Probing the inner circumstellar structures of T Tauri and Herbig stars

Jorick Vink (Imperial College London)

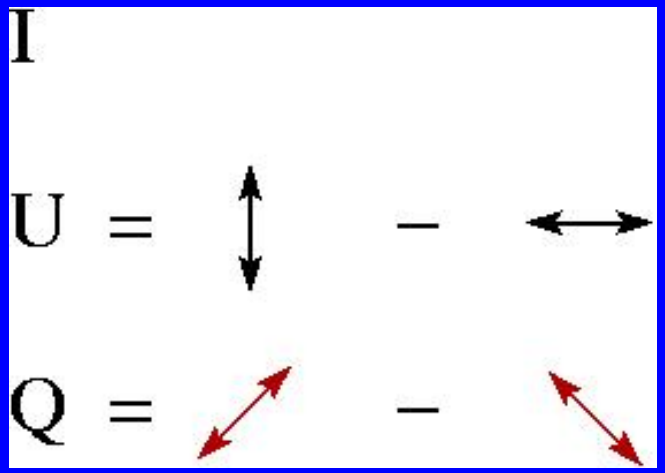
Janet Drew (Imperial), Tim Harries (Exeter),
Rene Oudmaijer (Leeds),

Vink et al., 2005b, MNRAS accepted, astro-ph/0502535

Outline

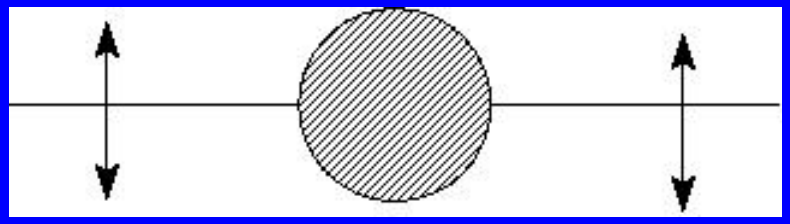
- Introduction on Spectropolarimetry
- Data
  - T Tauri 1 Msun
  - Herbig Ae 3 Msun
  - Herbig Be 10 Msun
- Disc scattering models
  - inner hole
  - undisrupted
- Conclusions

