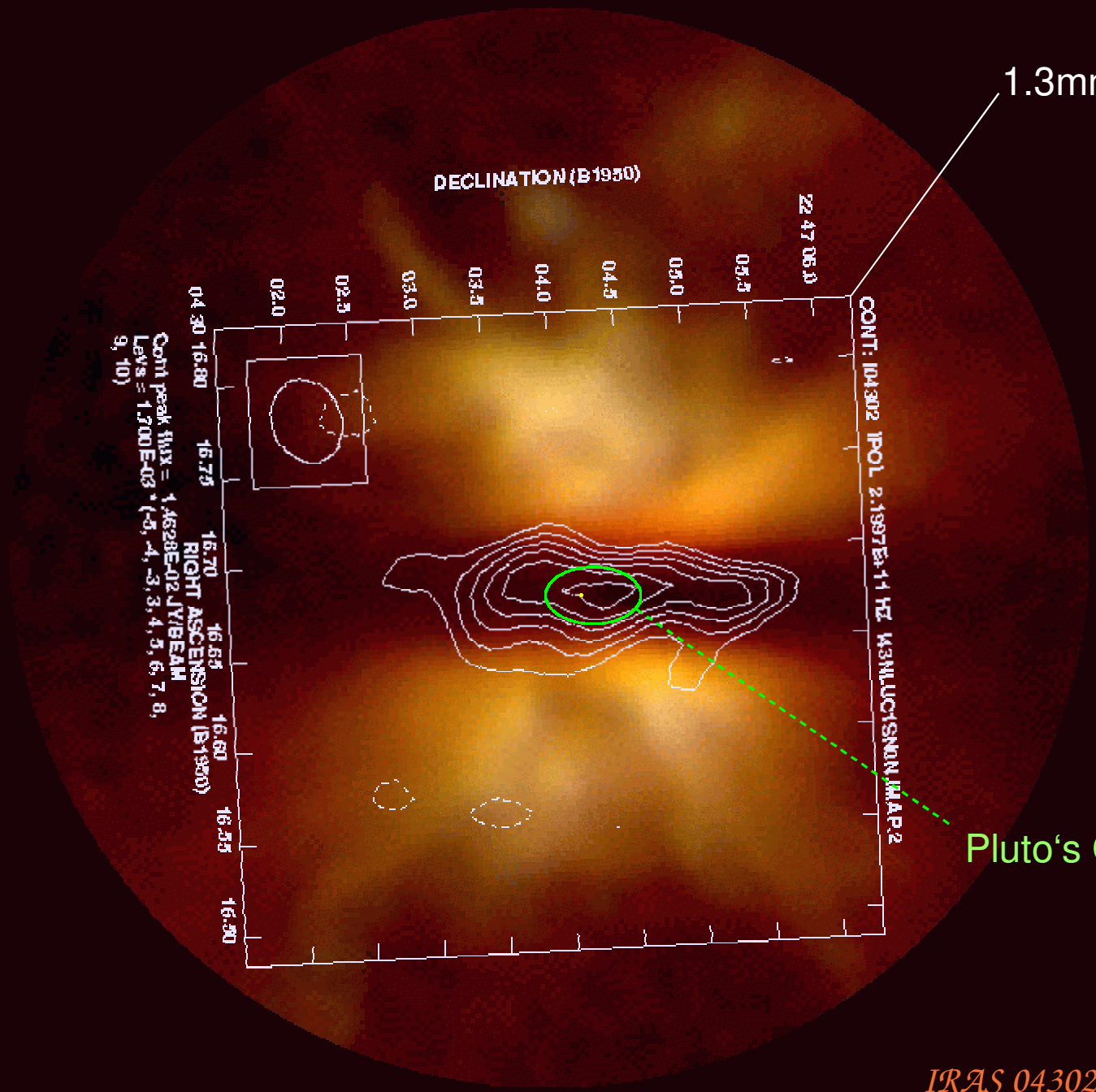
