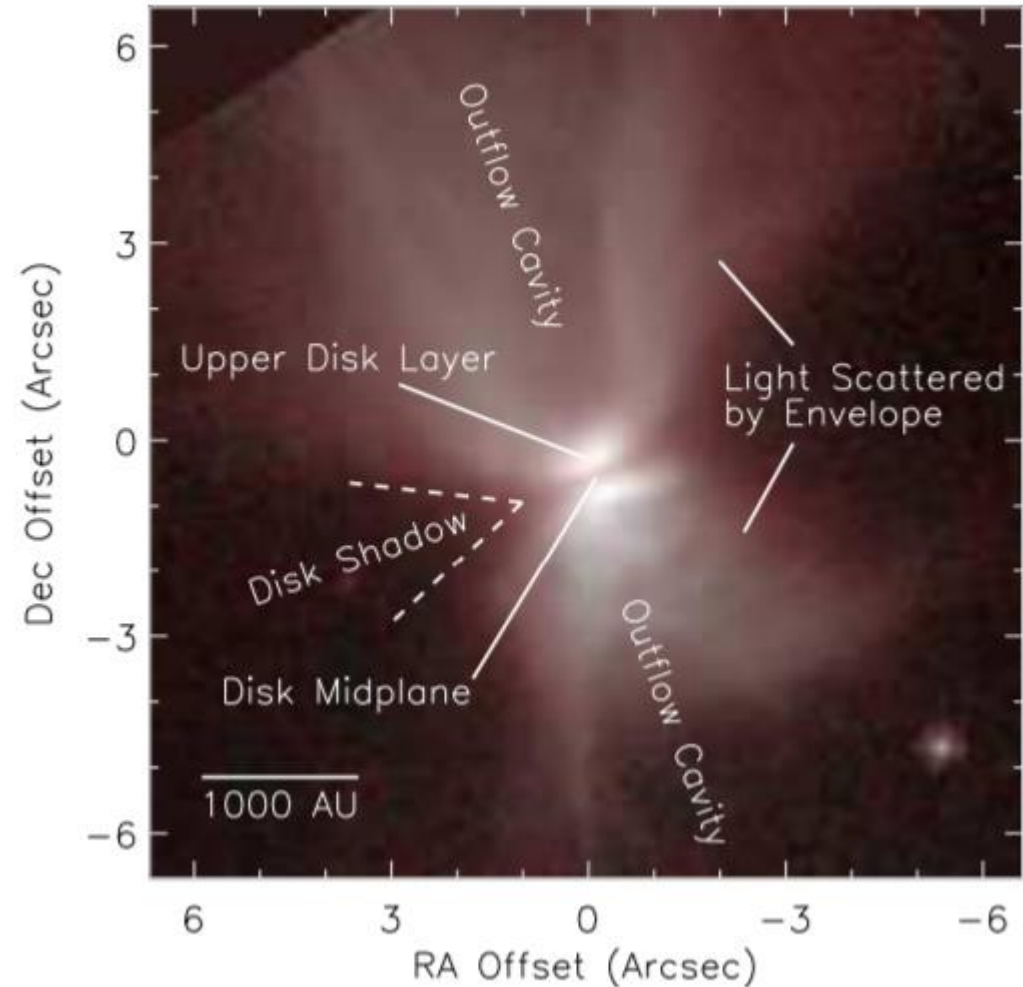


HOPS 136

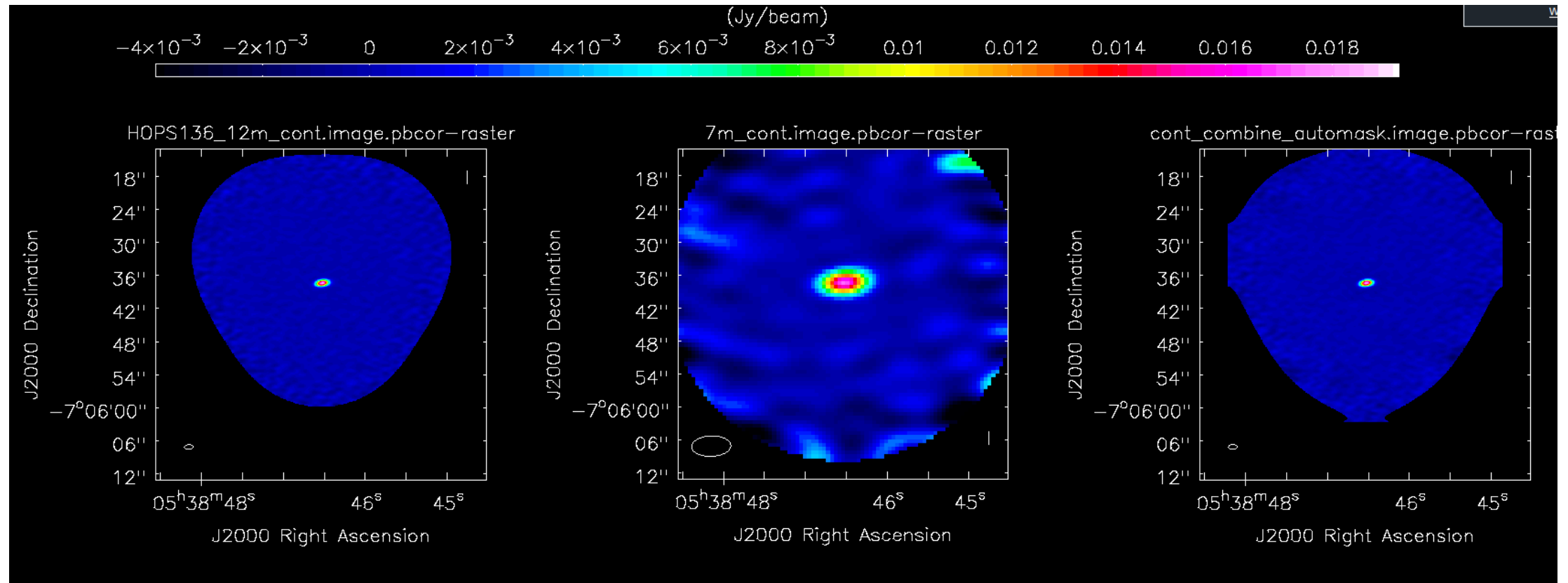
Wooseok Park, group 1

- A class I Young Stellar Object catalogued by HOPS (Herchel Orion Protostar Survey)
- Clearly shows bipolar outflow
- ALMA 12m+7m survey (Project Code 2012.1.01069.S, PI: Fischer, W.)



Fischer et al. (2013)