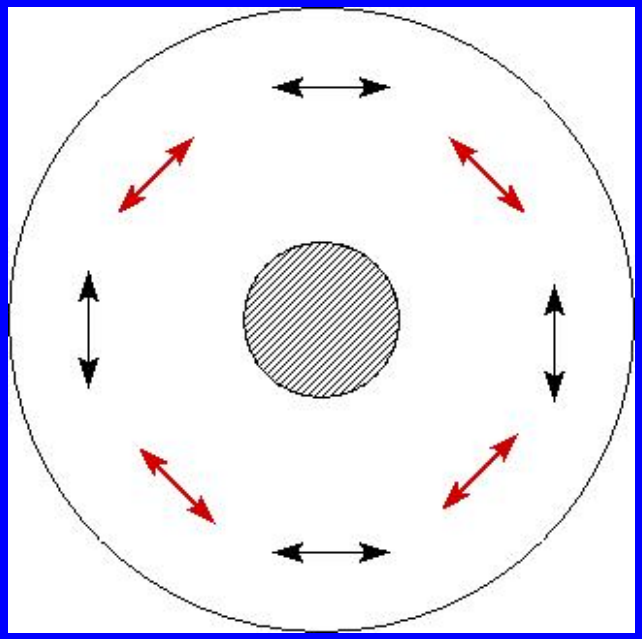
Polarimetry – from disks



$$P = \sqrt{(U^2 + Q^2)}$$

$$\theta = \frac{1}{2}\arctan\left(\frac{U}{Q}\right)$$

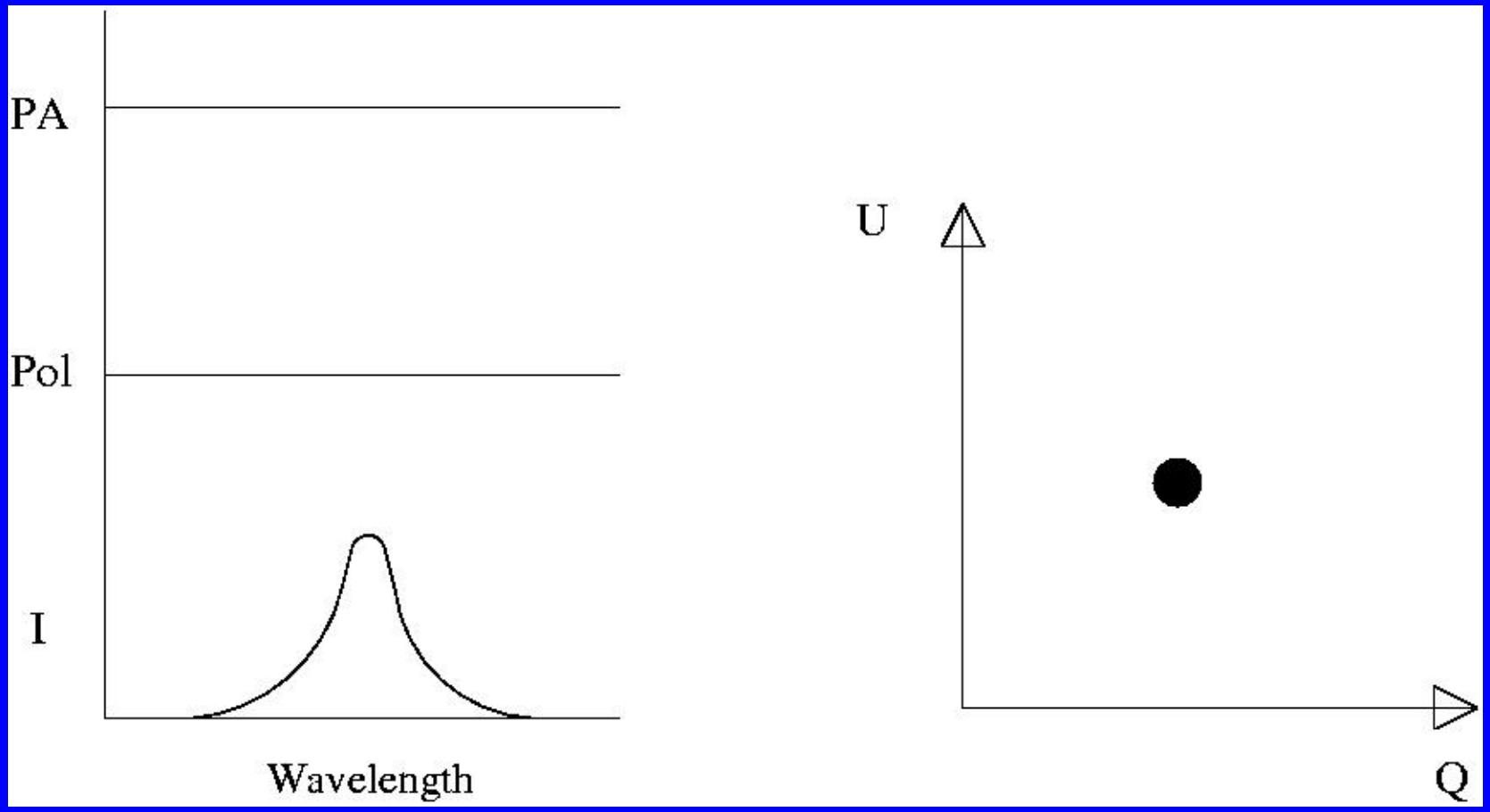




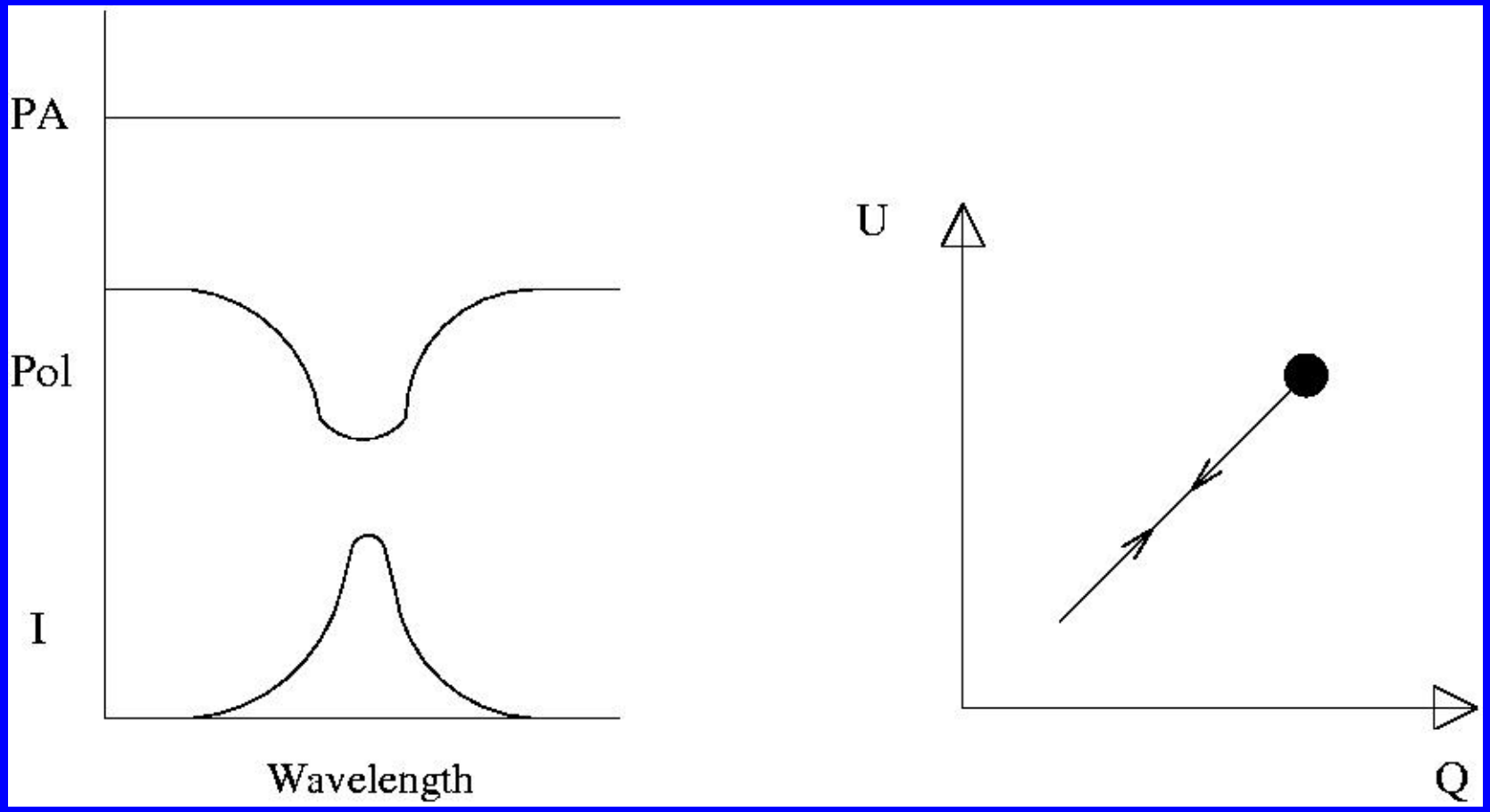
Polarisation across line?