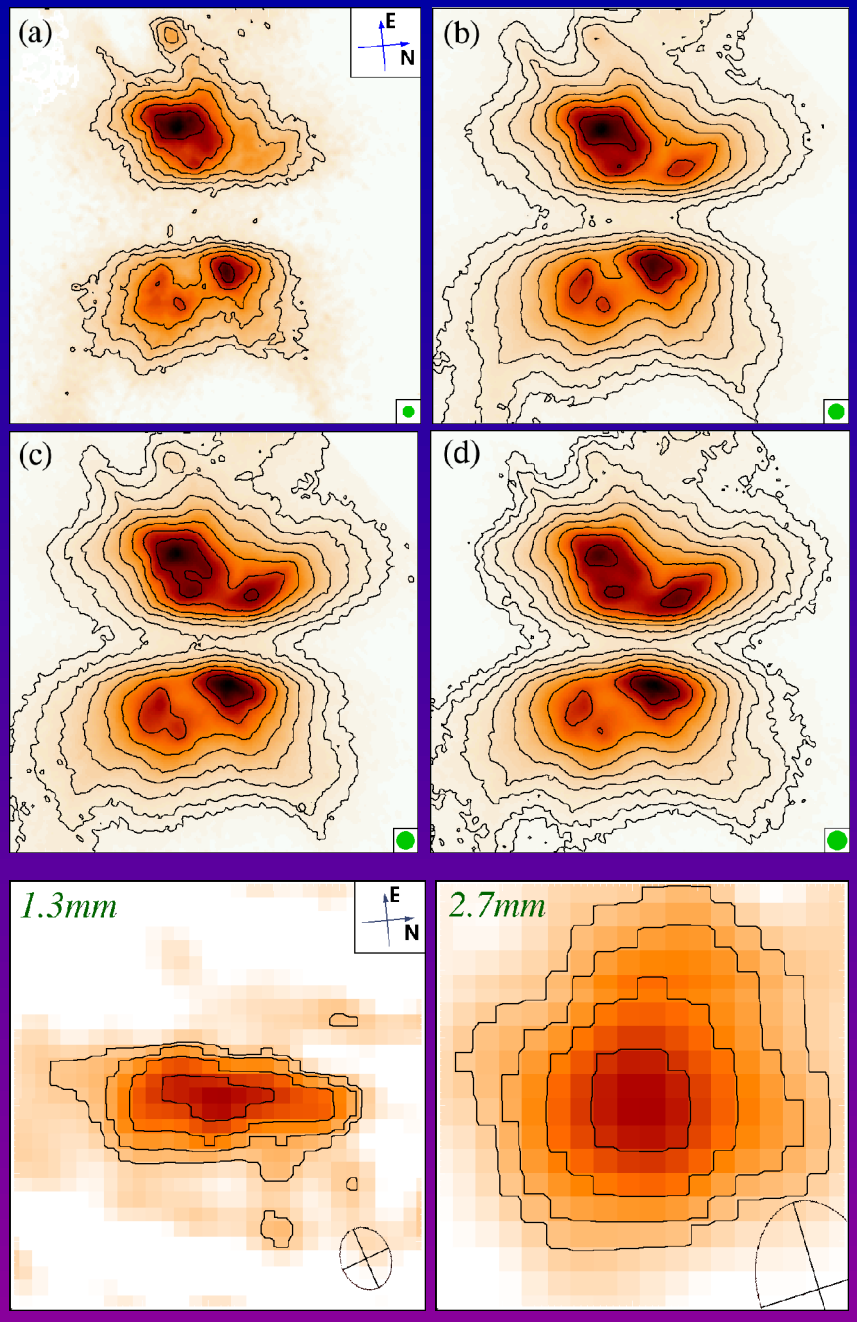