12m, 7m, 12m+7m image of Continuum



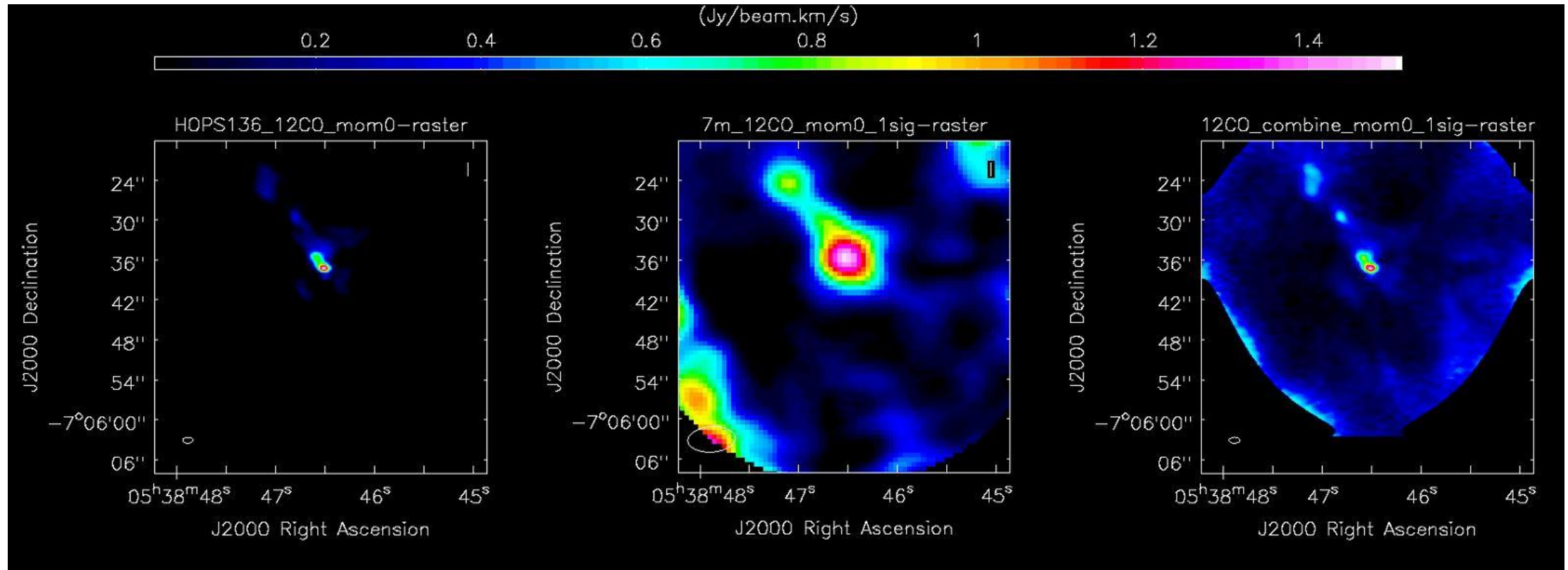
Deriving disk mass of HOPS 136

$$M_{\text{disk}} = 0.06 M_{\odot} \frac{F_{\lambda}}{1 \text{ Jy}} \left(\frac{d}{100 \text{ pc}} \right)^2 \frac{50 \text{ K}}{\langle T \rangle} \frac{0.01 \text{ cm}^2 \text{ g}^{-1}}{\kappa_{1.3 \text{ mm}}}, \quad (6)$$

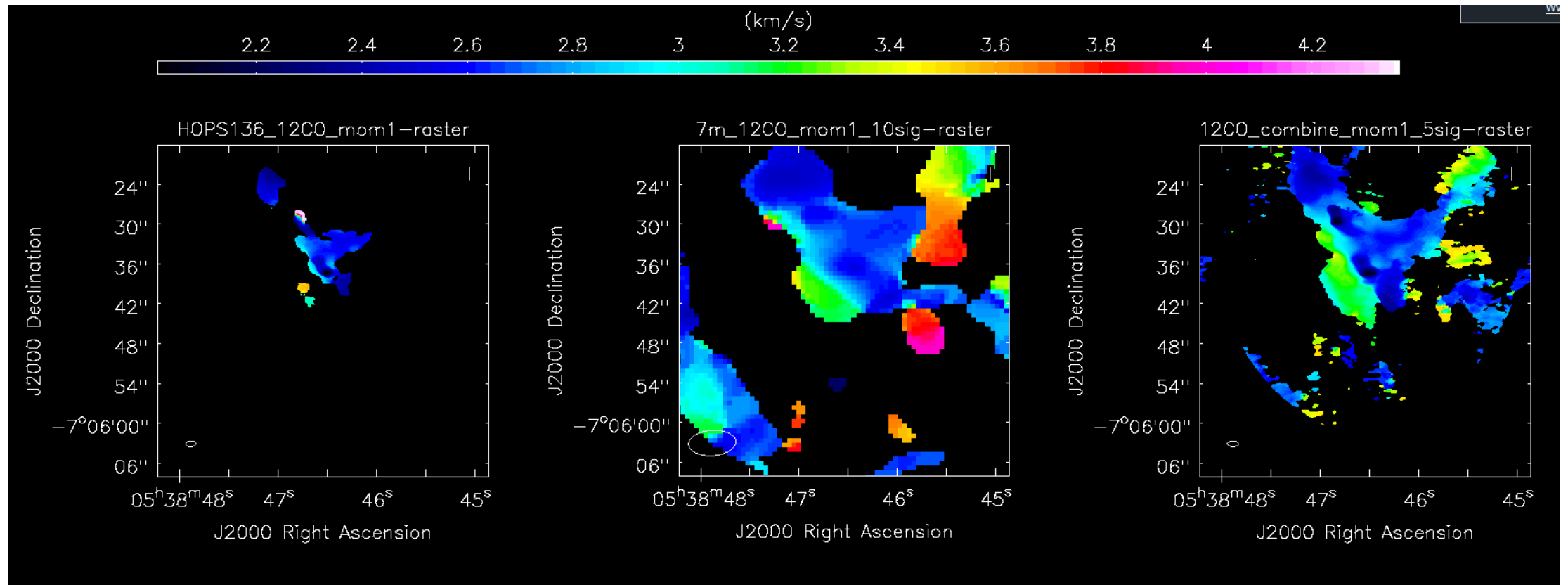
Thi et al. (2001)

