Sublimation Ring of HD45677

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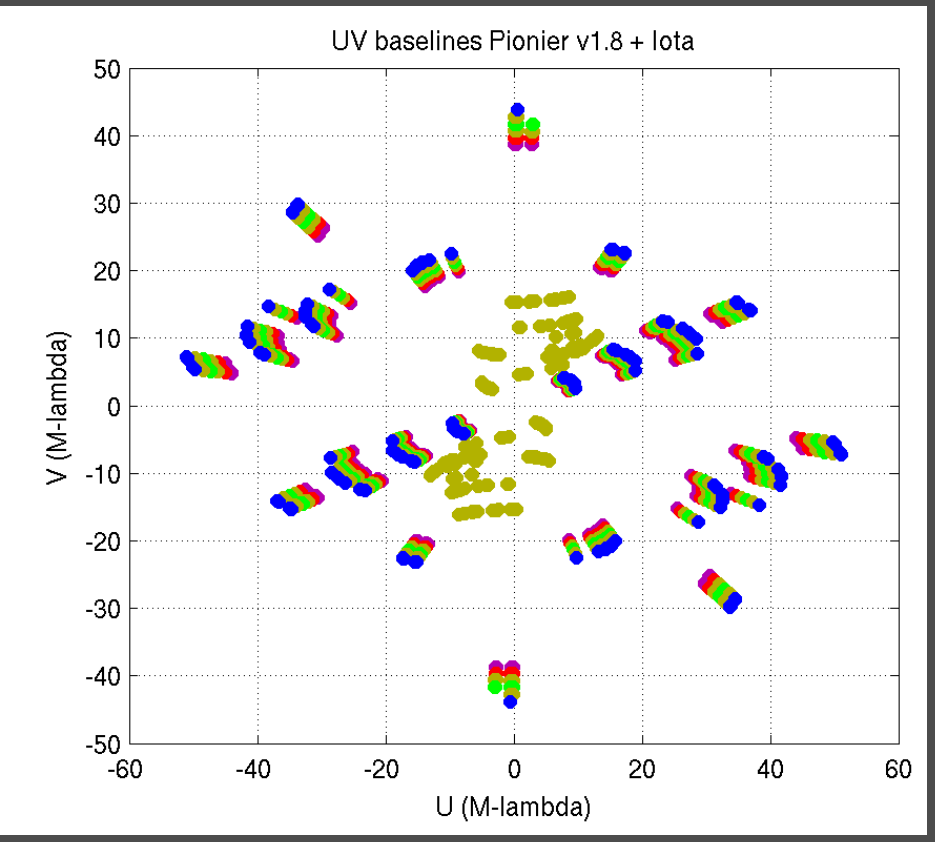
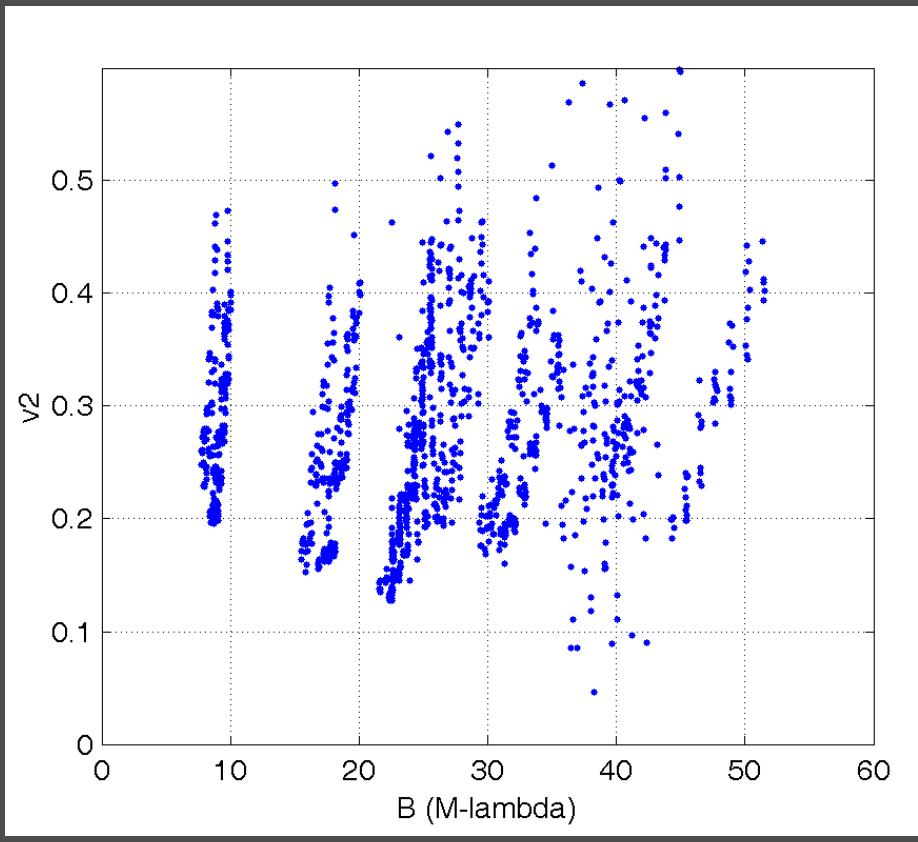
Multi-Wavelength Interferometry – Pionier 1.55-1.8µm