1.3mm map
DECLINATION (B1950)
22 47 06.0
05.5
05.0
04.5
04.0
03.5
03.0
02.5
02.0
CONT: I04302 IPOL 2.197E+11 HZ 43MLUCISNON.IMAP.2
04 30 16.80
16.75
16.70
16.65
16.60
16.55
16.50
RIGHT ASCENSION (B1950)
Pluto‘s Orbit
IRAS 04302+2247



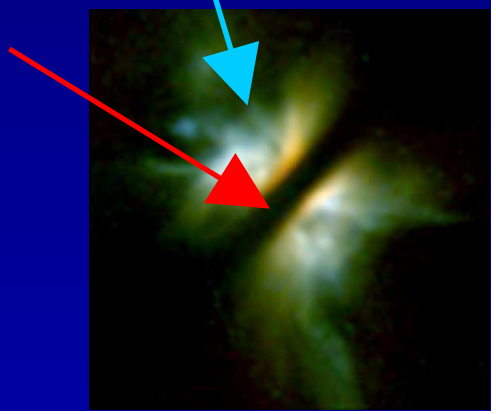
(Wolf, Padgett, & Stapelfeldt 2003)

„Butterfly Star" in Taurus

High-resolution near-infrared images (HST) +
Millimeter maps (OVRO)

First proof of
different grain growth scenarios
in the circumstellar envelope and disk:

1. Interstellar dust in the envelope
2. Dust grains with radii up to 0.1mm in the circumstellar disk



the model

Disk density profile:

Shakura & Sunyaev (1973)

$$\rho_{\rm disk} = \rho_0 \left(\frac{R_*}{\varpi}\right)^{\alpha} \exp\left\{-\frac{1}{2}\left[\frac{z}{h(\varpi)}\right]^2\right\}$$

Disk scale height: $h = h_0 \left(\frac{\varpi}{R_*}\right)^{\beta}$

Envelope structure:

Resulting from mass infall
under consideration of envelope rotation

(Ulrich 1976)

$$\rho_{\rm env} = \frac{\dot{M}}{4\pi}\left(GM_* r^3\right)^{-1/2}\left(1+\frac{\mu}{\mu_0}\right)^{-1/2}\left(\frac{\mu}{\mu_0}+2\mu_0\frac{r_{\rm c}}{r}\right)^{-1}$$

the model

- **Heating sources**
  - **Star:**
    - L_{bol} = 0.34 L_{sun} *(Padgett et al. 1999)*
    - R_* = 2R_{sun}, T_* = 4000 K *(Gullbring 1998)*
    - → L_* = 0.92 L_{sun} *(„flashlight effect“ - Yorke & Bodenheimer 1993)*
  - **Accretion luminosity**

    (Lynden-Bell & Pringle 1974)

$$dL_{\rm acc} = \frac{3}{4\pi}\frac{GM_*\dot{M}}{\varpi^3}\left[1-\left(\frac{R_*}{\varpi}\right)^{1/2}\right]dA$$

$$\dot{M} = \sqrt{18\pi^3}\alpha_{\rm visc} v_{\rm c}\rho_0\frac{h_0^3}{R_*} \qquad v_{\rm c} = \sqrt{\frac{GM_*}{R_*}}$$

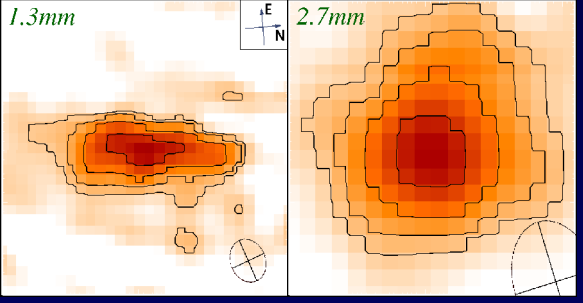
  - M_* = M_{sun}/2 *(Gullbring 1998)*
  - α_{visc} = 10^{-2} *(Hartmann et al. 1998)*

the model

- **Dust Properties:**
  - Homogeneous spheres
  - Grain size distribution:

$$n(a) \propto a^{-3.5}, \qquad a_{\min} < a < a_{\max}$$

  - Chemical Composition *(Weingartner & Draine 2001)*
    - Astr. Silicate: 62.5%
    - Graphite: 25% ($\epsilon_{\perp}$) + 12.5% ($\epsilon_{\parallel}$)