- Derive disk mass using Flux
- $d = 420 \text{ pc}$, $F(\text{flux}) = 0.019 \text{ Jy}$, $T = 30 \text{ K}$, $\kappa_{1.3 \text{ mm}} = 0.01 \text{ cm}^2/\text{g}$
- $M_{\text{disk}} = 0.0335 M_{\text{sun}}$

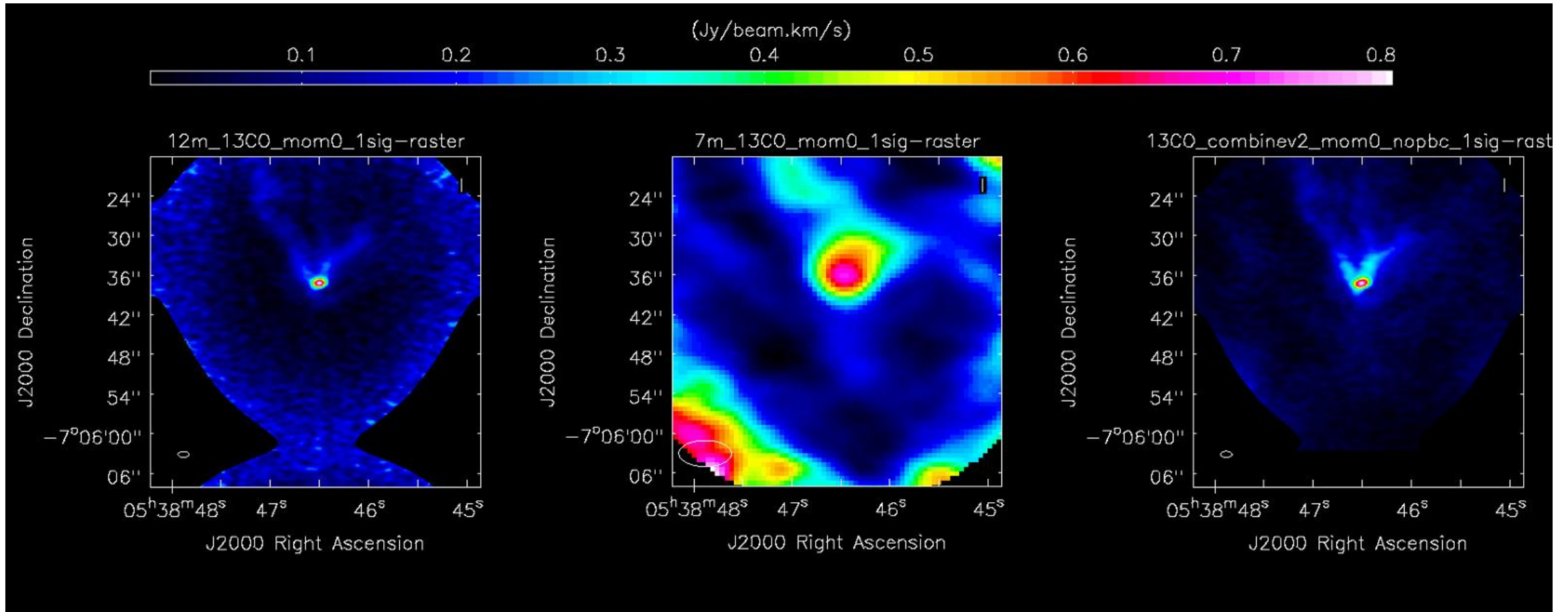
12m, 7m, 12m+7m image of 12CO line – mom0