- Benefits and challenges...
- Extended UV coverage
- But... B(x,y,ν) = b(x,y) x f(ν) ?? NO

- **Dominant pattern is unrelated to spatial structure**





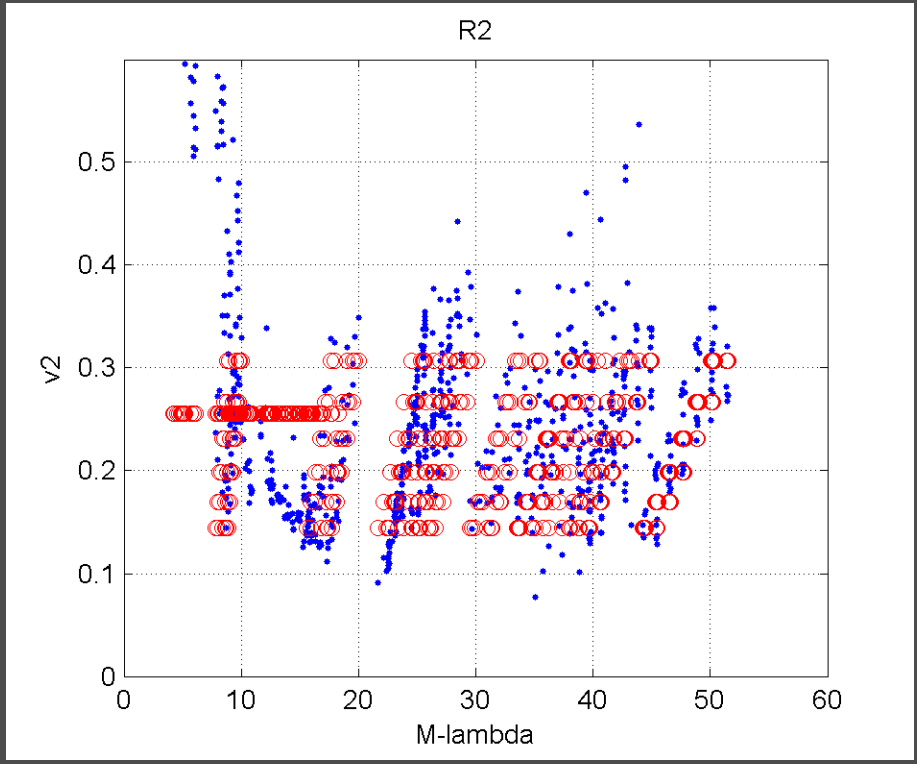
Adopted approach

- **Parametric model fitting (no existing imaging package can cope with non-grey case)**
- **Complexify model step by step**
- **Model fitting is done directly in UV plane**
- **Fully analytic model for visibilities**

1: Dilution with different spectral indices

$$V = 1 \times (\nu / \nu_0)^2 / (1 \times (\nu / \nu_0)^2 + r_{flux} \times (\nu / \nu_0)^{\kappa})$$

