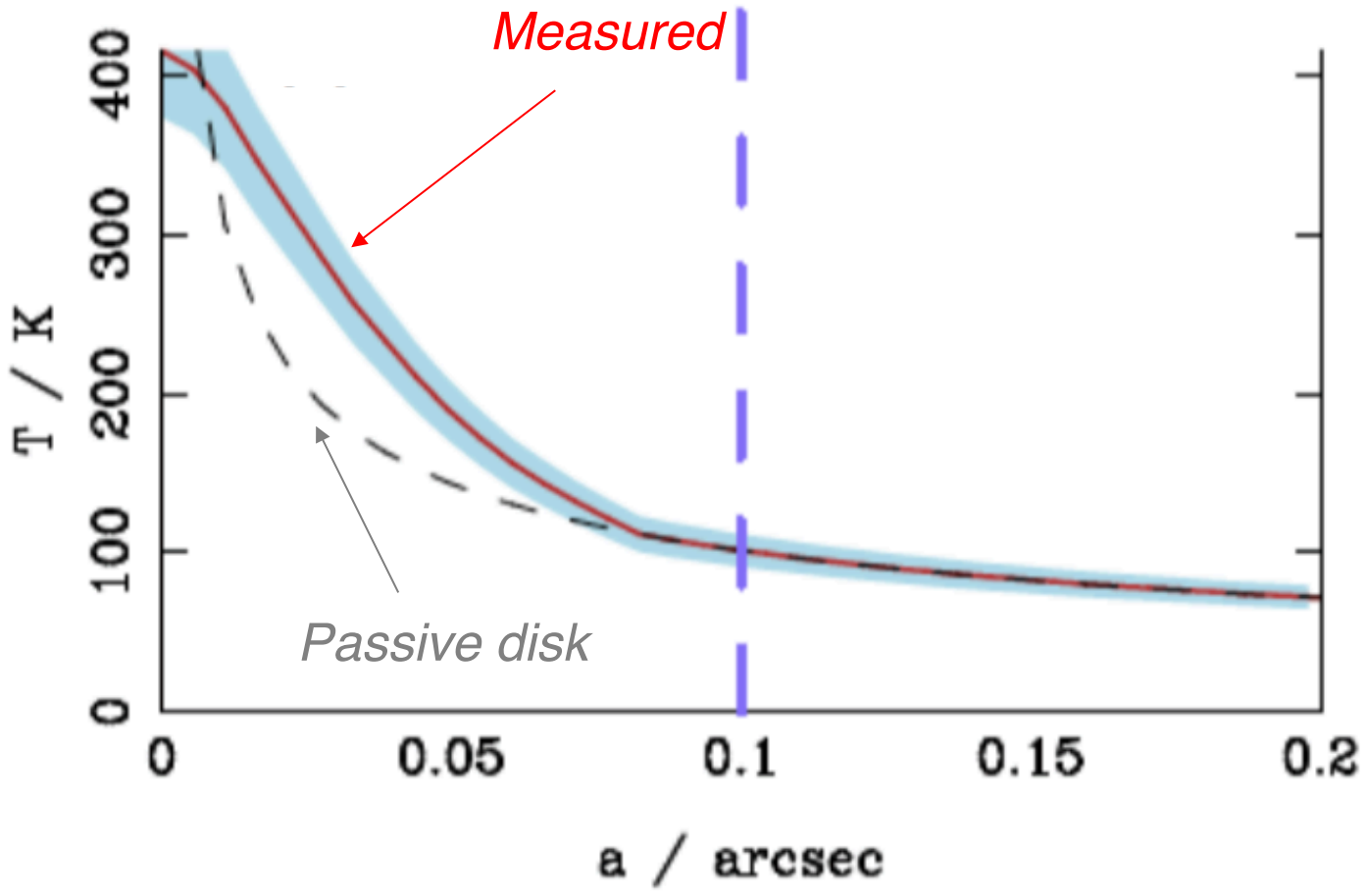
V883Ori





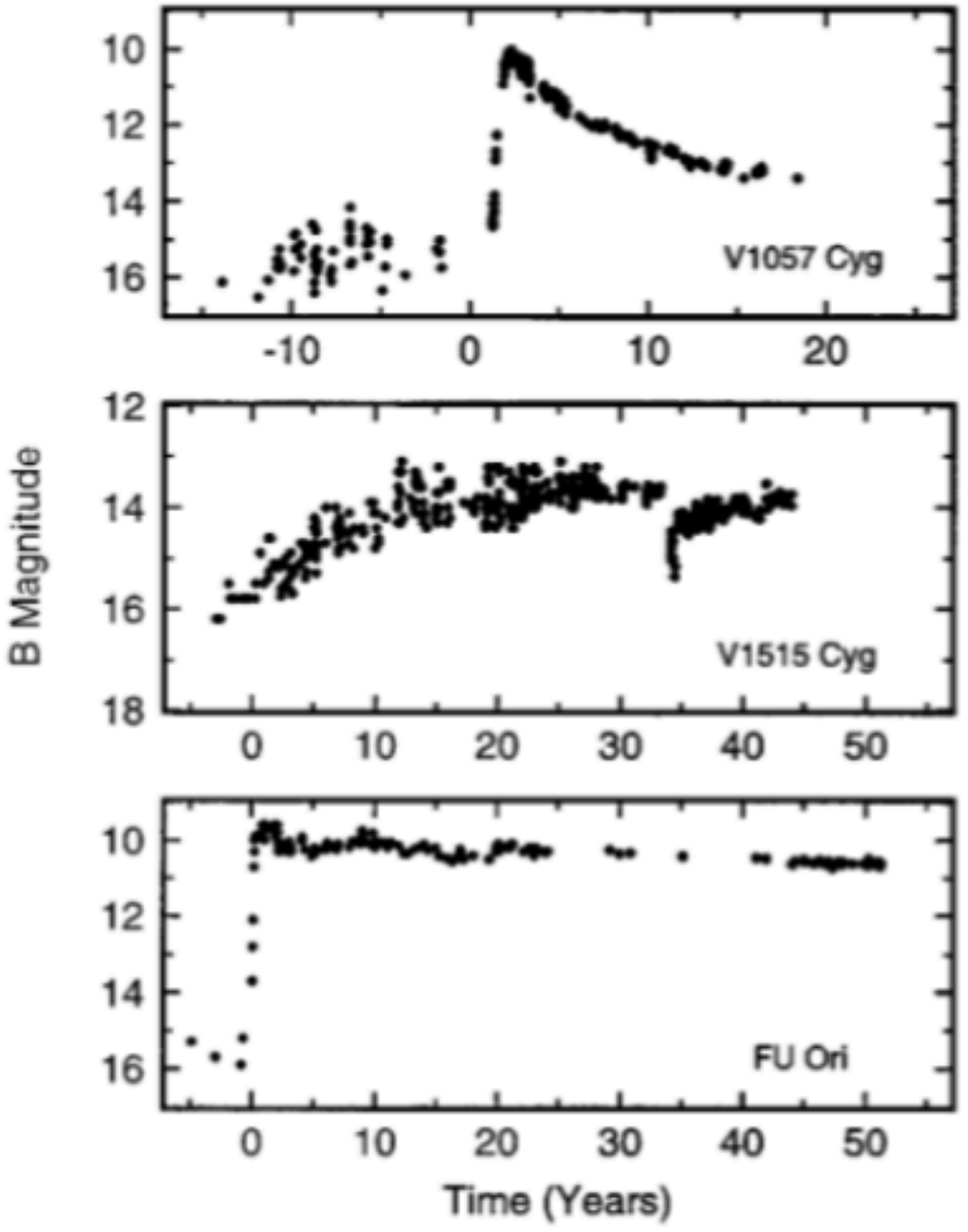
Cieza et al. (2016)