1. No change
2. Depolarisation
3. LINE Polarisation

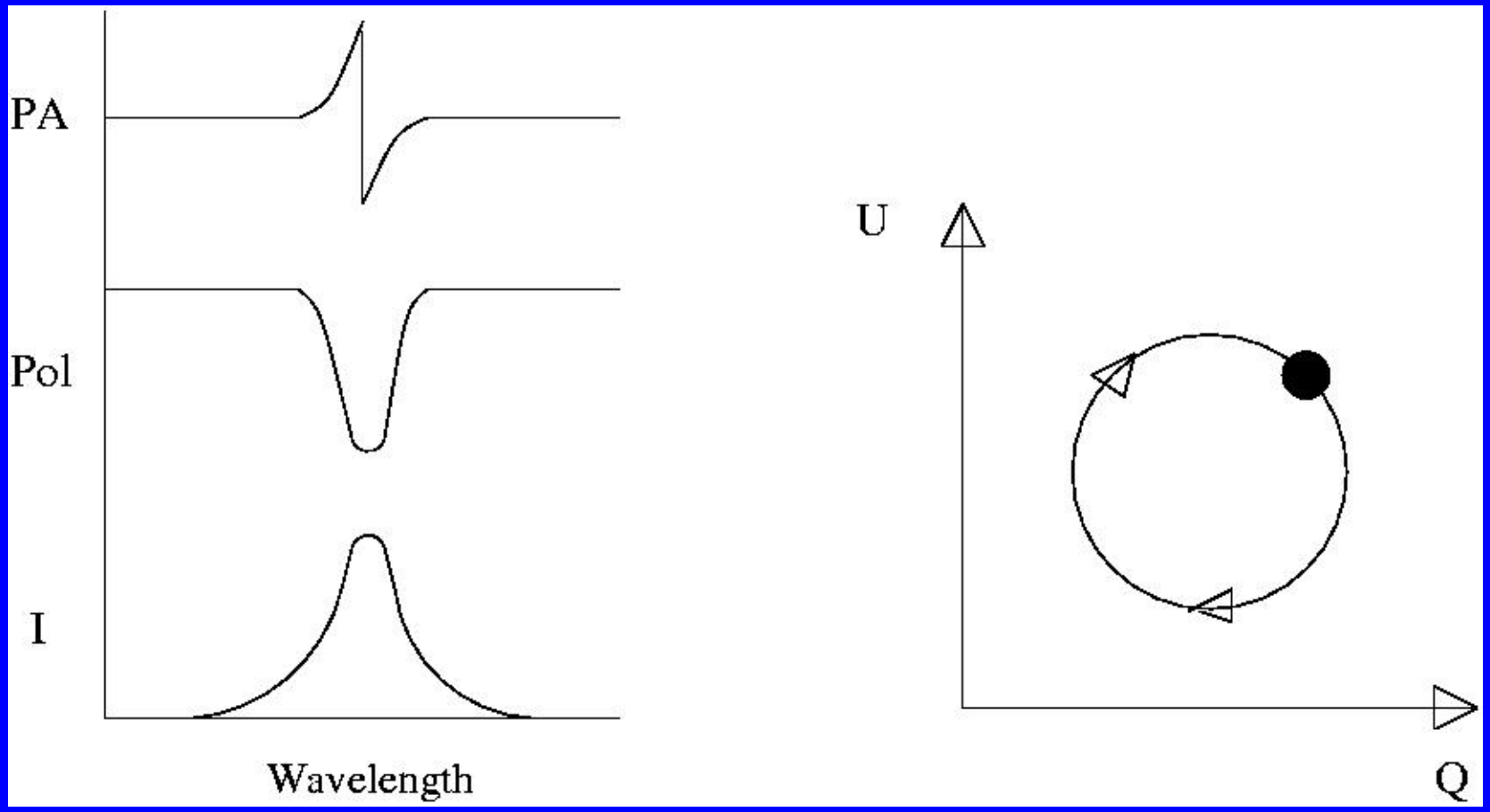
No Polarisation



Depolarisation



Line Polarisation – PA Flip



Survey Herbigs and T Tauris

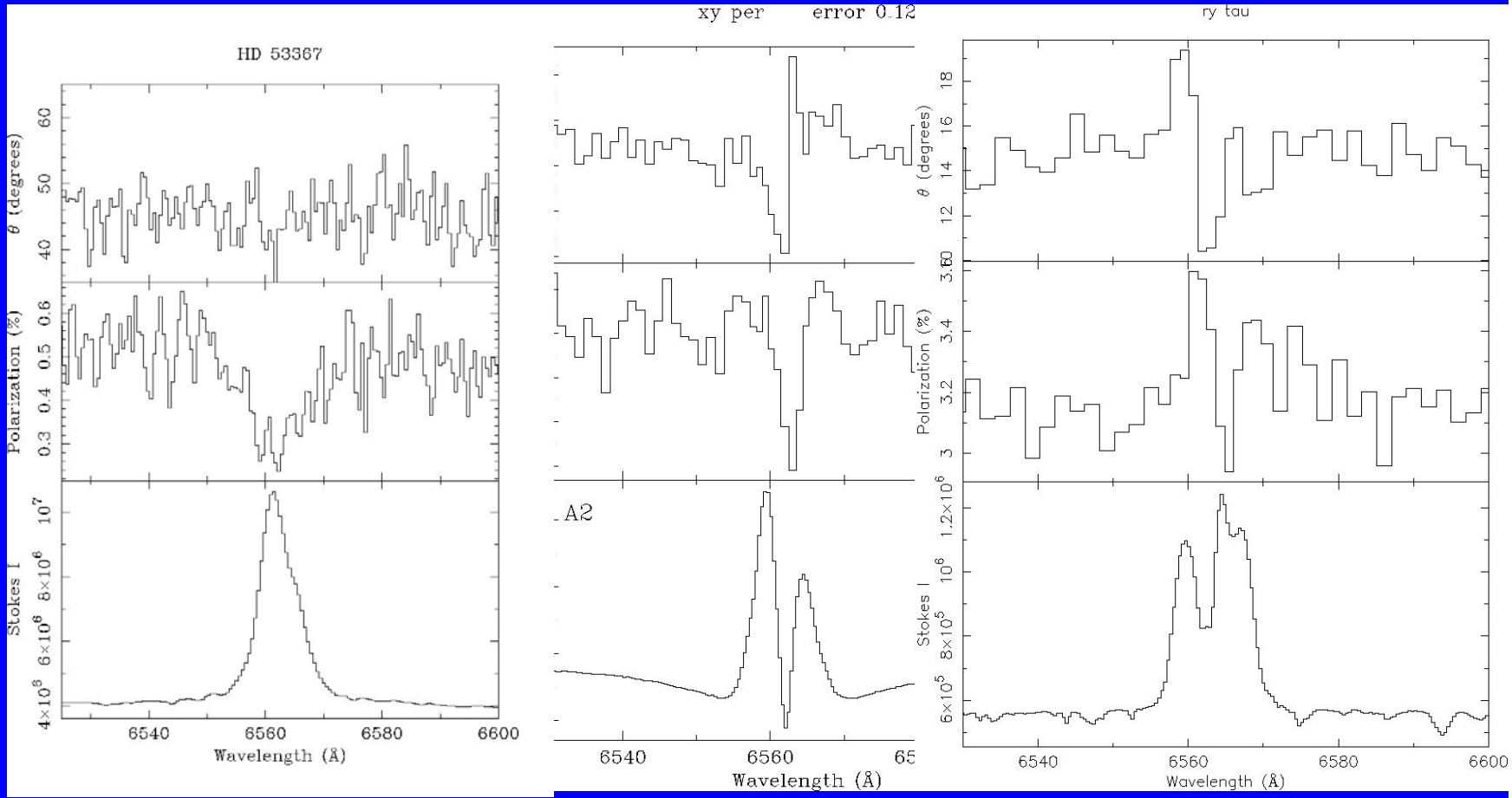
- Herbig Be stars: 12
- Herbig Ae stars: 11