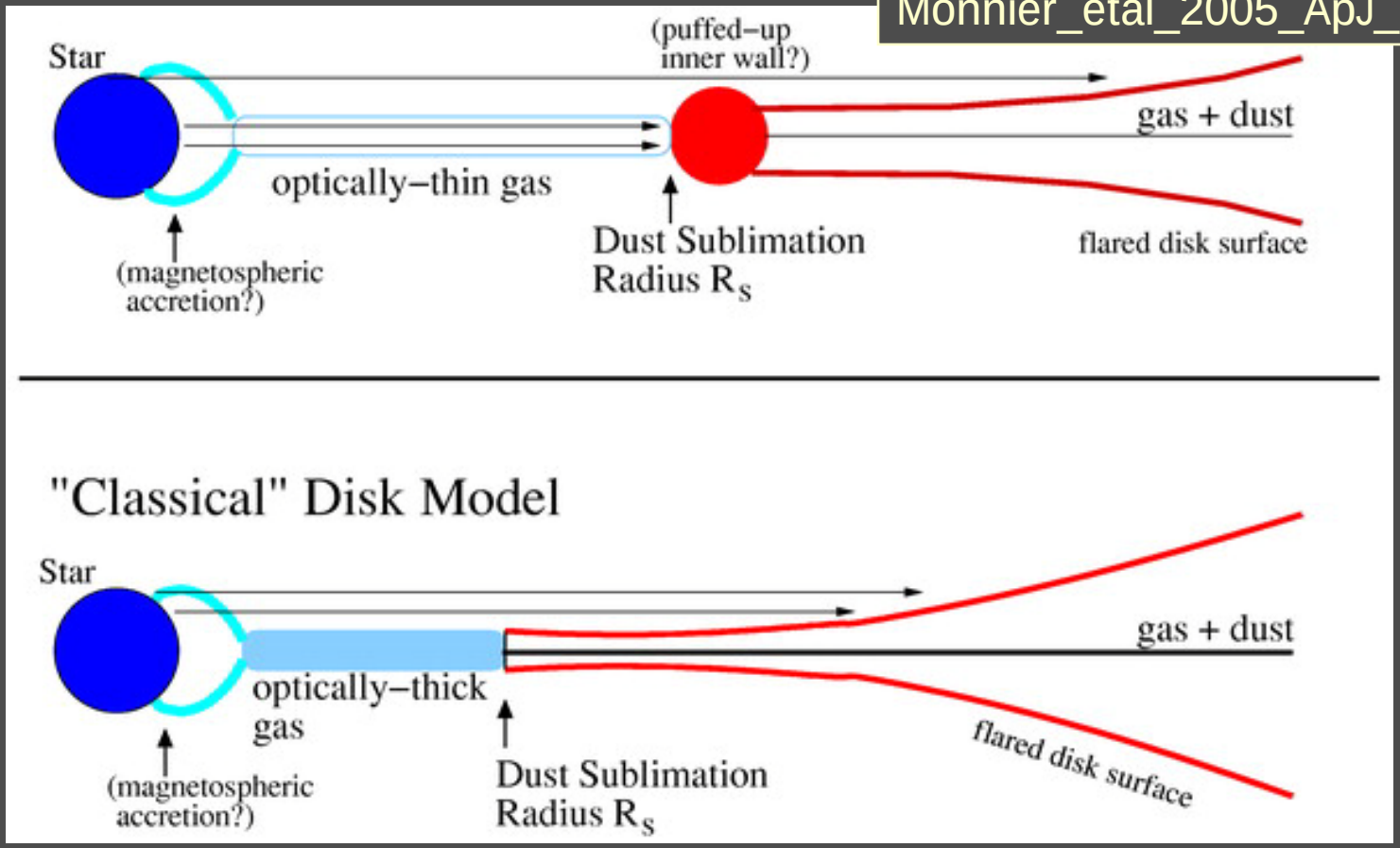
- **Two components with different spectral indices κ**
- **Star κ_S =+2 (RJ régime)**
- **Nebula κ_N (free parameter)**
- **Reproduces "commas" with NO spatial structure in model**



Spatial structure: why a ring?

- **Circumstellar matter settles into disk**
- **Stellar radiation zaps grains out to sublimation radius**
- **➔ bright inner ring**