Extra source of heating needed

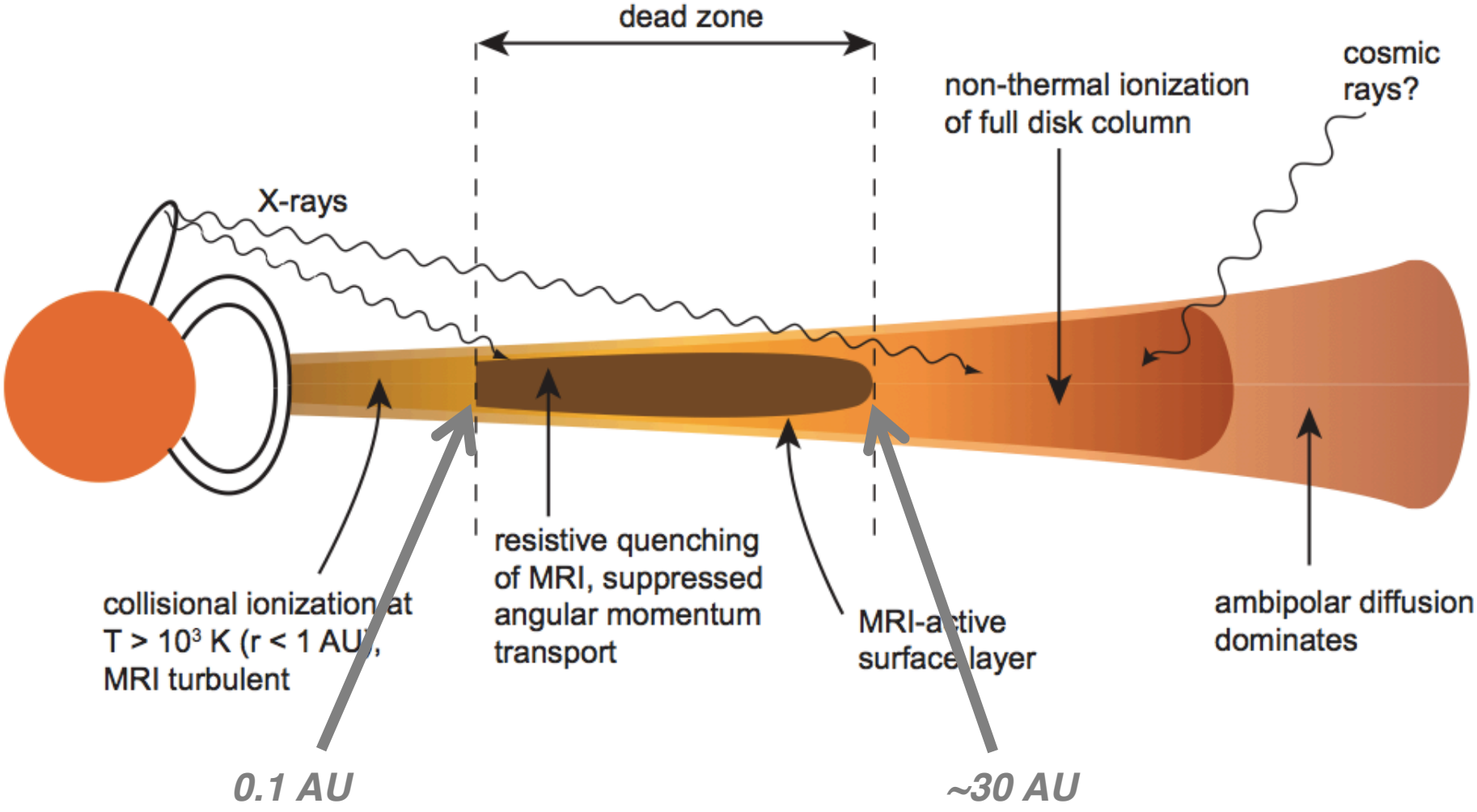


Cieza et al. (2016)