- T Tauri stars: 10

Data: Herbigs and T Tauris

PA

Pol

I



Herbig Be

Herbig Ae

T Tauri

Polarisation across line?

1. No change
2. Depolarisation → Herbig Be: 7/12
3. LINE Polarisation

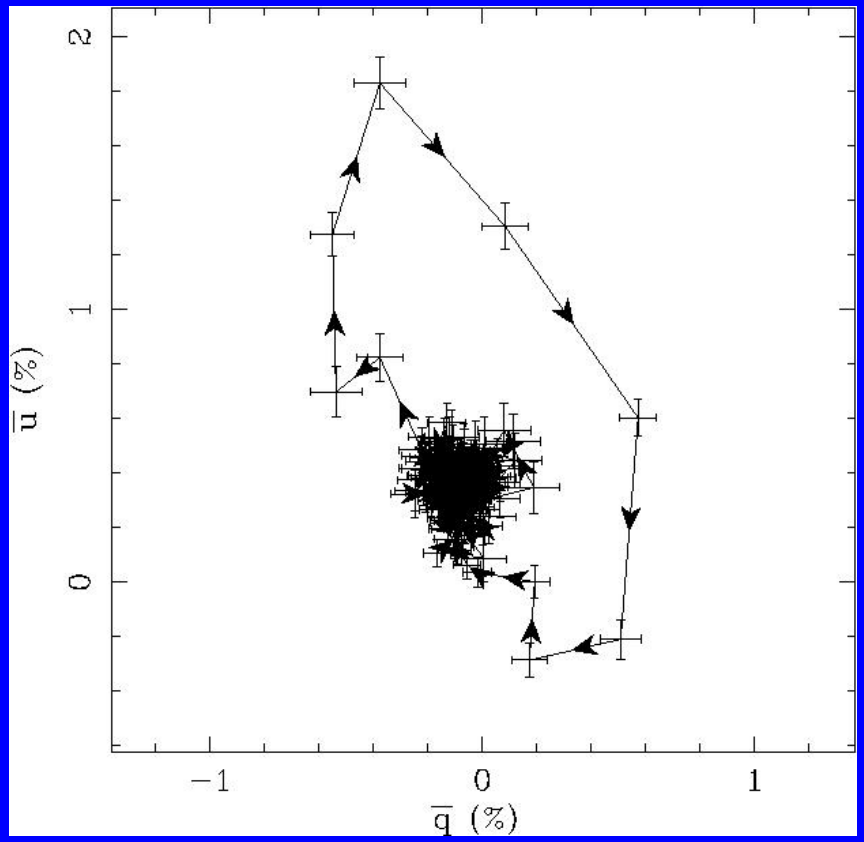
↓

Herbig Ae: 9/11 (Vink et al. 2002, MNRAS)