Monnier_etal_2005_ApJ_624



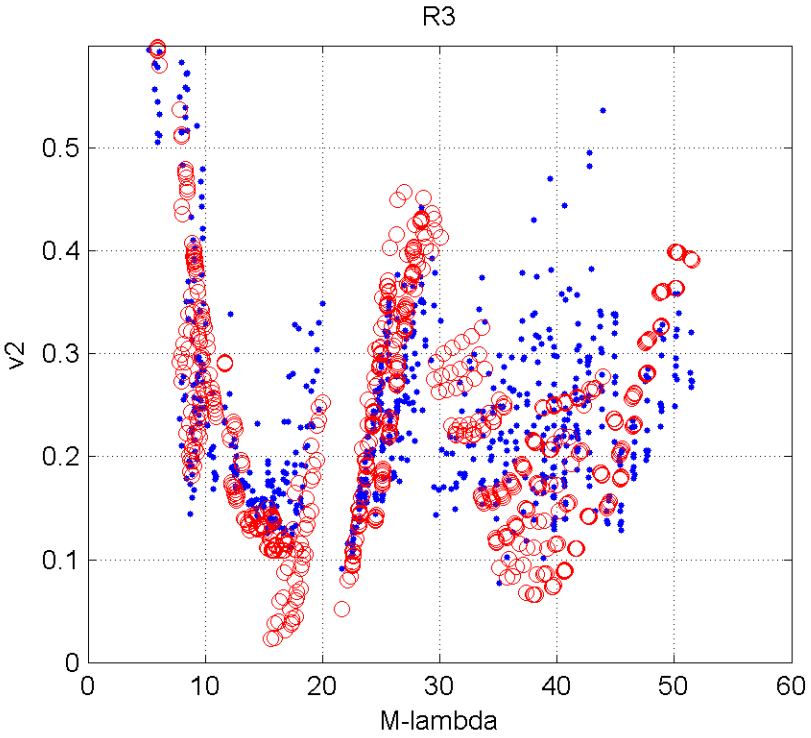
2: Analytic model for bright rim

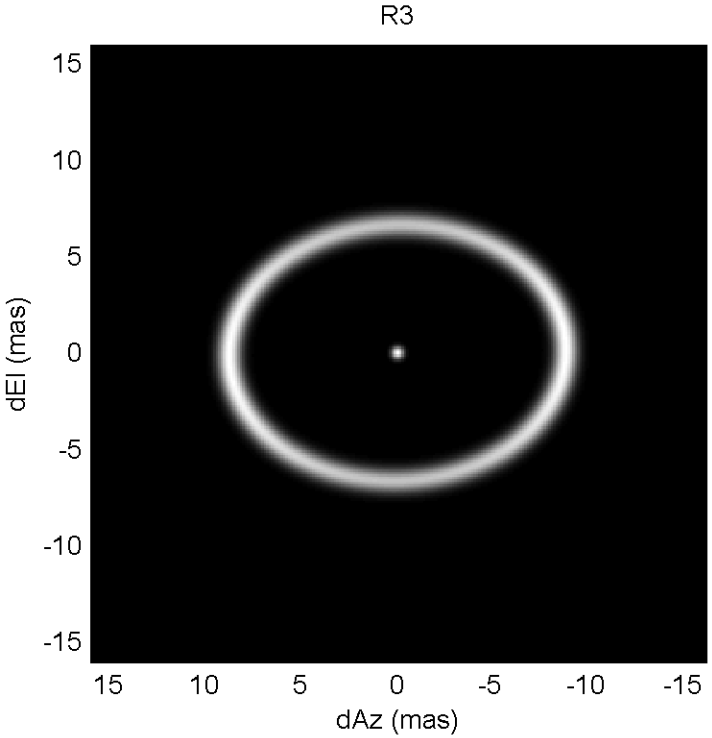
$$V_{neb}(u,v) = J_0(2\pi a\sqrt{u_c{}^2 + v_c{}^2})$$

$$u_c = u_r \quad v_c = v_r \times (b/a)$$

$$\begin{pmatrix} u_r \\ v_r \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \cdot \begin{pmatrix} u \\ v \end{pmatrix}$$