V883 Orionis is an FU Orionis star

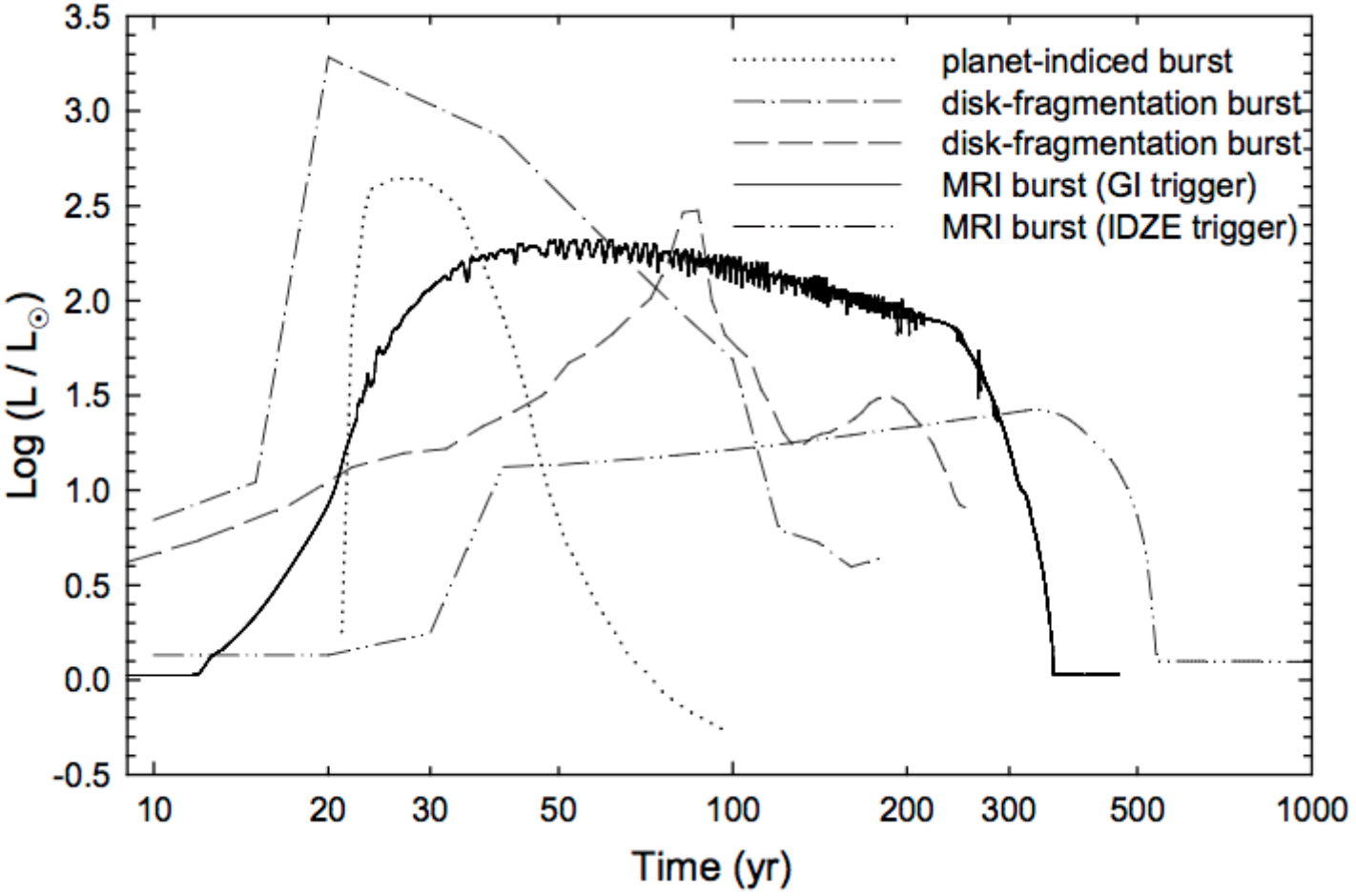


Episodic Accretion – Loading a dead zone



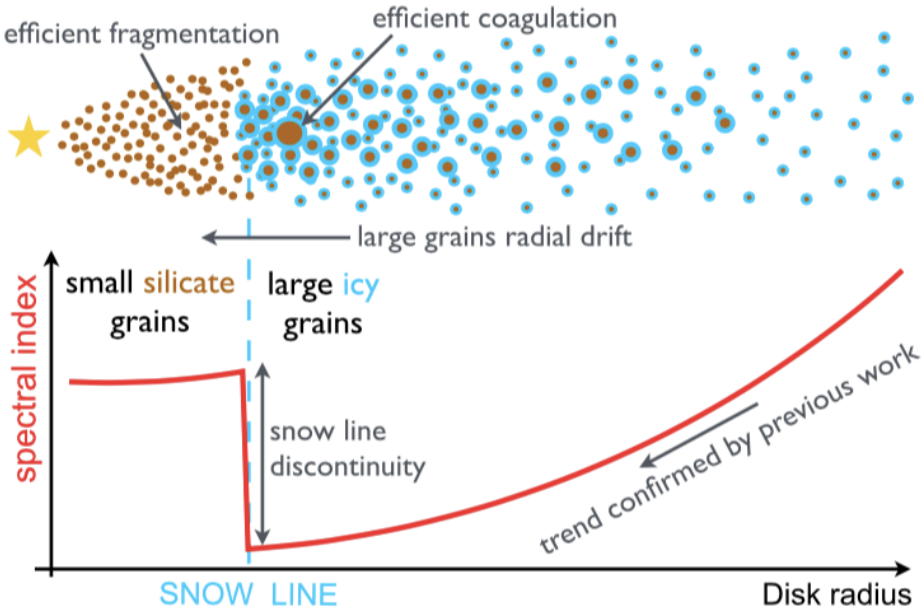
There should be a **magnetized, active zone**
and a **non-magnetic, dead zone**

Possible FU Ori triggers



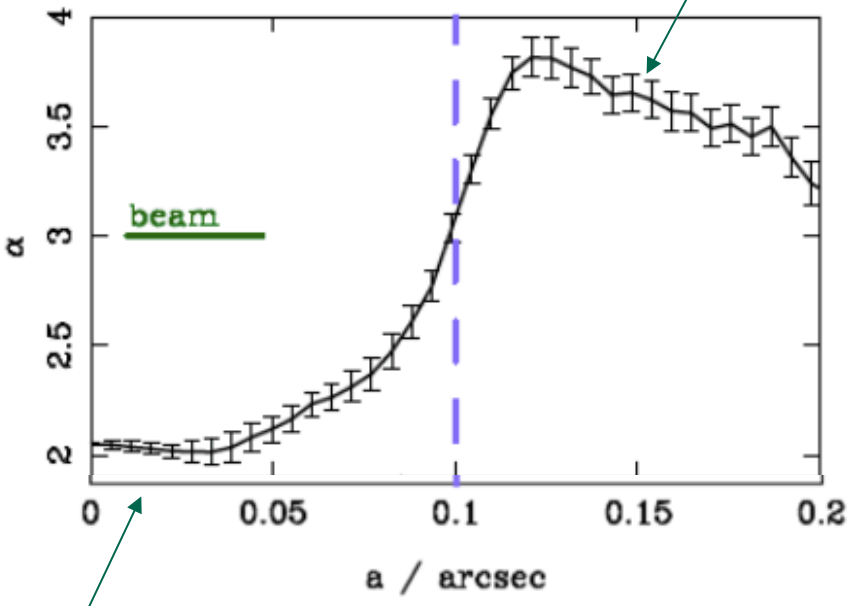
Audard et al. (2014)

