Molecular Jet of IRAS 04166+2706

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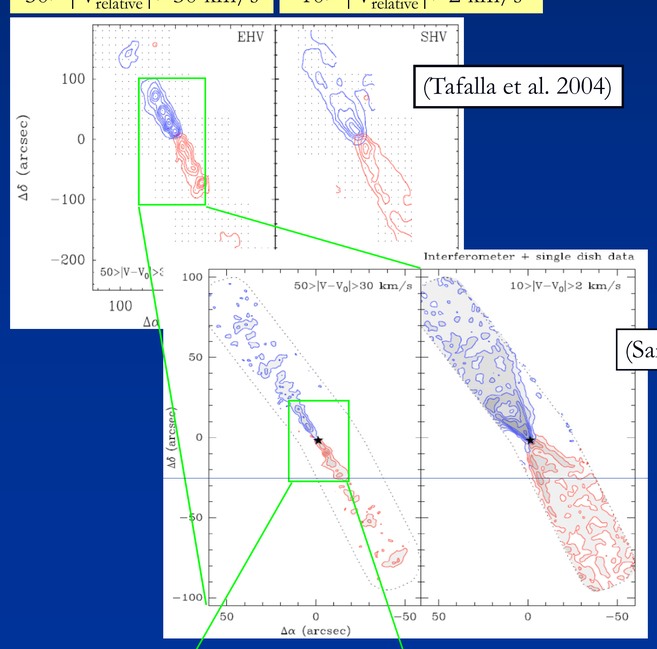
Context of IRAS 04166 molecular outflow (Taurus 140pc)

Collimated Jet and Conical Shell (COJ=2-1)

EHV regime: 50>|$V_{relative}$|>30 km/s

SHV regime: 10>|$V_{relative}$|>2 km/s

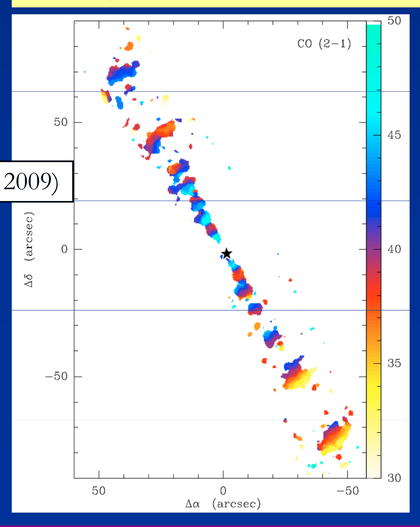


(Tafalla et al. 2004)

(Santiago-García et al. 2009)

Kinematic of the Jet

- Oscillating velocity pattern shown in first moment map.
- Internal velocity gradient in each knot implying variability of jet launching velocity.



Observation: SMA CO J=3-2

General Info.

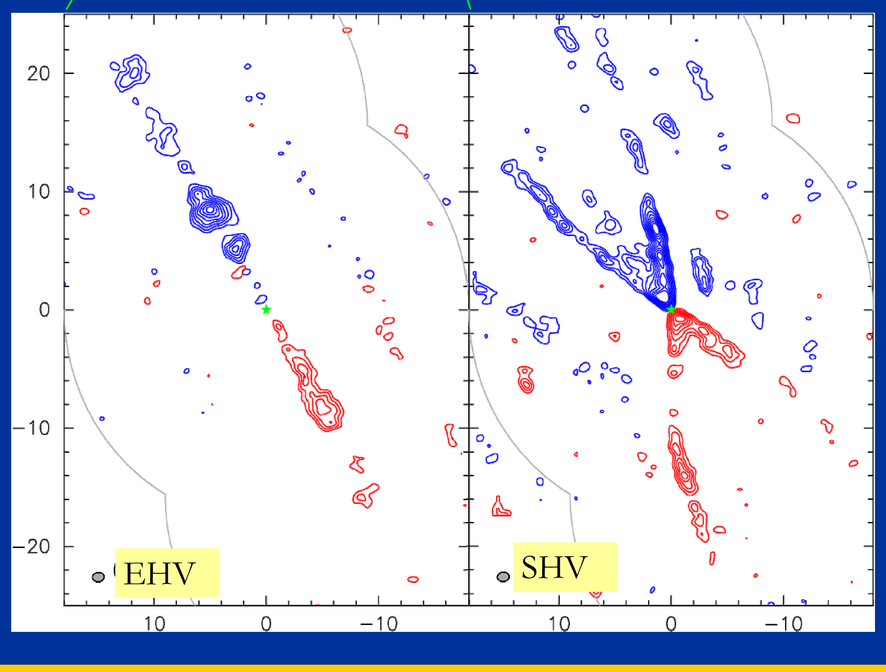
- **The Submillimeter Array (SMA)** at 345 GHz
  - Half-power beam width: ~36 arcsec (we use 3 pointing)
- Date: 2010 Sep 9th & 2010 Sep 22th in Extended configuration; 2010 Oct 5th in Compact configuration.
  - Projected baseline: 12~225 m
- Phase center (RA/DEC): 04h19m42.5s / 27°:13':38.0"