mm maps = disk reemission

Criteria / Parameters for comparison

1. Net flux
2. Peak flux
3. Spatial brightness distribution

→ **6 (almost) independent parameters**

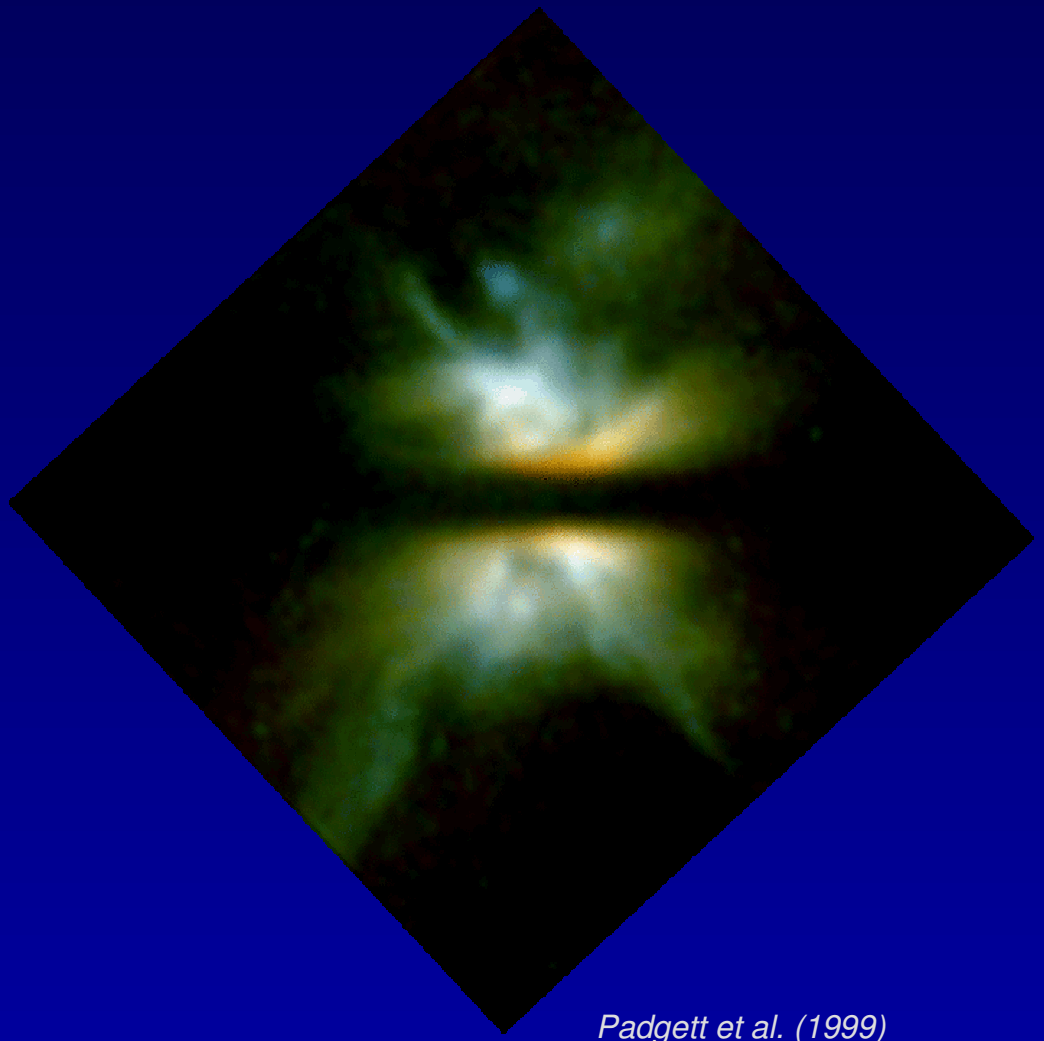