Signature of a snowline: Spectral index



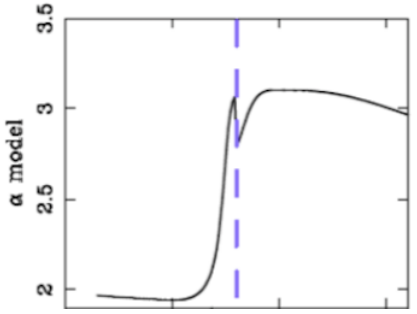
Banzatti et al. (2014)

Optically thin ISM-ilke values

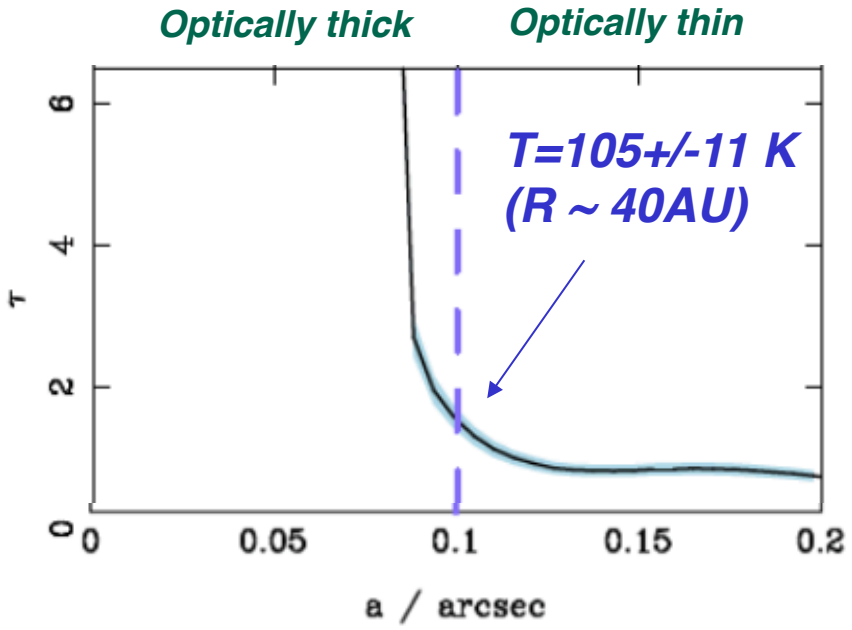


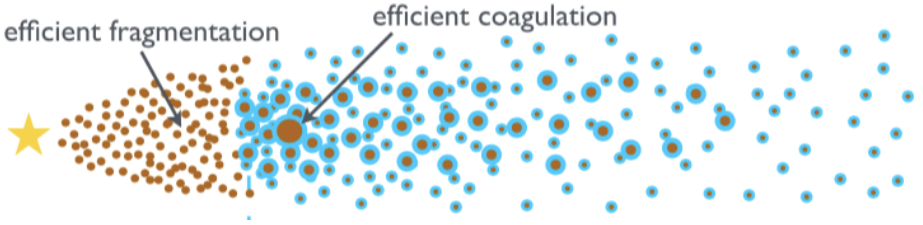
Optically thick blackbody emission

Cieza et al. (2016)