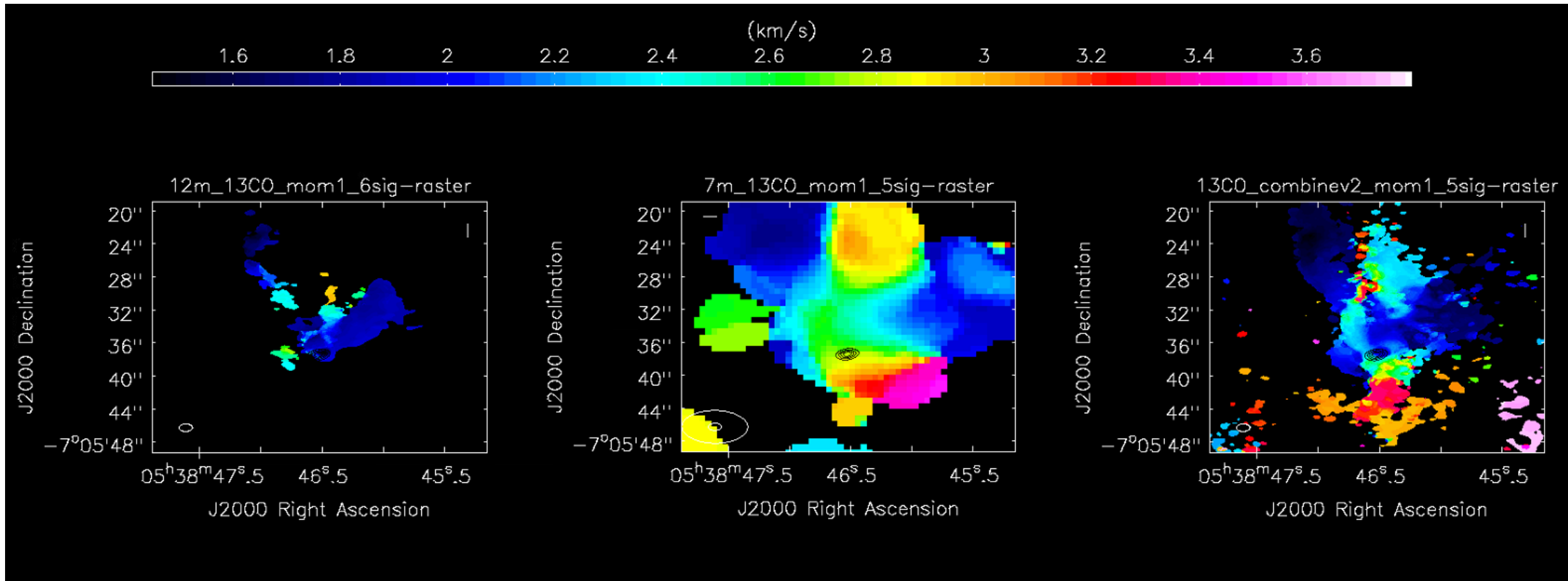
12m, 7m, 12m+7m image of 12CO line – mom1



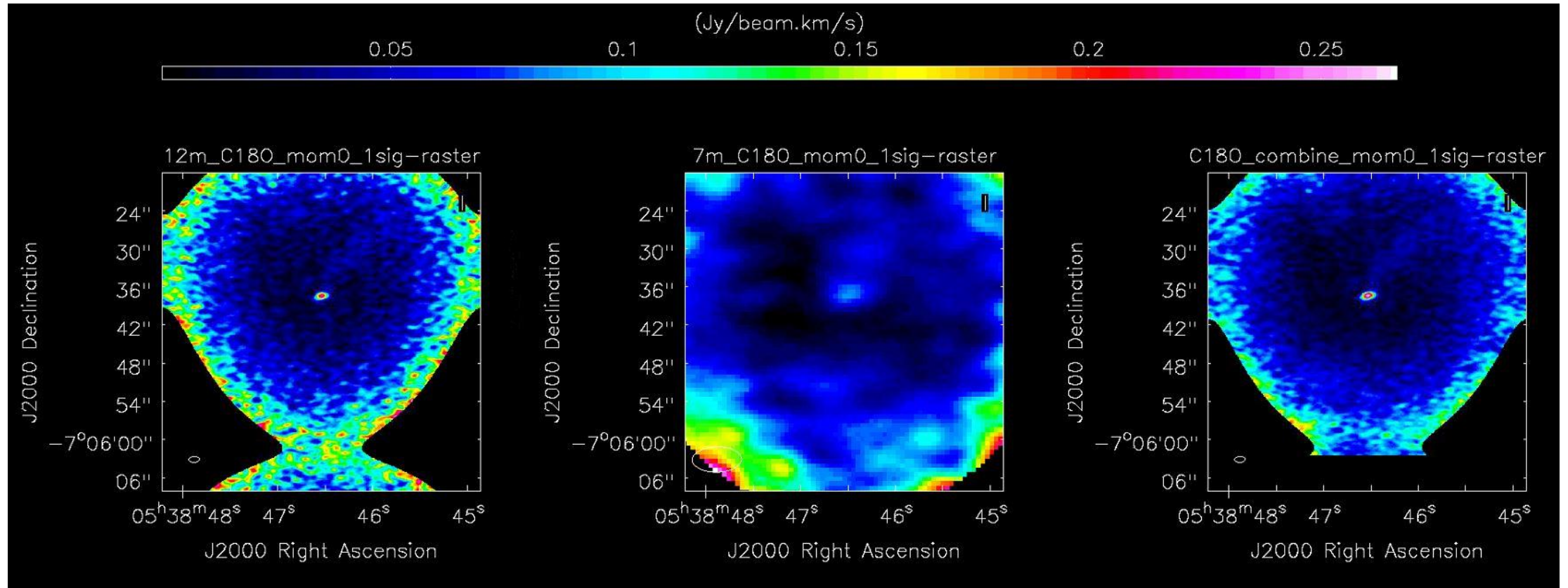
12m, 7m, 12m+7m image of ^{13}CO line – mom0