Disk outer radius:
300 AU

Radial/Vertical density profile:
α=2.37, β=1.29

Disk scale height:
h(100AU) = 15AU

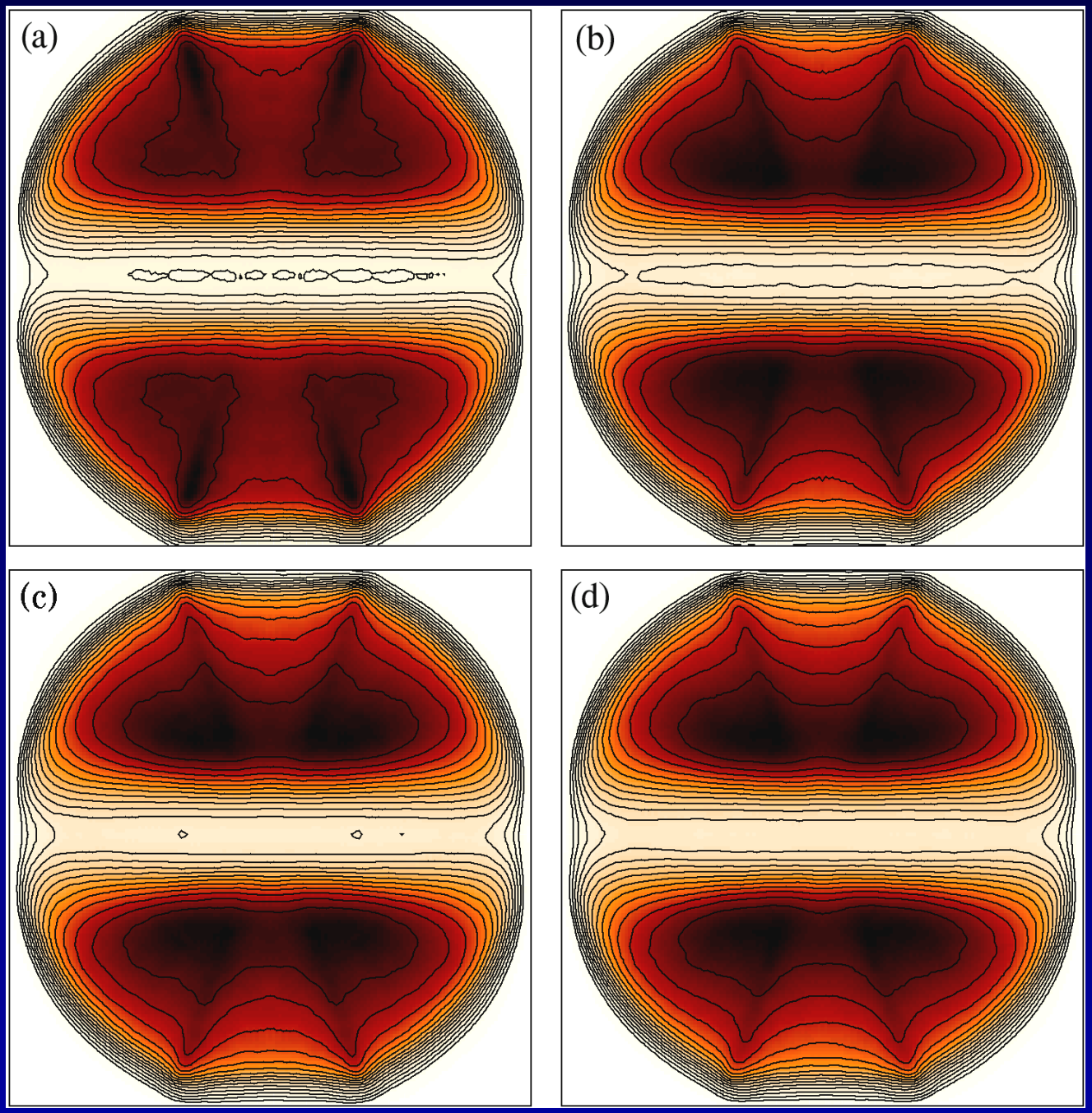
Grain size distribution:
a_{Grain} = (0.005 – 100) μm

