Probing the inner circumstellar structures of T Tauri and Herbig stars

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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

\[ I \]

\[ U = \uparrow \quad - \quad \rightarrow \]

\[ Q = \rightarrow \quad - \quad \uparrow \]

\[ P = \sqrt{U^2 + Q^2} \]

\[ \theta = \frac{1}{2} \arctan\left(\frac{U}{Q}\right) \]
Polarisation across line?

1. No change
2. Depolarisation
3. LINE Polarisation
No Polarisation
Depolarisation
Line Polarisation – PA Flip

![Graph showing polarisation properties with wavelength on the x-axis and PA, Pol, and I on the y-axis. The right side shows a circular plot with U and Q axes.]
Survey Herbigs and T Tauris

- Herbig Be stars: 12
- Herbig Ae stars: 11
- T Tauri stars: 10
Data: Herbigs and T Tauris

Herbig Be  Herbig Ae  T Tauri
Polarisation across line?

1. No change
2. Depolarisation
3. LINE Polarisation

Herbig Be: 7/12
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

Accurate measurement of intrinsic polarisation PA
## Imaged disks: position angles

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

(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