CO J=3-2 (345.796 GHz)

- Spatial resolution: 1.02"×0.8" (FWHM of the synthesized beam)
- Spectral resolution: 0.7 km/s
  - Smooth to 2 km/s
- RMS noise level: ~0.054 Jy/beam (per 2 km/s channel)

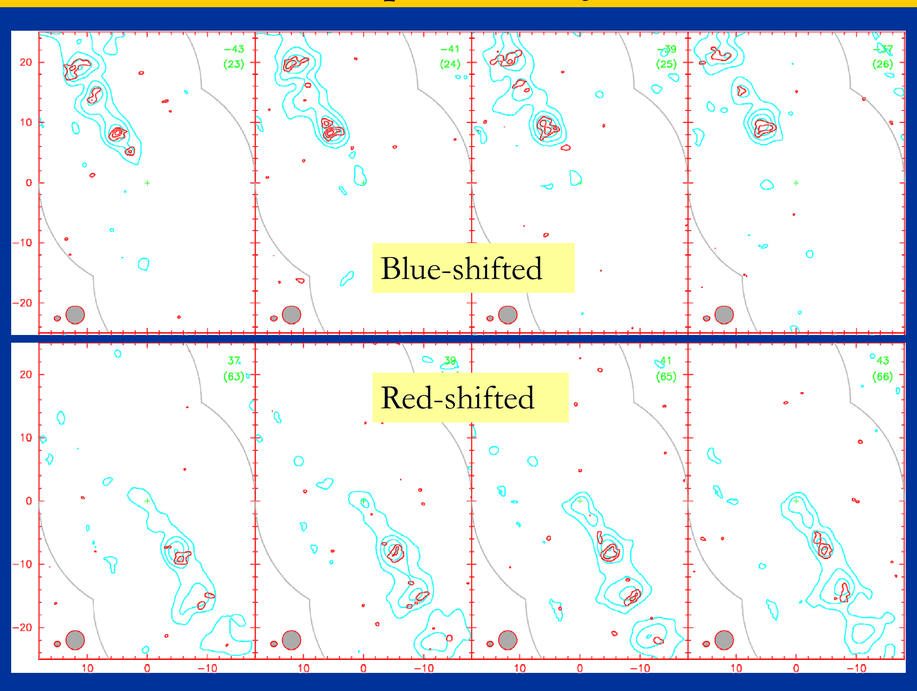
Results and Findings:

Similar feature observed in CO J=3-2



- *Left*: EHV regime (50>|$V_{relative}$|>30 km/s)
  - Inner four pair of highly collimated knots.
- *Right*: SHV regime: (10>|$V_{relative}$|>0 km/s)
  - Conical shell-like structure.