- **Circular ring**
- **Squeeze**
- **Rotate**





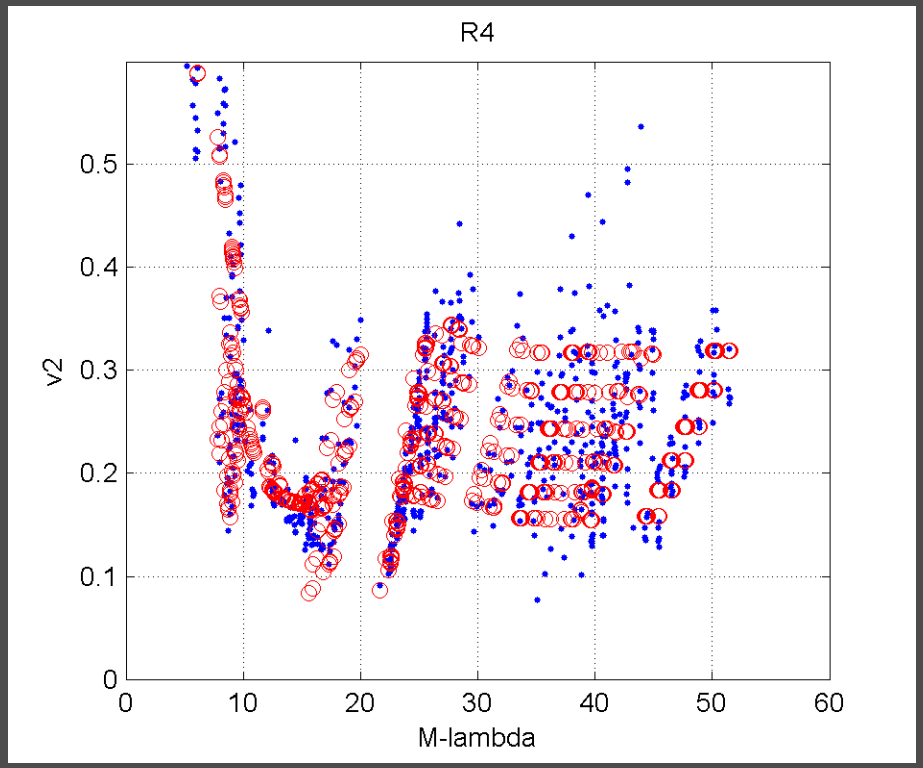
3: Put some flesh on the skeleton

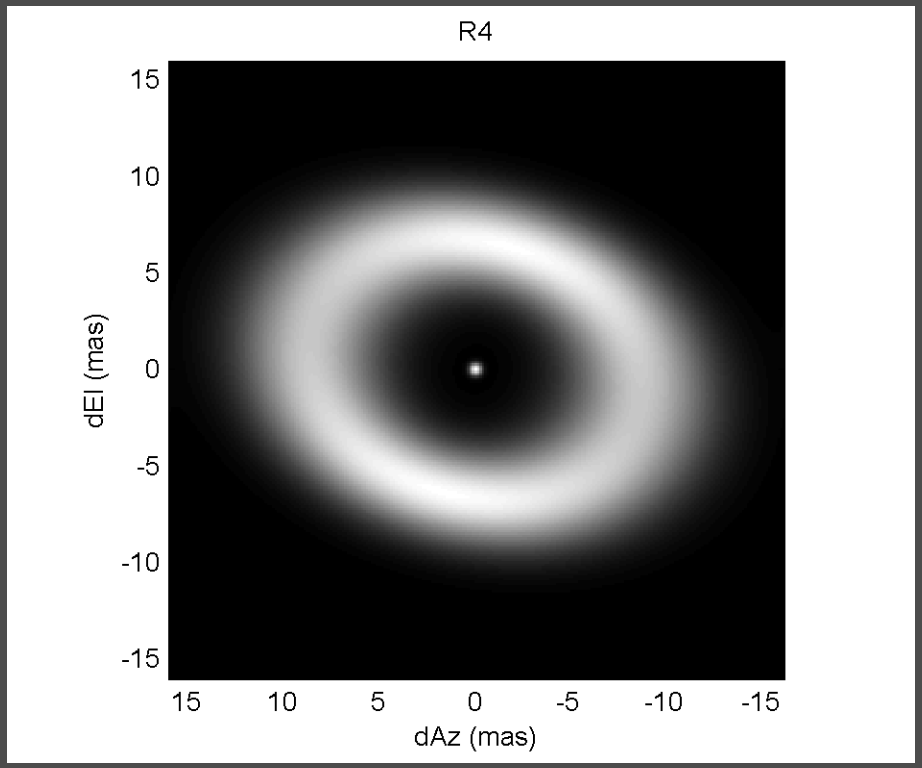
- **Convolve by gaussian**

$$V_{neb}(u,v) = V_{neb}(u,v) \times \exp\left[-\frac{\pi^2}{4\,Ln(2)} \left((a_g\, u_r)^2 + (b_g\, v_r)^2 \right) \right]$$

- **Multiplication is applied in ur vr coordinates**
- **ag bg : full width @half maximum**
- **Gaussian axes aligned with elliptical ring**