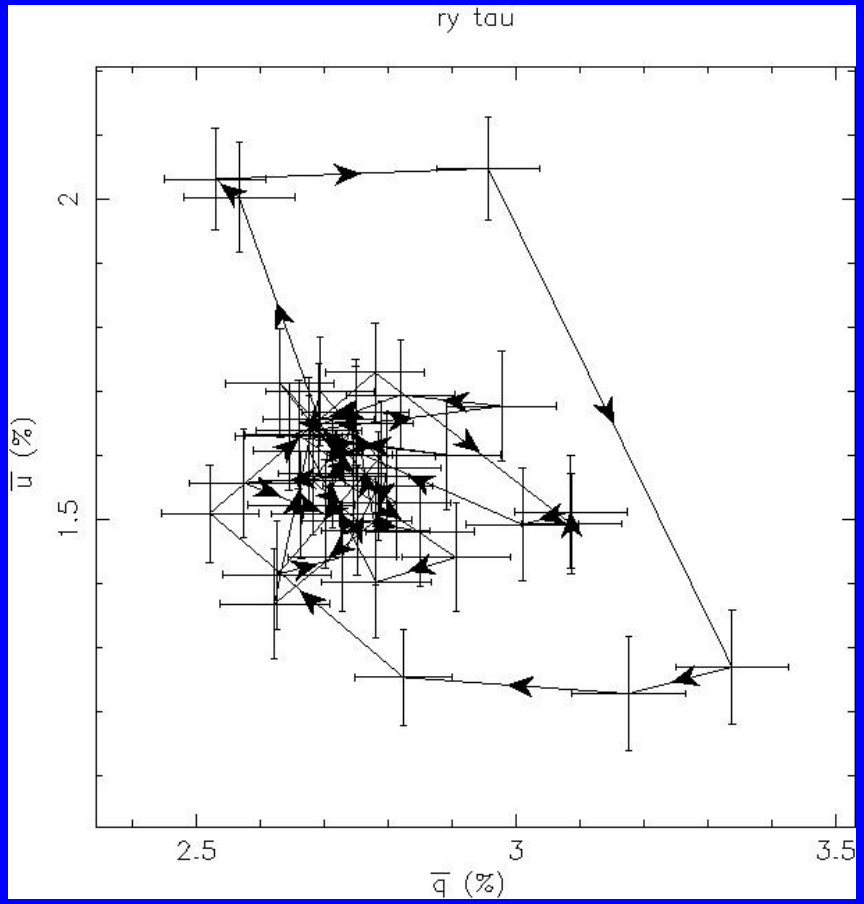
T Tauri: 9/10 (Vink et al. 2003, A&A)

(Vink et al. 2005b)