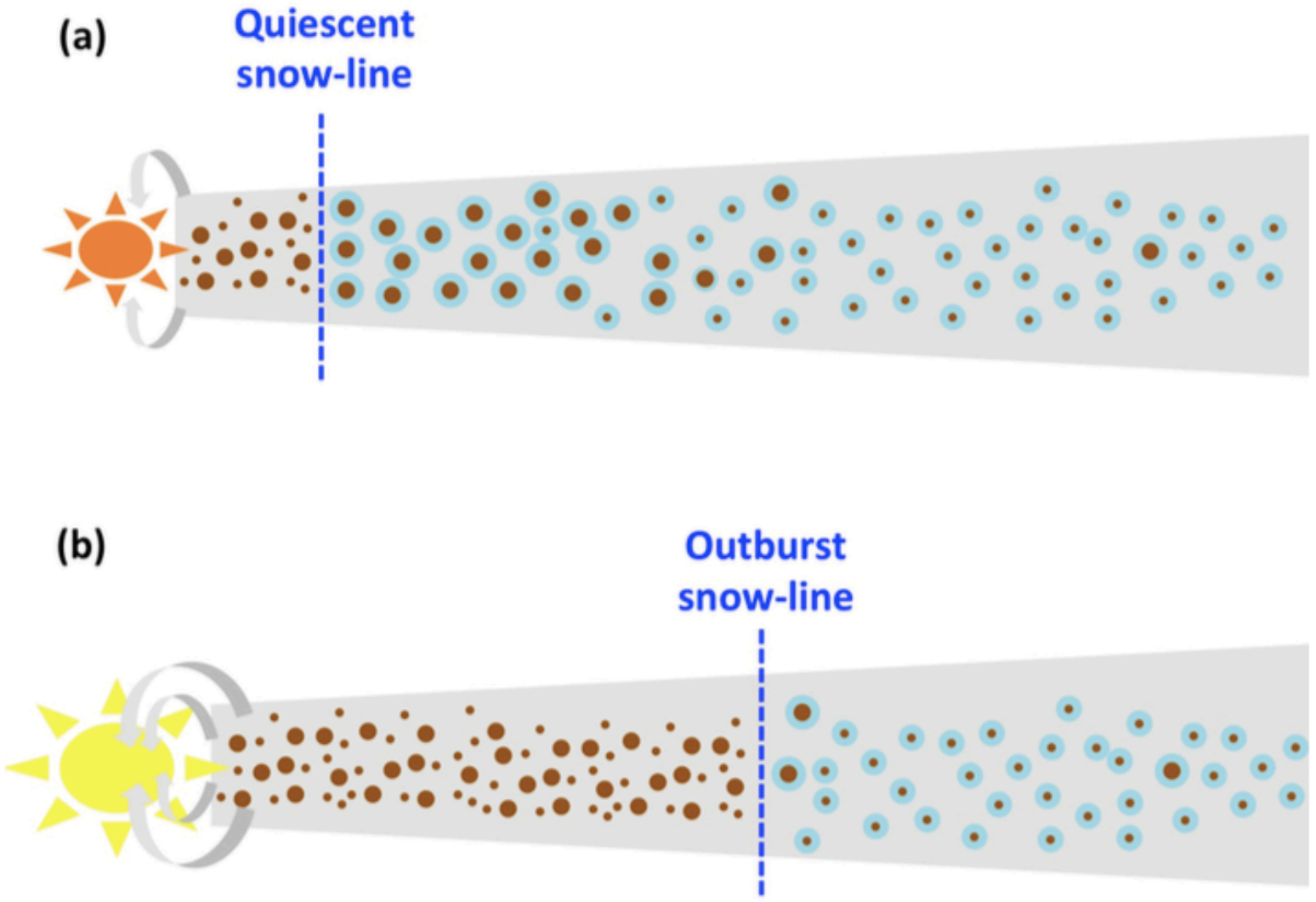
Signature of a snowline: Optical depth





Cieza et al. (2016)

Snowline pushed outward during outburst



Cieza et al. (2016)

The model

$$\Sigma = \Sigma_c \left(\frac{R}{R_c}\right)^{-\gamma} \exp\left[-\left(\frac{R}{R_c}\right)^{2-\gamma}\right]$$

$$q_{\rm irr} = \sigma_{\rm sb} T_{\rm irr}^4 = T_*^4 \left[\left(\frac{R_*}{r}\right)^2 H_h \left(\frac{dH}{dr} - \frac{H}{r}\right) + \frac{2}{3\pi^2}\left(\frac{R_*}{r}\right)^3\right]$$

Stellar heating

$$q_{\rm acc}^+ = \frac{3}{8\pi}\dot{M}\Omega_K^2 = \sigma_{\rm sb} T_{\rm acc}^4$$

$$\nu\Sigma = \frac{\dot{M}}{3\pi}$$

Viscous heating

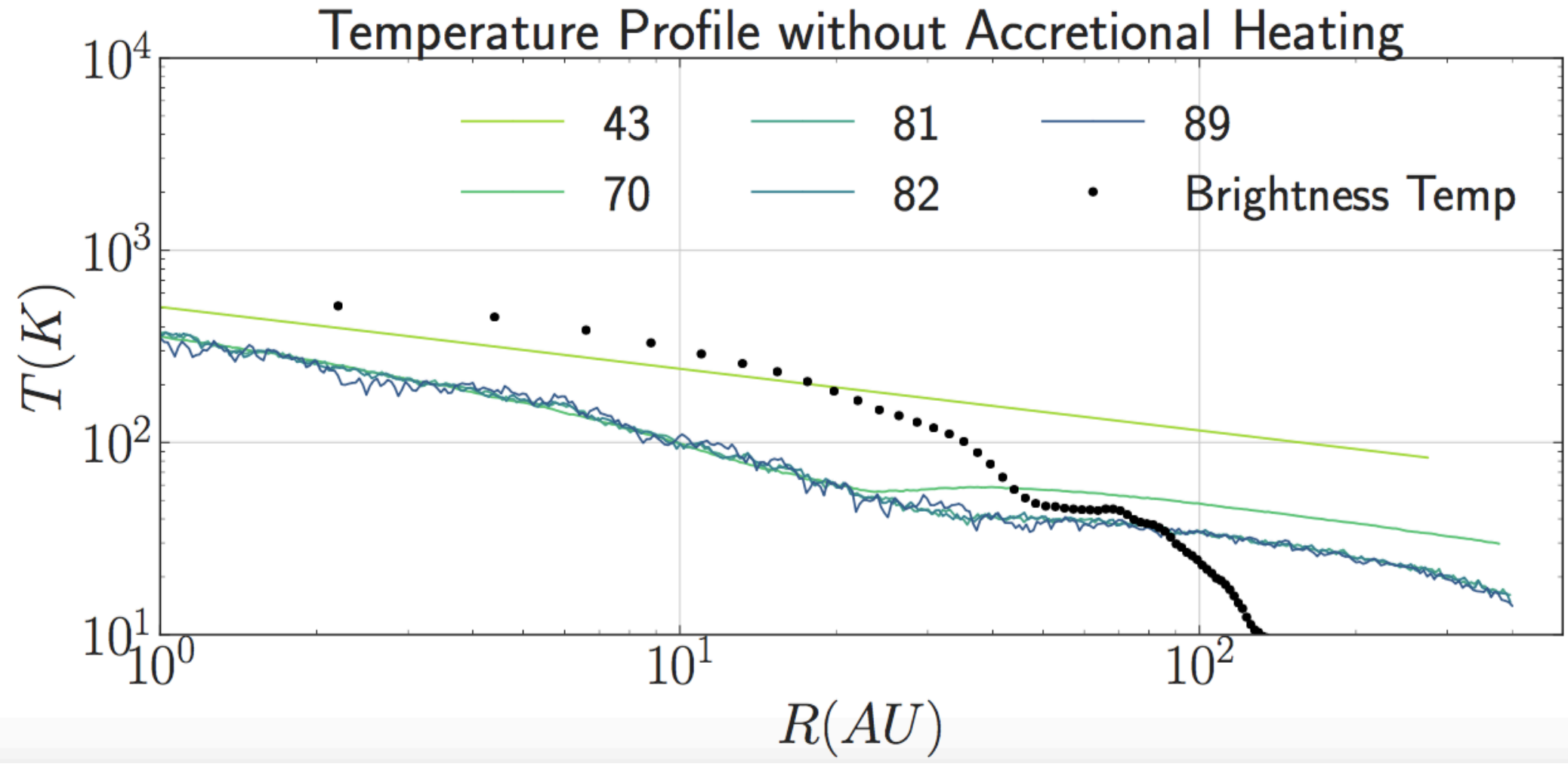
$$T_{\rm eff}^4 = T_{\rm irr}^4 + T_{\rm acc}^4$$