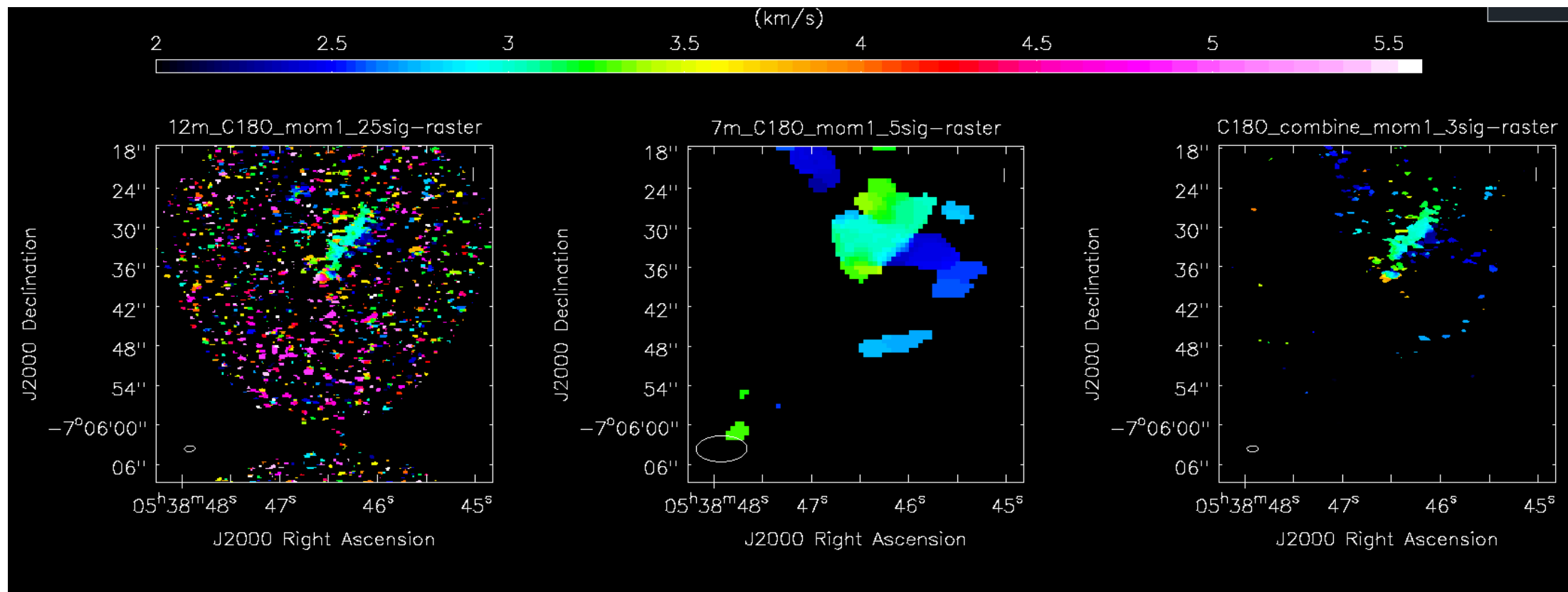
12m, 7m, 12m+7m image of ^{13}CO line – mom1