3: Put some flesh on the skeleton





4: Azimutal modulation

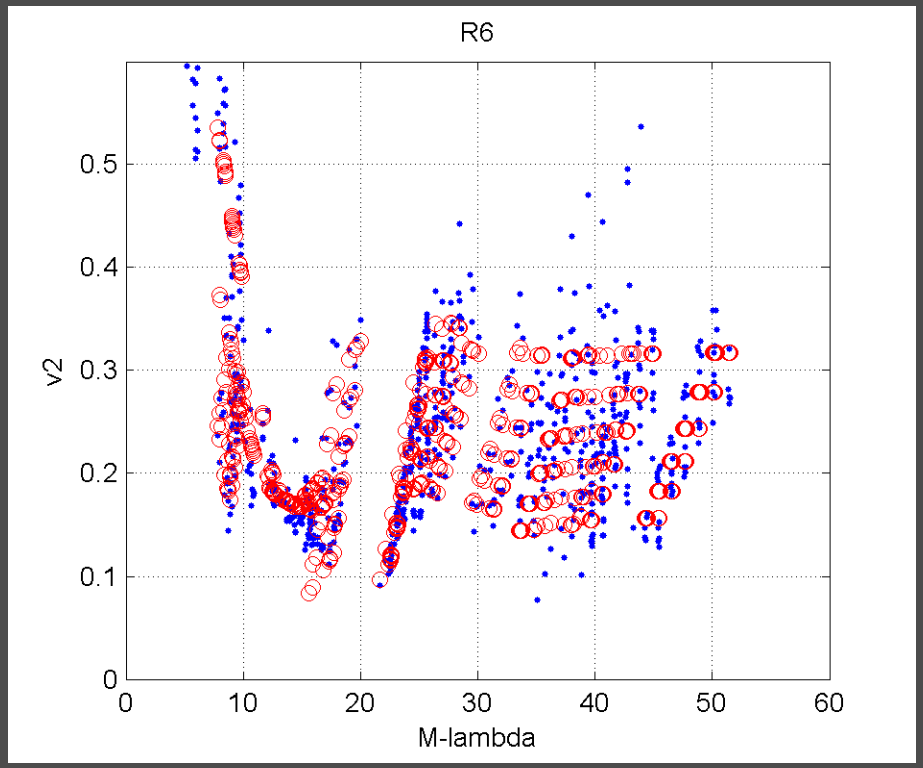
$$B(\vec{r}) = \delta(r-a)\cdot\left[\begin{array}{l} c_1\cos\alpha + s_1\sin\alpha + \\ c_2\cos 2\alpha + s_2\sin 2\alpha \end{array}\right]$$

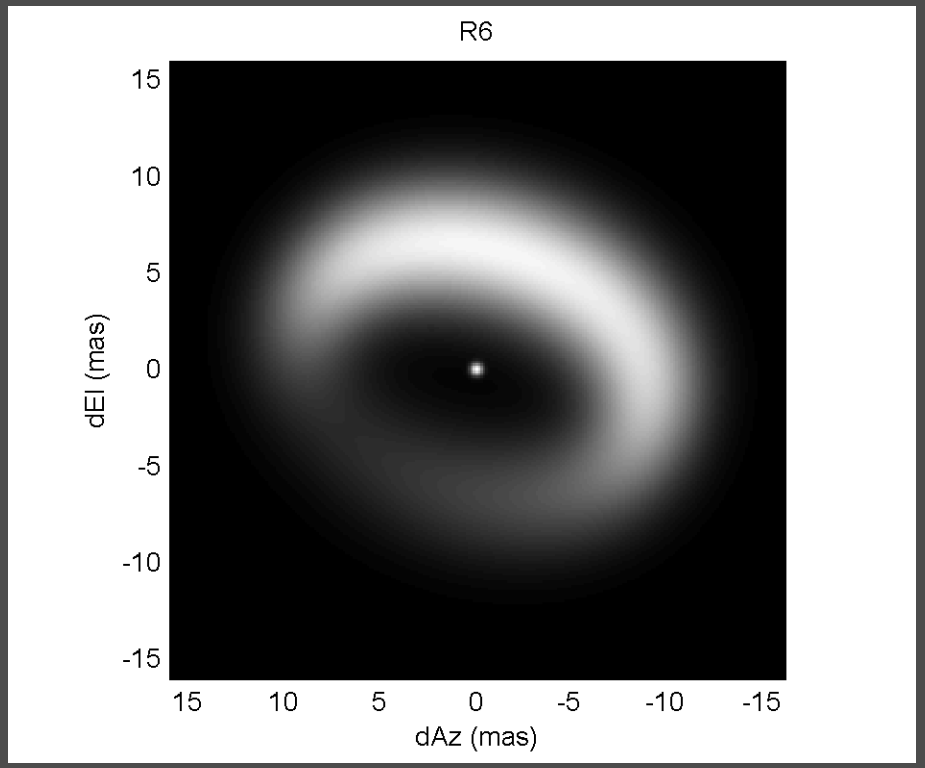
$$s = \sqrt{u_c^2 + v_c^2}$$

$$\begin{aligned} V_{neb}(u,v) = {} & J_0(2\pi as) \\ & -i\left(c_1\cos\alpha + s_1\sin\alpha\right)J_1(2\pi as) \\ & -\left(c_2\cos 2\alpha + s_2\sin 2\alpha\right)J_2(2\pi as) \end{aligned}$$

- **Modulated circular ring (m=1, m2)**
- **Complex visibility**
- **Then: squeeze and rotate as before**

