Star-disk interplay in the resolved emission of young stellar objects

The case of MWC158 observed with the VLTI


ESO conference « Ten years of VLTI: from first fringes to core science »
Garching, 24-28 October 2011
Close environment of young stars

Dullemond & Monnier (2010, ARAA)
Close environment of young stars

Near-infrared interferometry

- magnetospheric accretion
- pure gas disk
- dust inner rim
- planet forming region
- outer disk (mass reservoir)

Dullemond & Monnier (2010, ARAA)

VLT Interferometry is now mature enough to provide:
- Enough data to perform a precise modelling of the environment
- Image reconstruction using aperture synthesis
Can we perform **gray** image reconstruction?

MWC 158 data obtained with VLTI/PIONIER.

- Why is there such a large visibility dispersion with wavelength?
- Is **image reconstruction** using **wavelength synthesis and gray hypothesis** still valid?
MWC158 observed with AMBER

✓ Precise modelling of a disk with: $\theta = 72\pm7^\circ$ and $i = 56\pm4^\circ$

✓ H-band data more dispersed than K-band data:
  ➡ Is it because of the instrument and the atmosphere?
H-band: difference between broad-band data and spectral dispersed data in HD 45677

IONIC

PIONIER
Lazareff et al. (2011, in prep.). See Wed talk.
MWC 158 in H-band with PIONIER and AMBER

AMBER

PIONIER
MWC 158 in H-band with PIONIER and AMBER

![Graphs showing visibility versus B/\lambda (cycles/arcsec) for AMBER and V2 data for PIONIER.](image)

- AMBER
- PIONIER

⇒ this is not an instrumental defect!!
Components in the Spectral Energy Distribution

\[ Ft = Fs + Fd \]

\[ Ft \ Vt = Fs \ Vs + Fd \ Vd \]
Components in the Spectral Energy Distribution

Lachaume (2004)  

Malfait et al. (1998)

\[ Ft = Fs + Fd \]

\[ Ft \ Vt = Fs \ Vs + Fd \ Vd \]
Polychromatic Model: standard disk + star

- Centro symmetric model
- Non-resolved star
- Rings-modelized thin disk
- SED modeling
- Interferometric data modeling
Polychromatic Disk Model + star: simulations

\[ Vt = f + (1-f) Vd \]

\[ \Rightarrow \]

\[ 1-Vt = (1-f) (1-Vd) \]

Degenerescence between \( f = Fs/Ft \) and \( Vd \). We need \( f \)
« Correcting » from star contribution

Corrected data seems to be more resilient to chromatic effects

\[ Vd = 1 - \frac{1 - Vt}{1 - f} \]

\[ f = \frac{Fs}{Ft} \]

\[ Vd \text{ vs. } Vd^2 \]

\[ Vd = \frac{1}{1 + \frac{B}{\lambda}} \]
Image reconstruction

Radical differences:

- presence of central extended emission
- presence of a ring of emission
- directions of elongations are different
Modelling

size (FWHM) :
\[ a = 2.82 \pm 0.04 \text{ mas} \]

Object orientation :
\[ \theta = 72^\circ \pm 1^\circ \]
\[ i = 55.9^\circ \pm 0.9^\circ \]

Star flux ratio : \sim 30\%
Gaussian flux ratio : \sim 50\%
Ring flux ratio : 15-20\%
Summary and Conclusion

- Interplay between the disk and the star emissions and not an instrumental effect.
- Polychromatic changes due to astrophysical properties of the objects are important in H-band
- Possibility to correct from this effect
- Be careful with modeling and image reconstruction !!

Work in progress:
- Closure phases may be significant
- Carefull modeling with minimum components
- PMS nature is not yet definitive
- Application to other objects
- New image regularization