Effective temperature

$$T_{\rm mid}^4 = \frac{3}{4} T_{\rm acc}^4 \left(\tau_{\rm mid} + \frac{2}{3}\right) + \frac{T_{\rm irr}^4}{2}$$

Midplane temperature

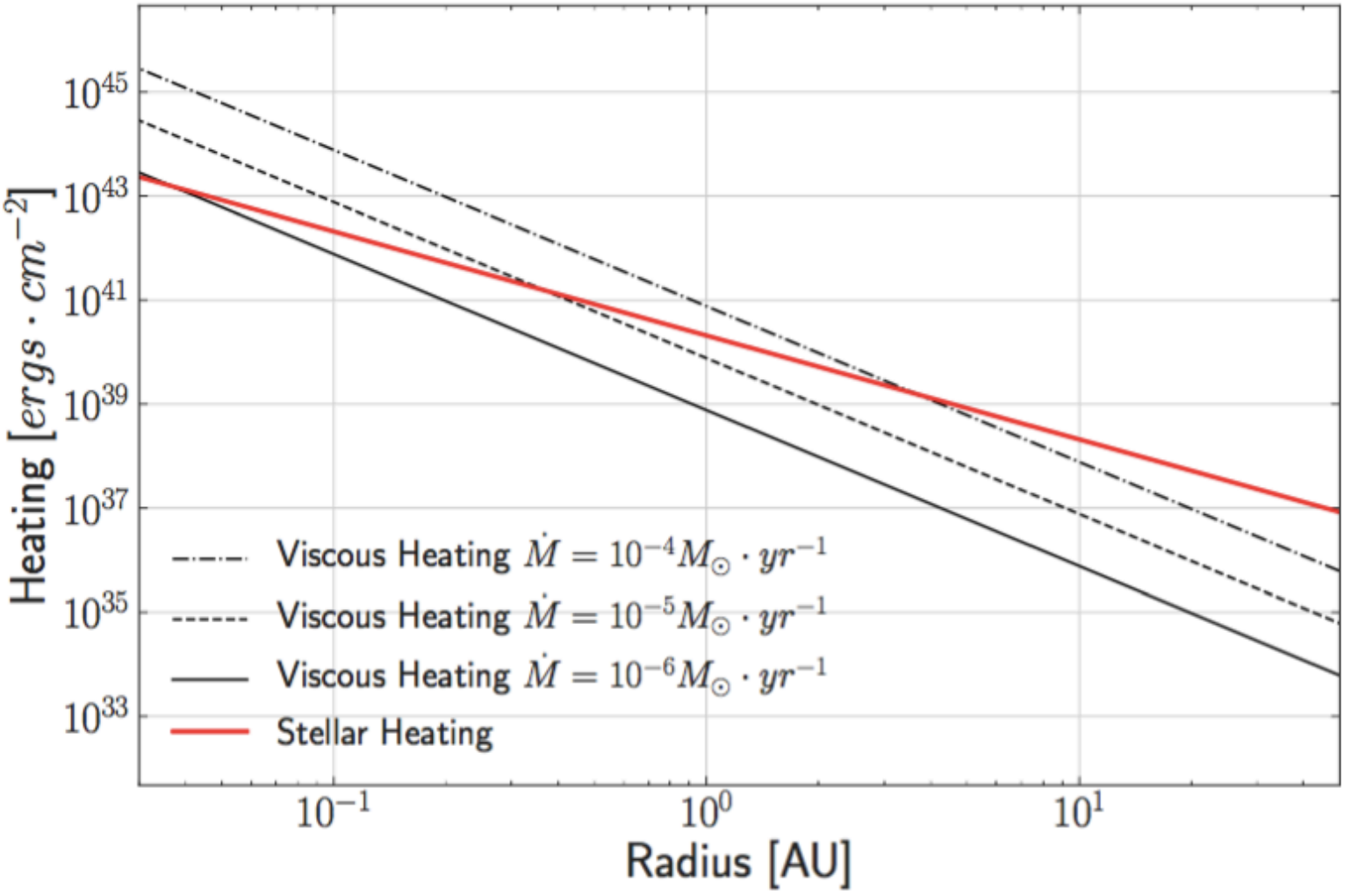
Chiang et al. (2001), Alarcon et al. (in prep)



Alarcon et al. (in prep)

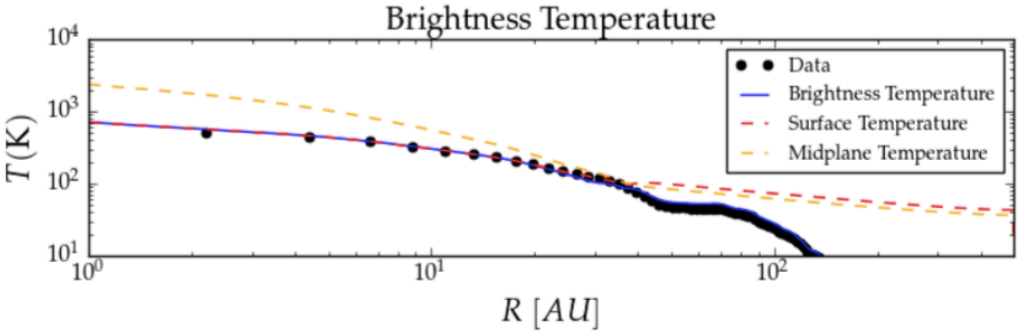
Viscous heating

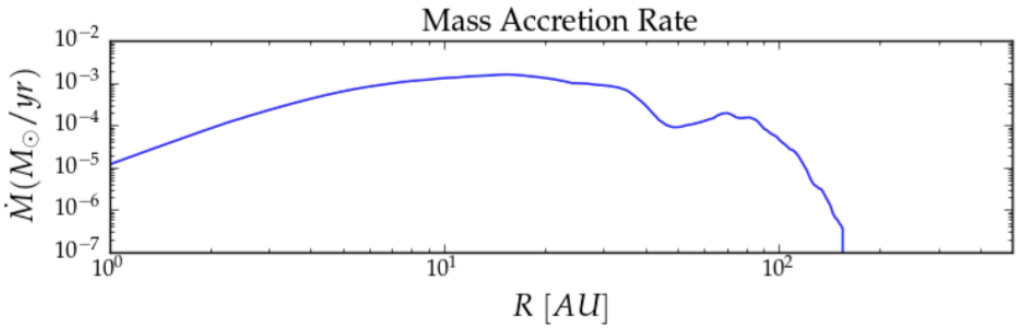
$$q^{+} = \frac{3}{8\pi}\dot{M}\Omega_K^2$$

