Zooming into high-mass star-forming regions

Henrik Beuther

SMA

PdBI

VLA

ATCA
Important questions

- What are the characteristics of accretion disks/large toroid in high-mass star formation?

- Can we constrain the magnetic field structure?

- Fragmentation and core densities

- The Orion outflow: What are the driving sources?

- Not touched: Initial conditions, feedback, IMF, chemistry
The Disk candidate in IRAS 18089-1732

$10^{4.5} L_\text{sun}$ source, size~2000AU, $T$~350K

Beuther et al. 2005
The Disk candidate in IRAS 18089-1732

- Clear east-west velocity gradient.
- Non-Keplerian motions.
- $T > 100K$ in rotating structure.

Beuther & Walsh 2008
A sample of 12 massive disk candidates

Sample of 12 sources observed in NH3(4,4) & (5,5) with ATCA at arcsecond resolution.

Excitation temperatures of lines $E_{\text{lower}}=200$ & 295K $\rightarrow$ trace hot inner gas.

11 out of 12 sources detected, 6 with rotation and/or infall signatures.

At 1000AU resolution, no flattened structures, no Keplerian signature. $\rightarrow$ Real disks likely <1000AU in size.

Rotation of an IRDC $\rightarrow$ next talk C. Fallscheer
Analytic and numerical modeling of cores and disks $\rightarrow$ Posters by B. Vaidya & R. Kuiper

Beuther, Walsh & Longmore 2009
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Magnetic field measurements from submm continuum and CO(3-2) observations

Grey: polarized submm continuum
Red cont: int. 870µm
Blue cont: int. SiO(8-7)

Beuther et al., in prep.
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Multi-wavelength observations of the HMPO IRAS 05358

Beuther et al. 2002
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Beuther et al. 2007
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Beuther et al. 2007
Density distribution of sub-sources

\[ V(s) \sim s^a \]

with \( a = p + q - 3 \)

and \( T \sim r^{-q} \)

\( q \sim 0.4 \)

\[ n \sim r^{-p} \]

\( p = 1.5 \rightarrow a = -1.1 \)

\( p = 2.0 \rightarrow a = -0.6 \)
Low-turbulence starless cores

color: MSX at 8μm; contours: 1.2mm dust continuum

Beuther & Henning 2009
Low-turbulence starless cores

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Potential driving sources of the Orion-KL outflows

Color: MIR (Greenhill et al.)
Contours: 865µm (Beuther et al.)
The two Orion-KL outflows and their potential driving sources

Grey: H$_2$

Contours: C$^{18}$O

Color: 865µm

Contours: SiO(8-7)

Beuther & Nissen 2008
Sequential star formation around S255IR

Color: GLIMPSE 8µm, white contours: NVSS cm, green contours: SCUBA
Sequential star formation around S255IR

Poster by Wang et al.

Color: GLIMPSE 8 µm, white contours: NVSS cm, green contours: SCUBA
Sequential star formation around S255IR

Poster by Wang et al.
Summary and Outlook

- Rotating structures on scales of several 1000AU. Rarely Keplerian motions. Genuine disks likely on smaller scales below 1000AU.

- Magnetic field appears to be aligned with outflow direction on core and larger outflow scales.

- Density gradients of cores and clumps are similar.

- Many low-turbulence cores in high-mass environment.

- SMA1 potential driving source for large Orion outflow.

- Lots to come in the field with Herschel and ALMA.