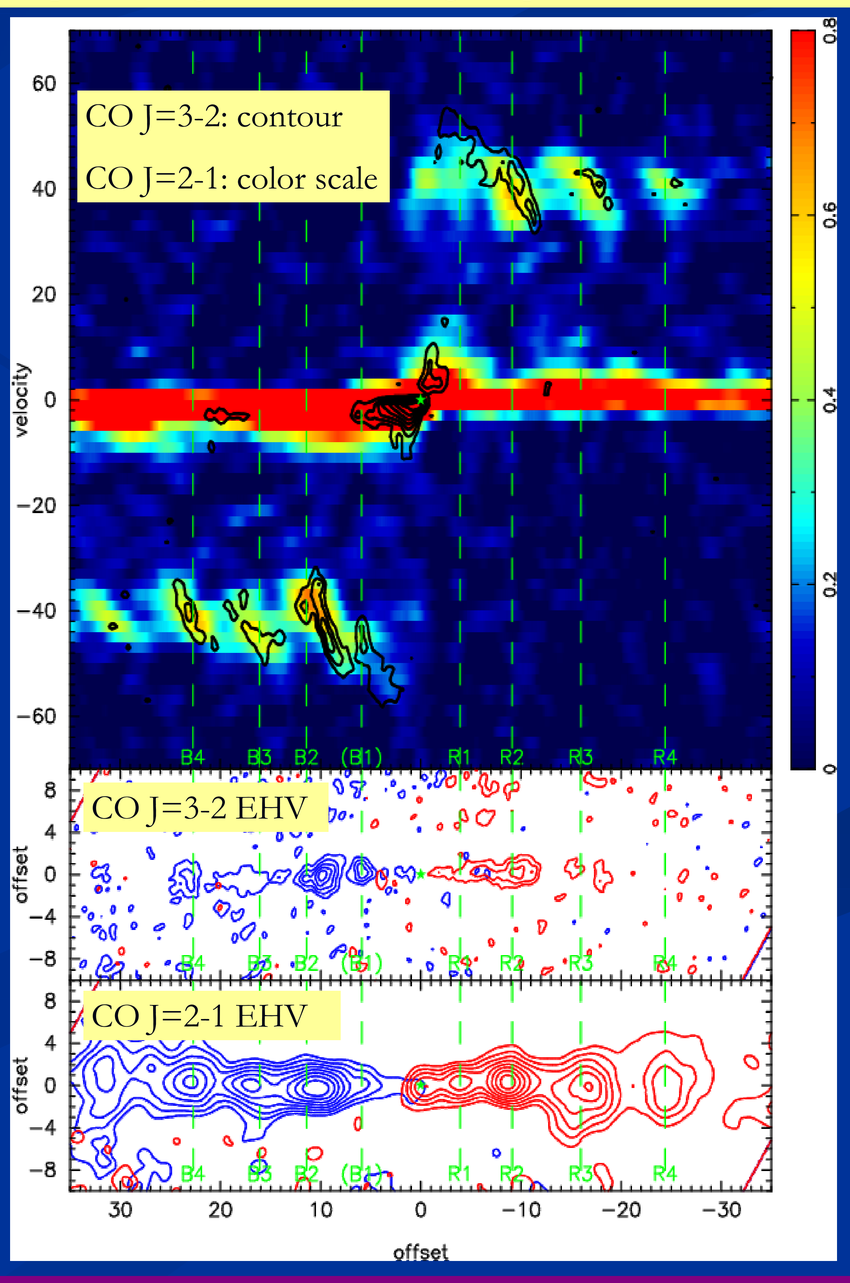
Position shift with respect to CO J=2-1 in 2 km/s channel map



- CO J=2-1: Blue contour
  - 3.00×3.00 arcsec
- CO J=3-2: Red contour
  - 1.02×0.80 arcsec
- There appear to be a position difference between CO J=3-2 and CO J=2-1, where the 3-2 emission tends to peak slightly further away from the central source for a given channel. This is more apparent for Red-shifted lobe than the blue-shifted.

Position-Velocity Diagram of CO J=3-2 (& CO J=2-1)

- *Upper*: The position velocity diagram along jet axis (PA 30°). Dark contour: CO J=3-2. Color scale: CO J=2-1. Green dash line and labels are the knot positions identified through CO J=2-1 EHV map. *Lower*: CO J=3-2 and CO J=2-1 EHV map rotated for comparison.
- Remark: (1) Clear internal velocity gradient along jet axis. (2) Knot B1 now clearly identified from B2. (3) CO J=3-2 emission tends to peak a little further from the central source than CO J=2-1 at a given velocity, and also peaks at higher velocity for a given position.



Preliminary Conclusions

- CO J=3-2 emission generally resembles the feature observed in CO J=2-1. Conical shells are present within the SHV regime (10> |$V_{relative}$| >2 km/s), while the highly collimated knots are detected in the EHV regime (50> |$V_{relative}$| >30 km/s).
- Position-velocity diagram of CO J=3-2 emission along outflow axis reveal the same velocity pattern observed in CO J=2-1, which is consistent with a pulsed jet interpretation. But we find two notable differences.

(1) The innermost knots R1 and B1 have a higher velocity than average. This may suggest a trend of increasing ejection velocity over the outflow history.

(2) The CO J-3-2 emission almost always peaks slightly further away from the central source than the CO J=2-1 in the channel maps. It also tends to appear (or concentrate more) at a higher velocity than CO J=2-1 for a given position. This is demonstrated in the position-velocity diagram.

References

Tafalla, M., Santiago, J., Johnstone, D., & Bachiller, R. 2004, A&A, 423, L21

Santiago-García, J., Tafalla, M., Johnstone, D., & Bachiller, R. 2009, A&A, 495, 169