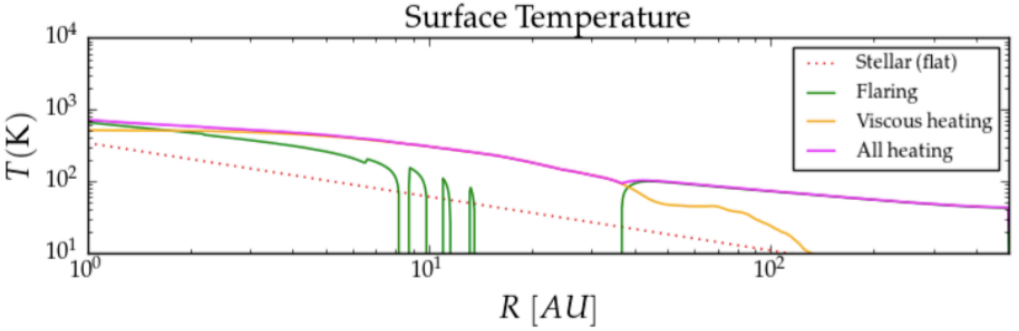


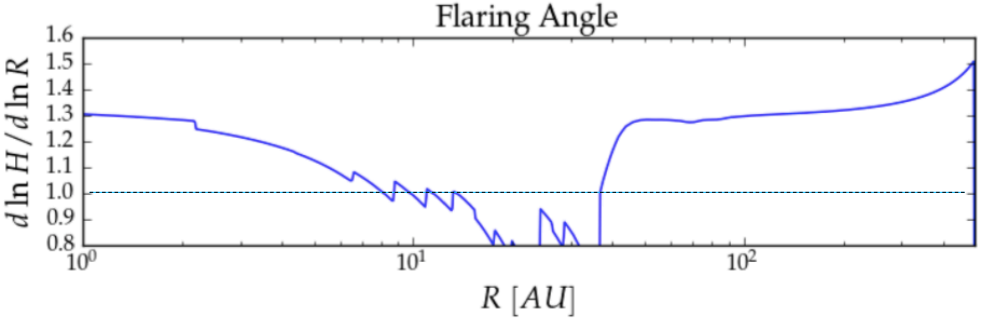
Alarcon et al. (in prep)