QU: Herbig Ae and T Tauri star



MWC 480

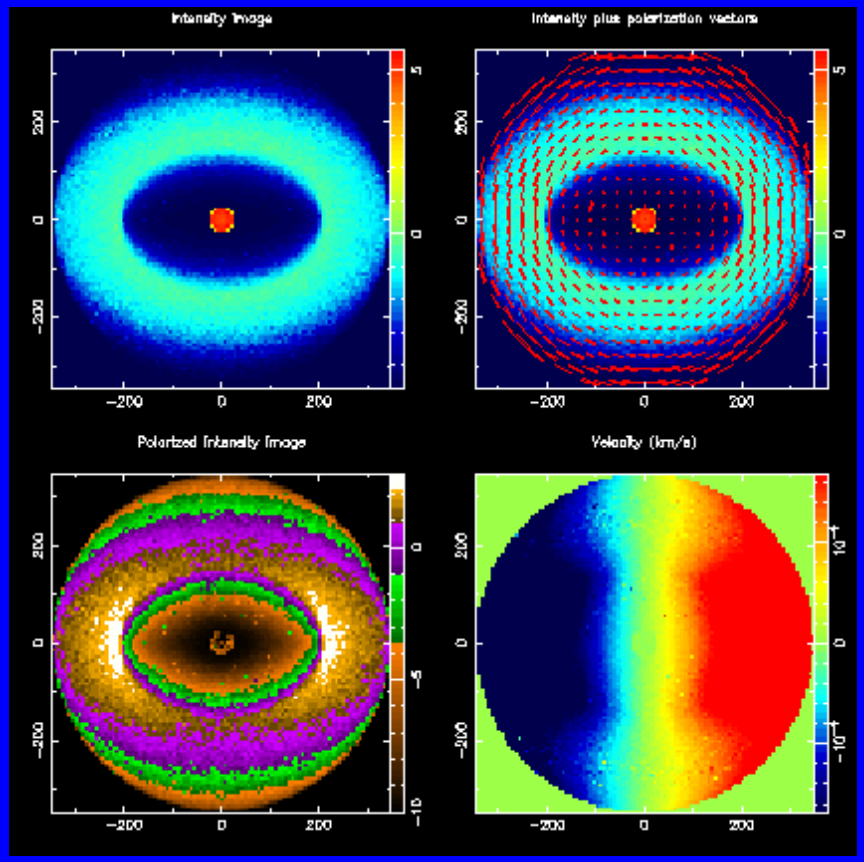


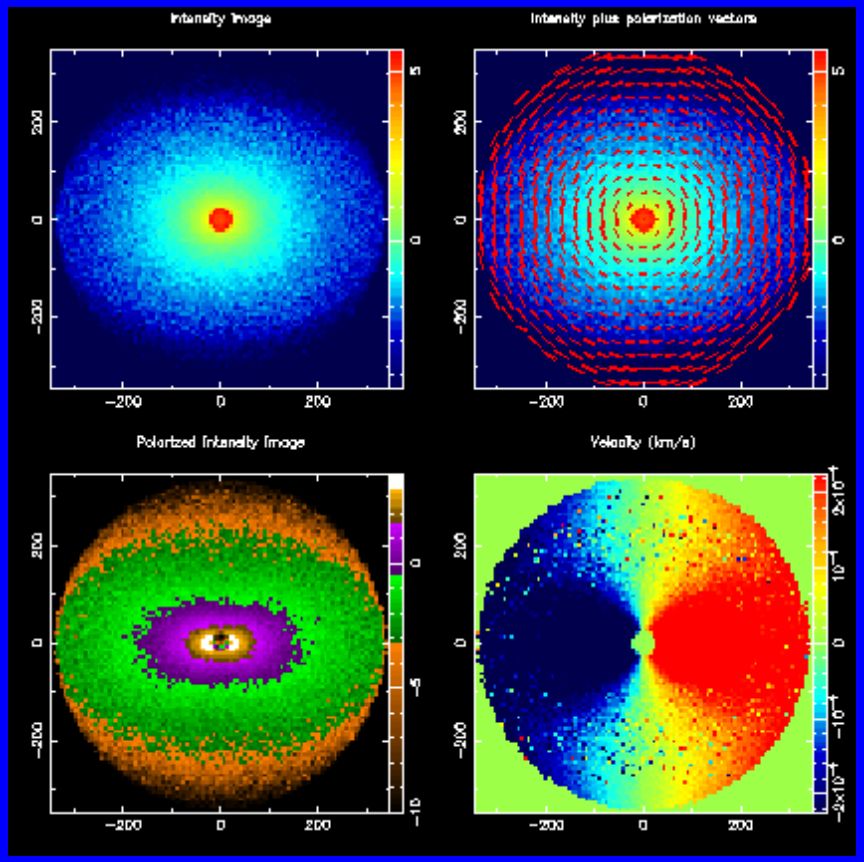
RY Tau

Models of COMPACT line emission

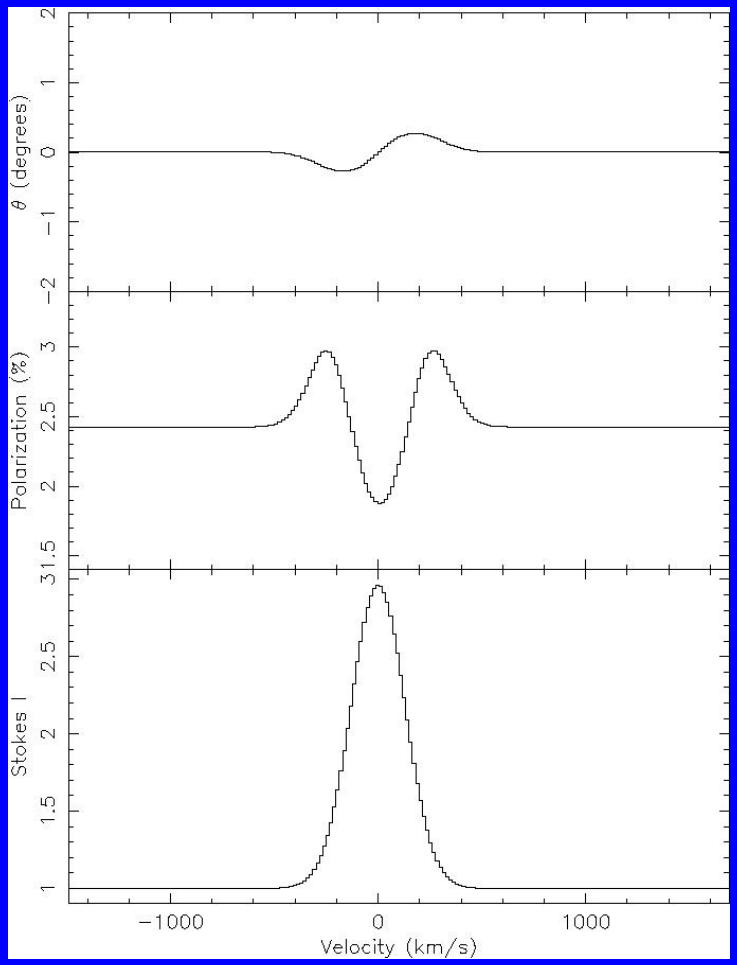
- 3D Monte Carlo
- Keplerian rotating disk
- Flat or constant opening angle
- Scattering only – no line transfer
- With and without an inner hole