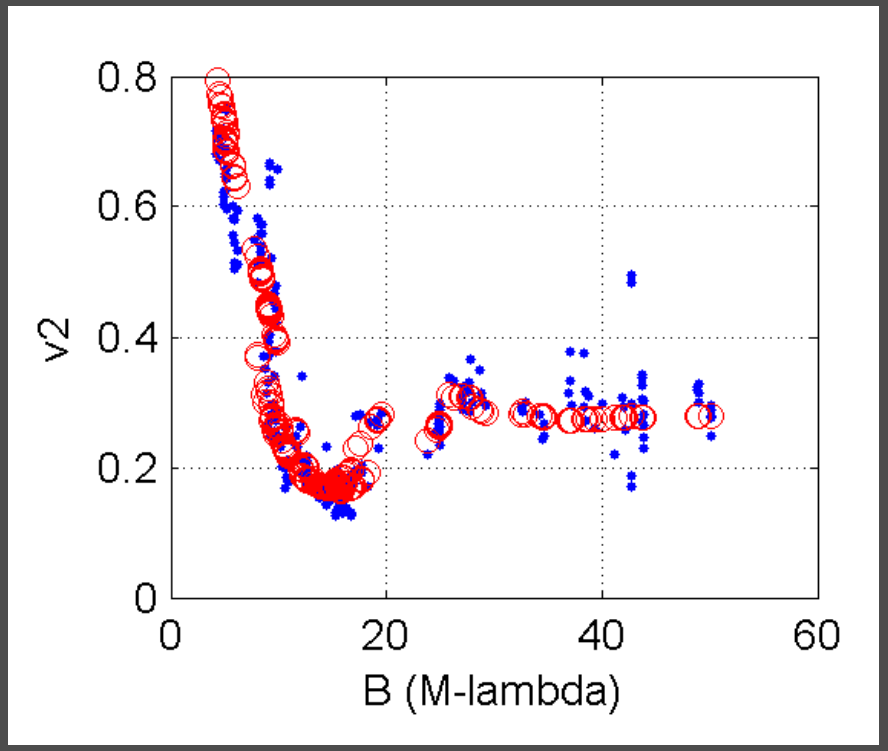
4: Azimutal modulation (m=1 + m=2)

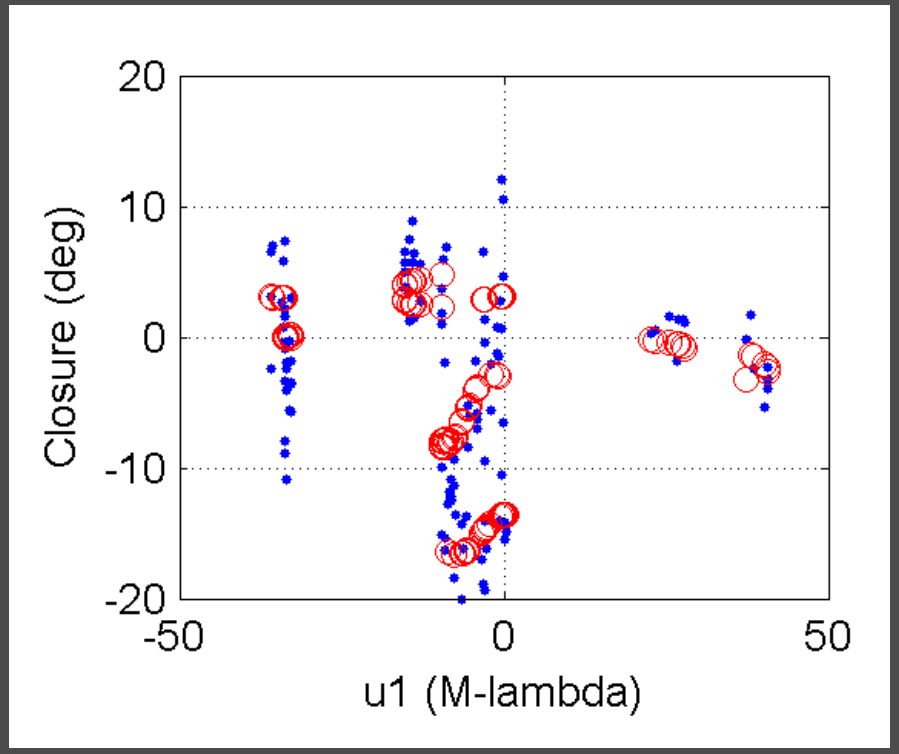




Good agreement with Monnier et al 2006

4: Azimutal modulation (m=1 + m=2)