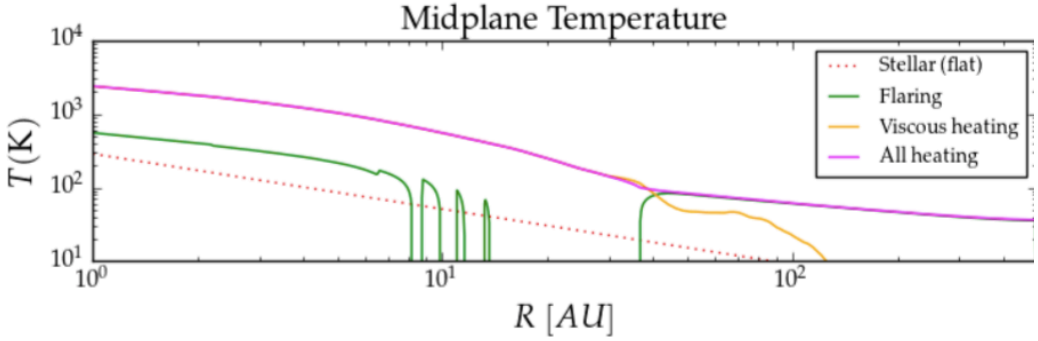
Best fit

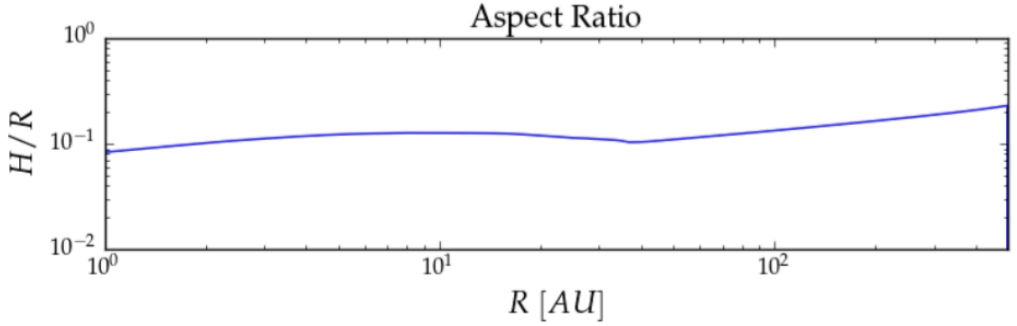






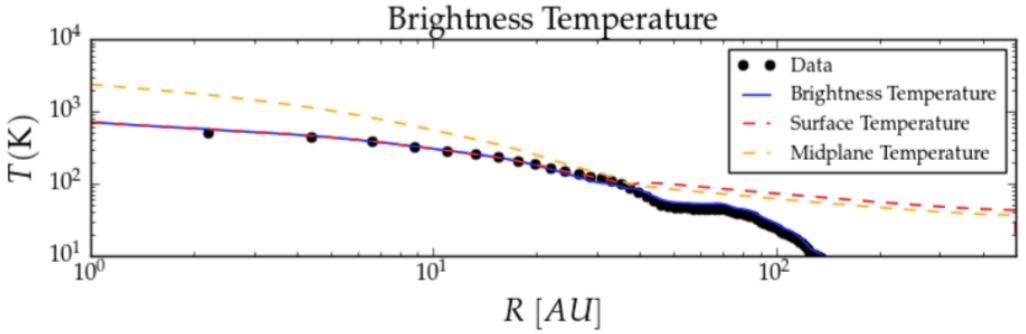


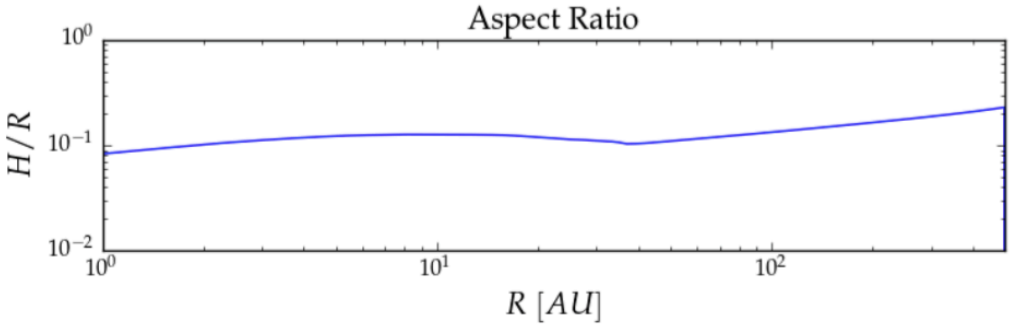


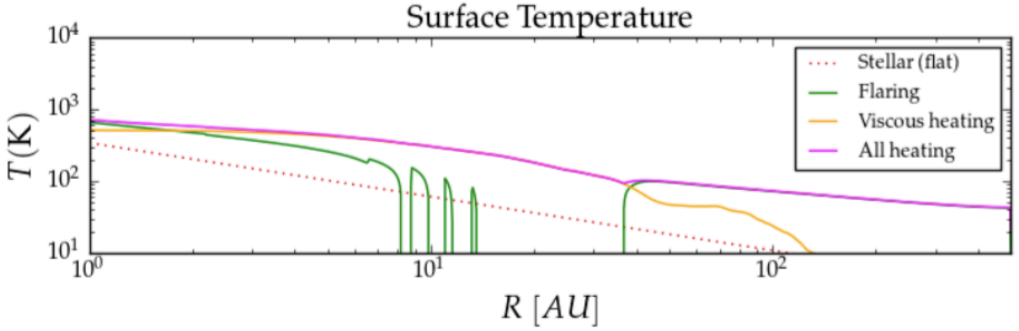


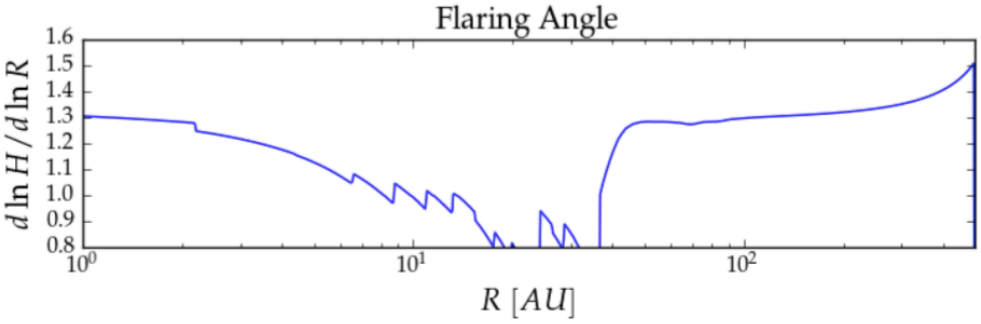
Alarcon et al. (in prep)

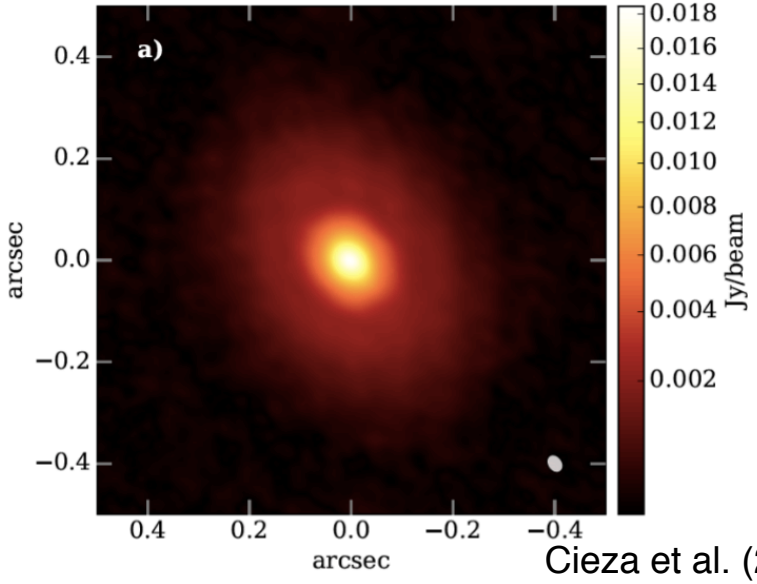
Self-shadowing

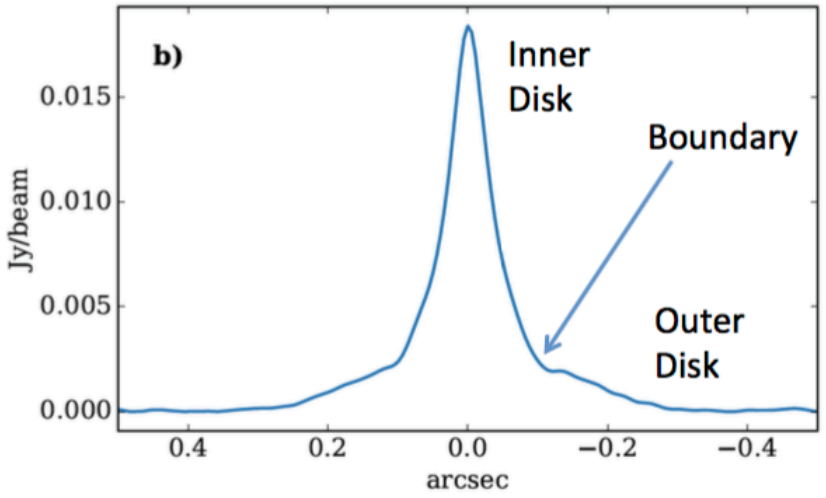












Cieza et al. (2016), Alarcon et al. (in prep)

Conclusions

- First water snowline observed;
- Brightness temperature needs active heating;
- Fit consistent with accretional inner disk, passive outer disk;
- Self-shadowing reproduced;
- Episodic accretion is powering V883 Ori !
    - *What is the mechanism???*
    - *Can we use it to study whatever is causing it?*
        - *Gravitational instability?*
        - *Magnetorotational instability?*
        - *Planet?*
        - *All of the above?*