simulation setup: near-IR images



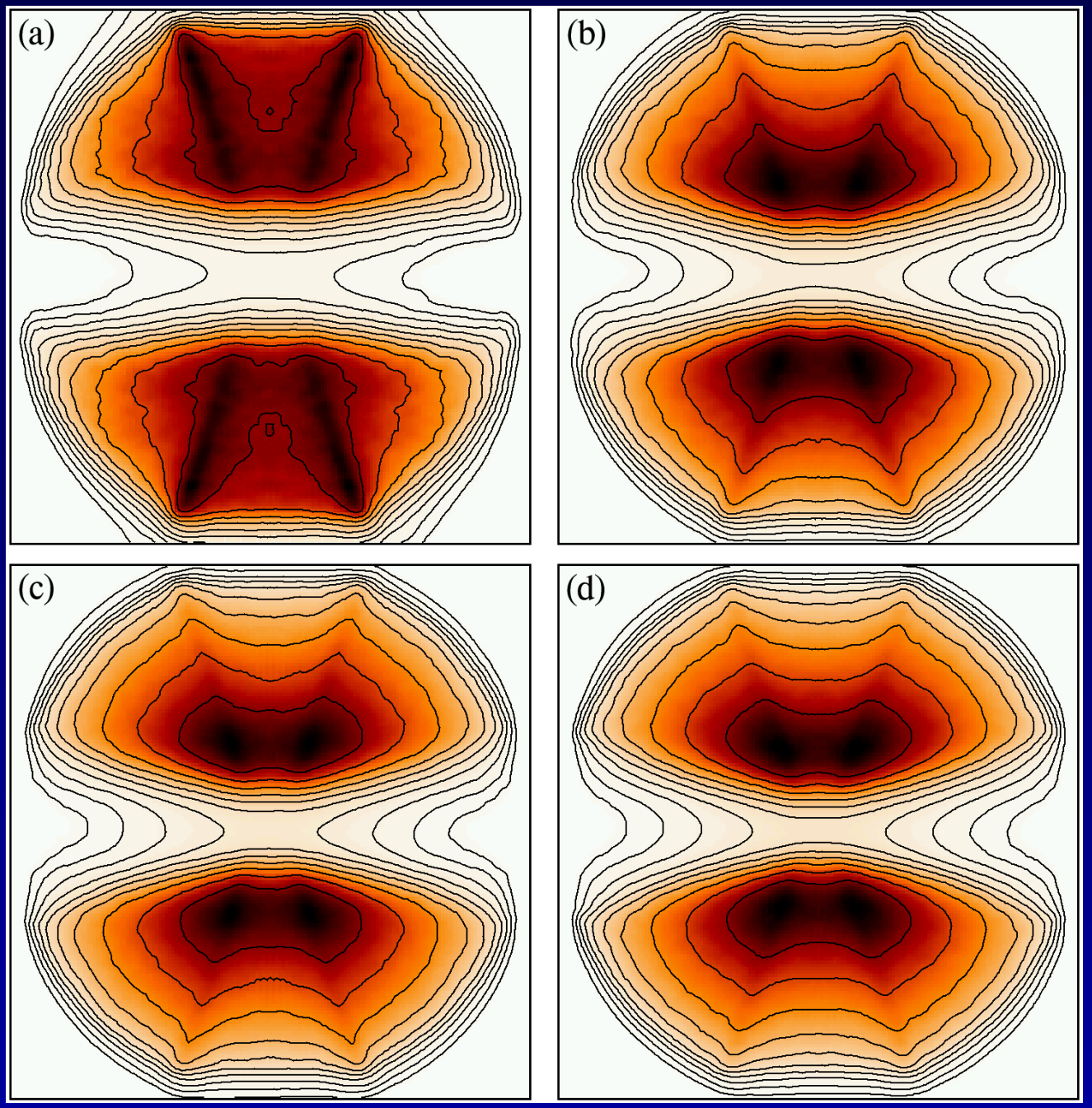
Padgett et al. (1999)

- Wavelength-dependence of the dust lane width
- Relative change of the brightness distribution from 1.1μm-2.05μm
- Slight symmetry of the brightest spots