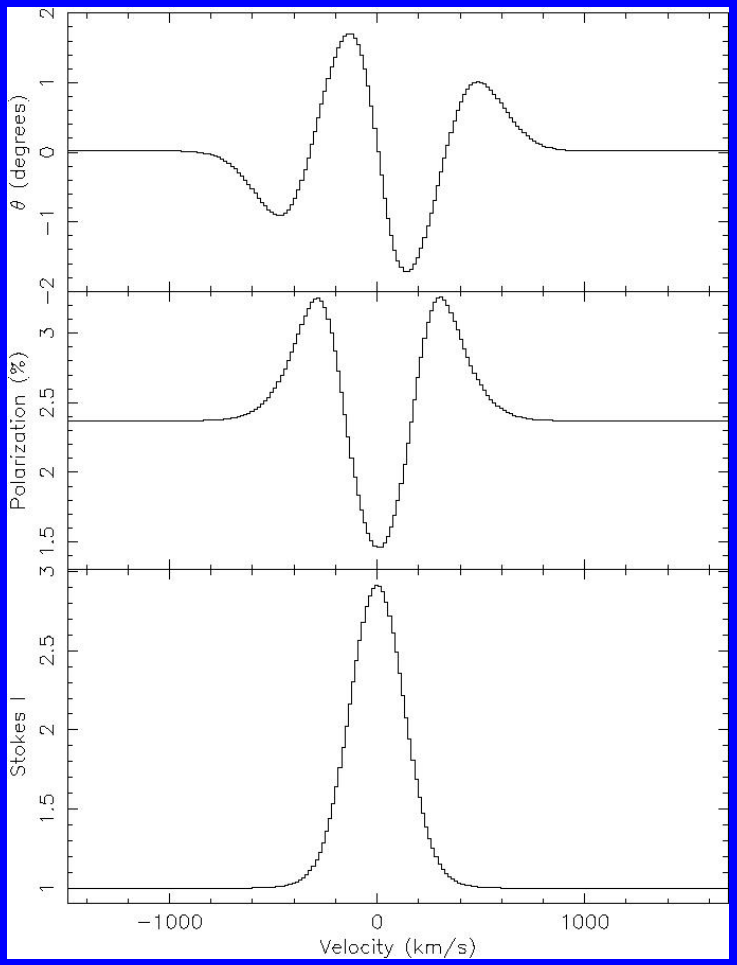
With/without an inner hole





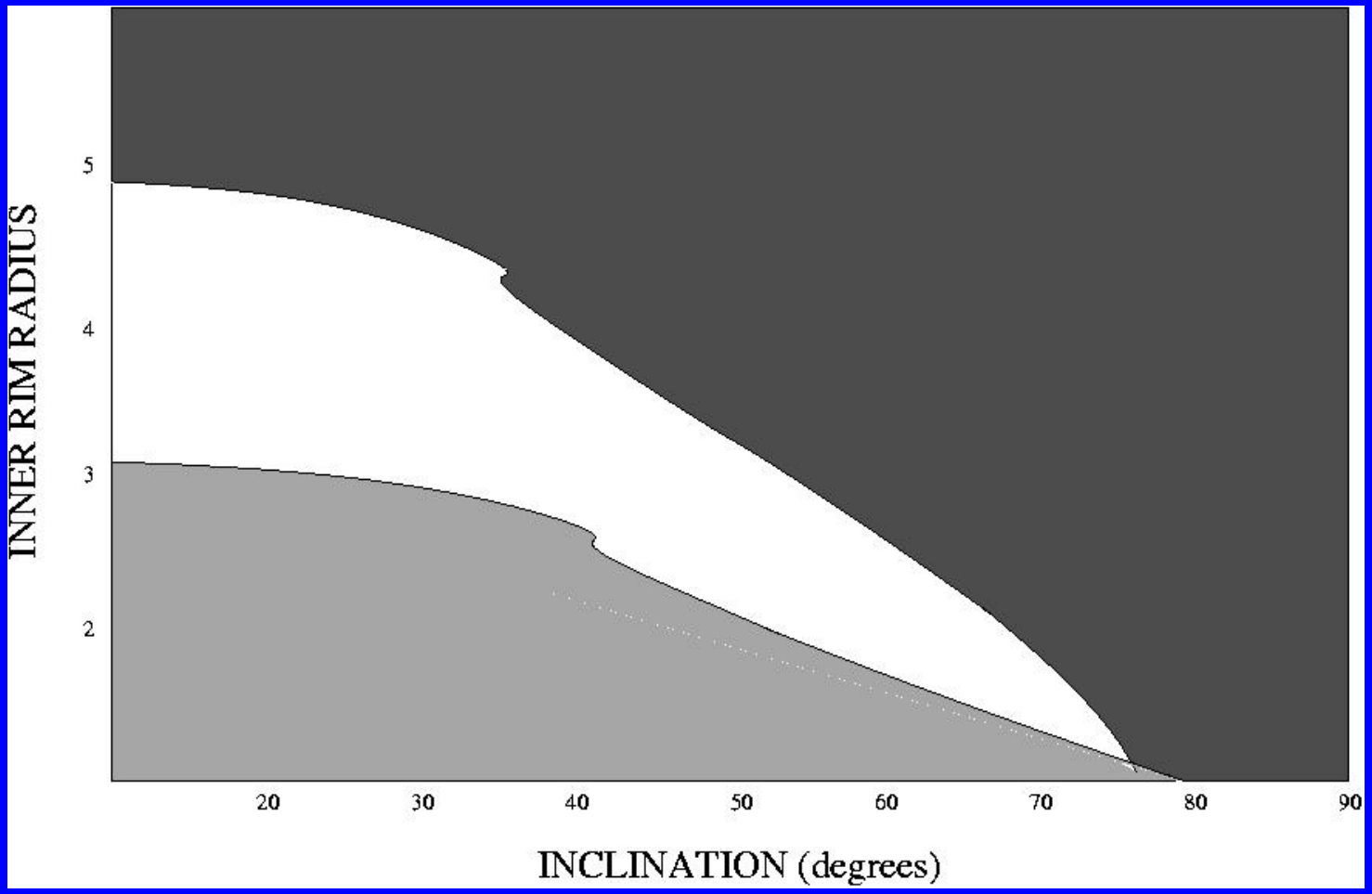
With/without a hole





Vink et al., 2005a, A&A accepted

Constraining the inner disk radius



Constraining the inner hole size:

Single PA flip; known inclinations

→ AB Aur Inner rim > 5 Rstar

→ CQ Tau Inner rim > 4 Rstar

→ SU Aur Inner rim > 3 Rstar

Gradual PA change

→ GW Ori Inner rim 3 or 4 Rstar

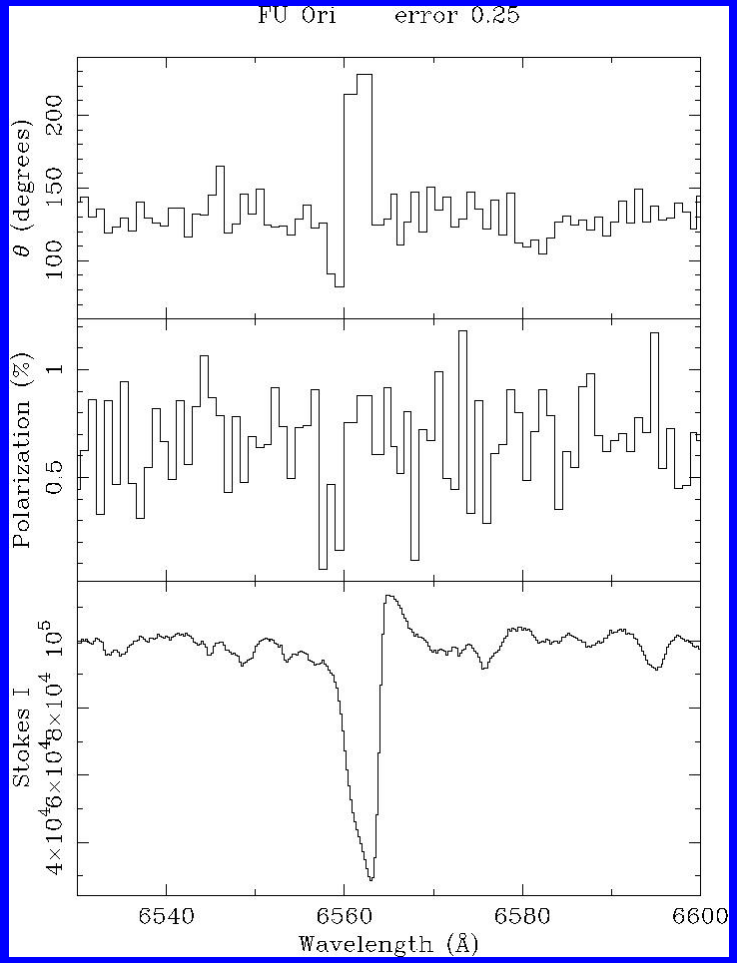
(Vink et al. 2005a, 2005b)

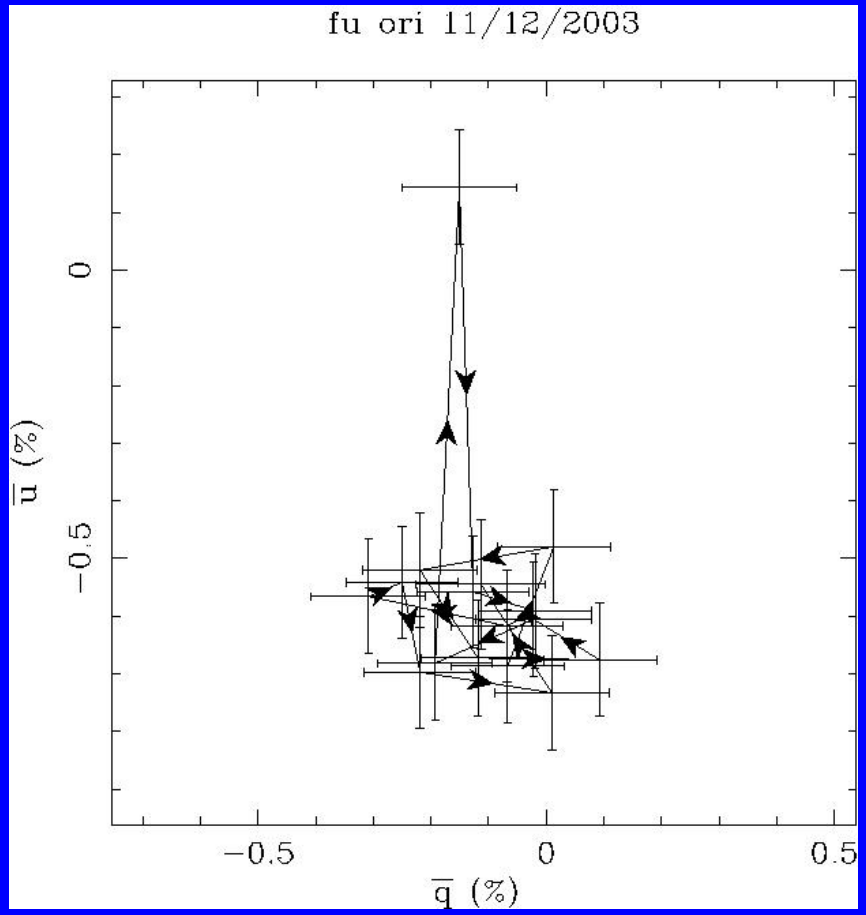
McLean effect in FU Ori

PA

Pol

I





Accurate measurement of intrinsic polarisation PA

Imaged disks: position angles

	PA line pol	PA direct	Delta PA
AB Aur	160	60/80	80/100
MWC 480	55	150	95
CQ Tau	20	105	95
RY Tau	163	62	101
FU Ori	45	47	2
SU Aur	130	127	3
DR Tau	120	128	8

(Vink et al. 2005b)

Conclusions

- Herbig Be: disks on small scales
- Herbig Ae/T Tau: rotating accretion disks
- Inner rim sizes 3 – 5 stellar radii
- Herbig Ae: polarisation PA perpendicular to disk PA → optically inner thin
- T Tauris: polarisation PA parallel to disk PA → optically thick

Vink et al., 2005b, MNRAS, astro-ph/0502535