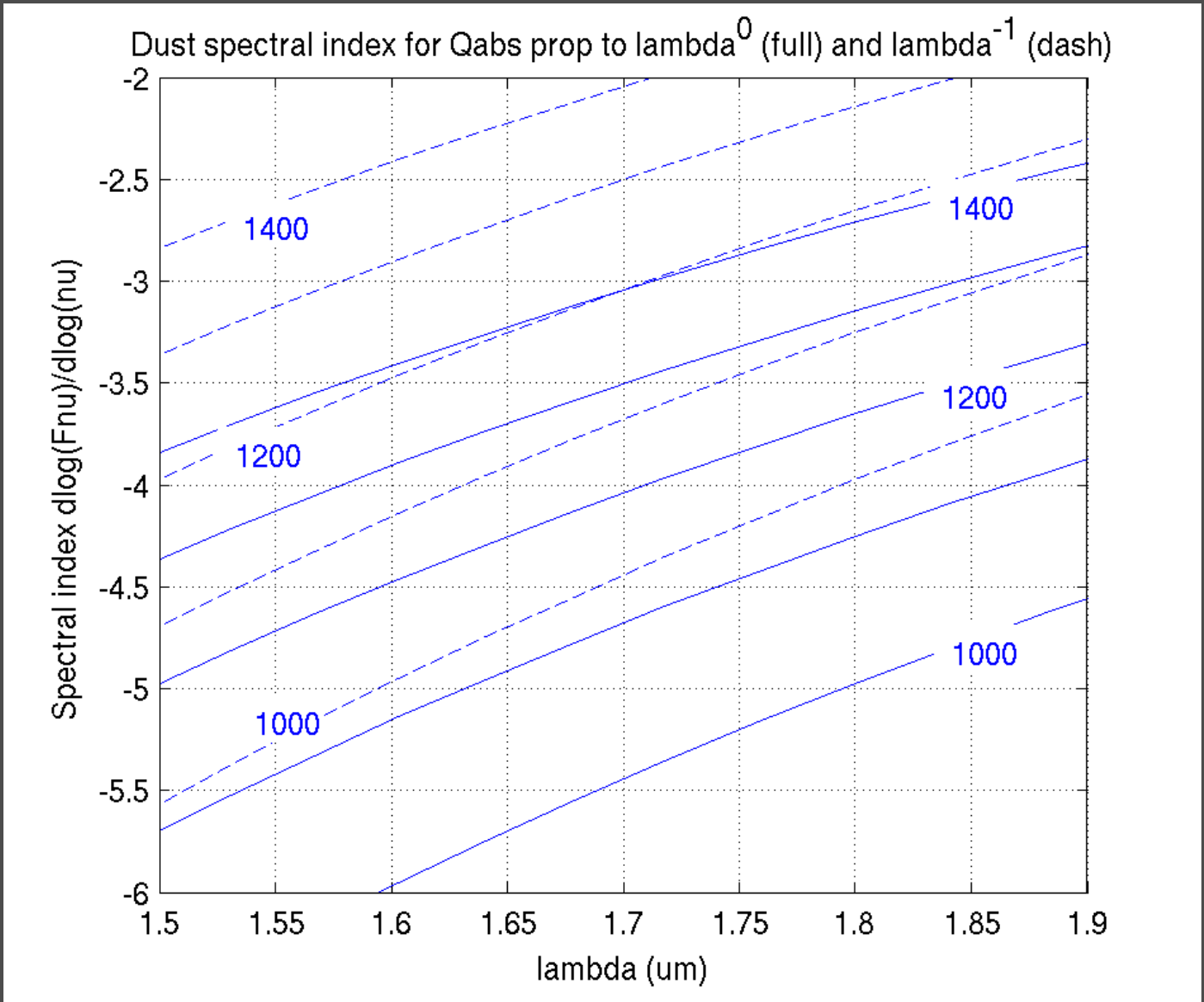


Final fit parameters

F_{NEB}/F_{STAR}	0.80
Nebular spectral index	-3.51
Semi major axis (mas)	9.59
Semi minor axis	6.37
P.A.	73°
Broadening	4.54 / 5.49
M=1 cos	-0.12
M=1 sin	0.78
M=2 cos	-0.29
M=2 sin	0.10

$$\chi 2 \approx 3$$

Dust temperature



Dust sublimation radius

- **From dust properties (Laor & Draine 1993)**

$$\theta_{sub} = \frac{r_{sub}}{d} = 34 \times 10^{-0.2[V_0 + BC]}$$

- **Independent of distance**
- **Plug in values for HD45677**

$$\theta_{sub} = 7.7 mas$$