Large grains in Disk + Envelope

600 AU x 600 AU



Disk:

large grains

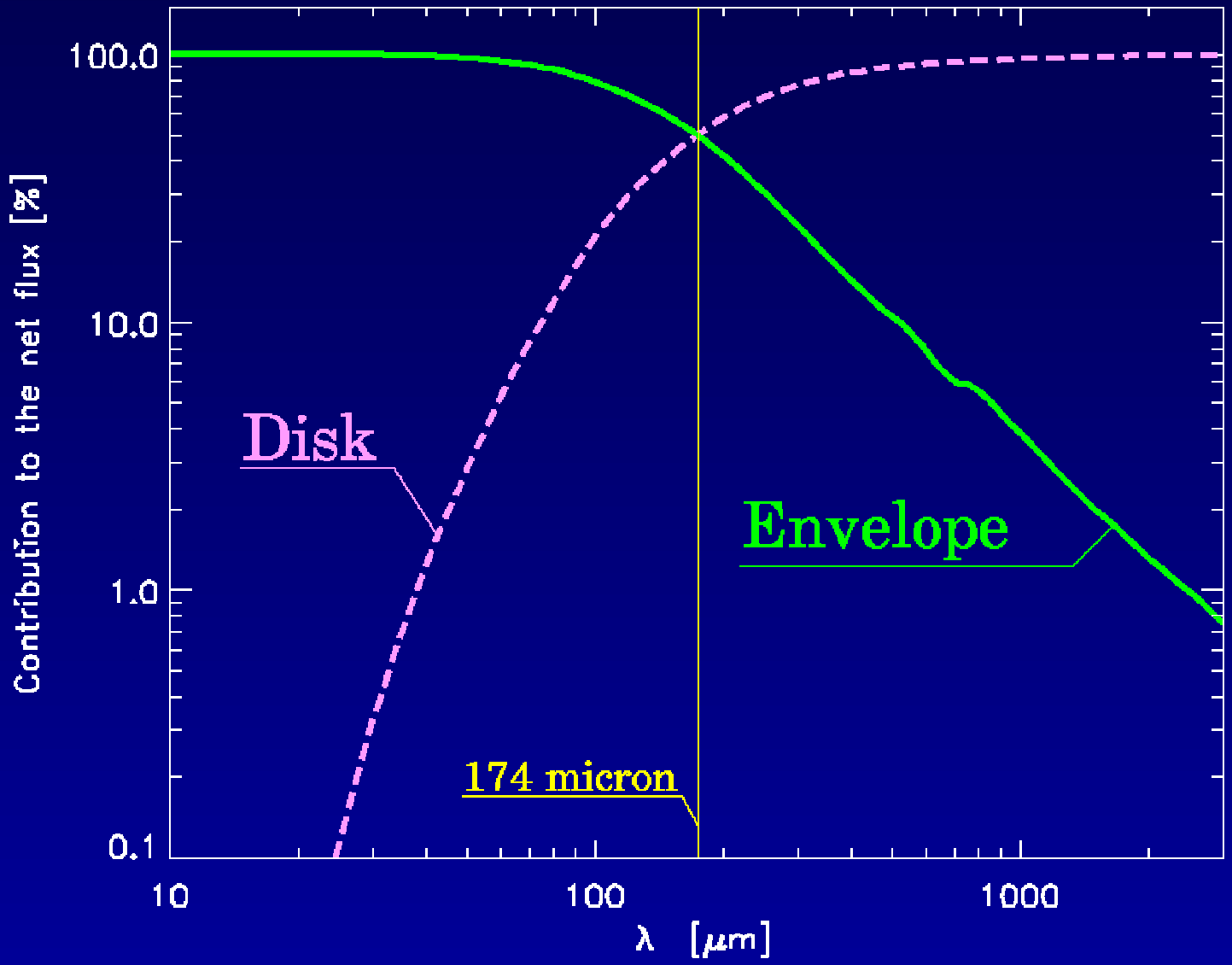
Envelope:

small grains

600 AU x 600 AU

mid-IR - mm SED: Comparison

Contributions to the SED



Conclusions

Different dust evolutionary scenarious
in the dense circumstellar disk
and the circumstellar envelope:

Grain growth results in
submm-sized grains in the disk midplane,
while the grain size in the circumstellar envelope is much more similar
to the interstellar medium grains.