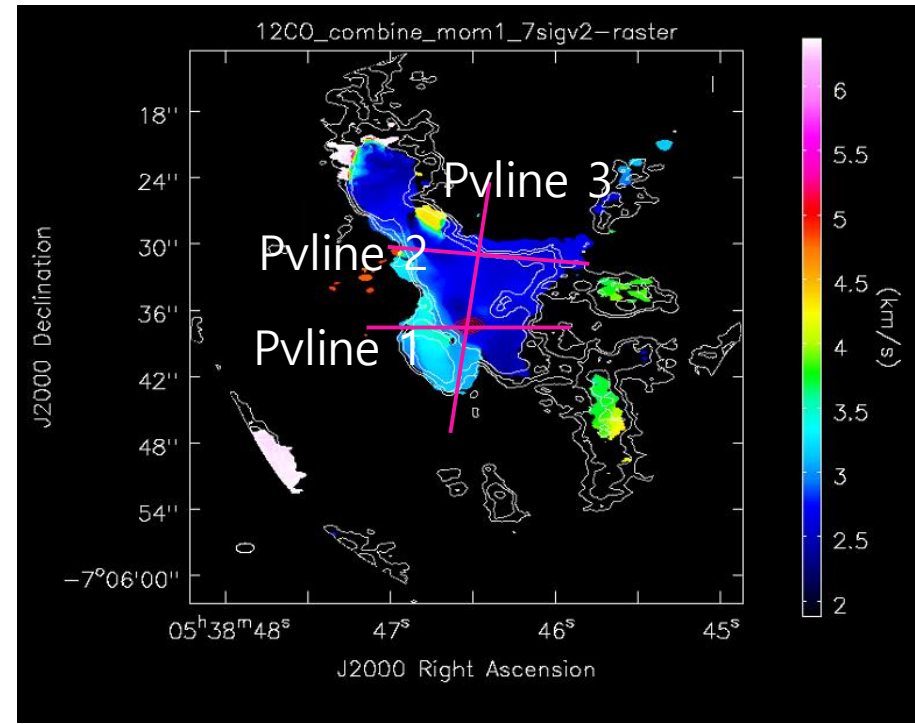
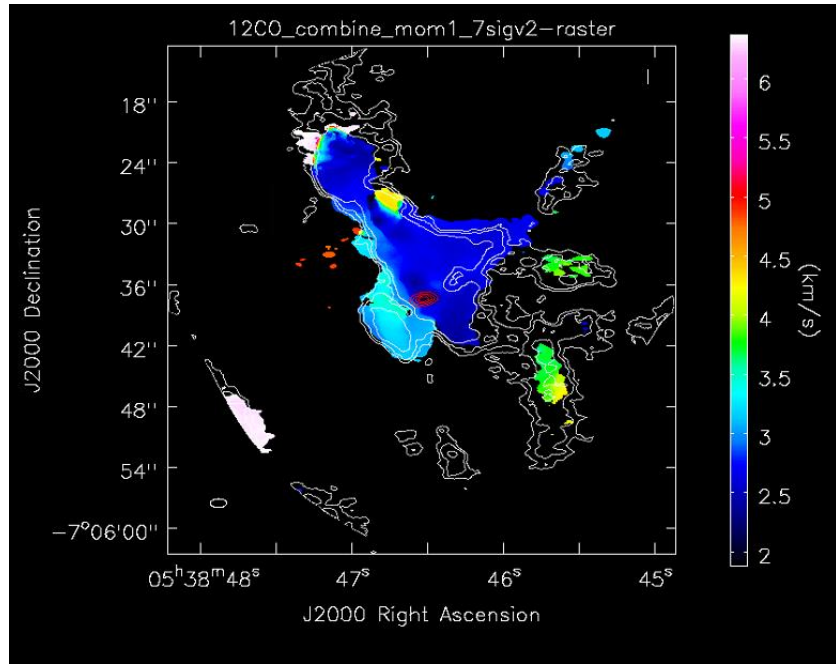
12m, 7m, 12m+7m image of C18O line – mom0



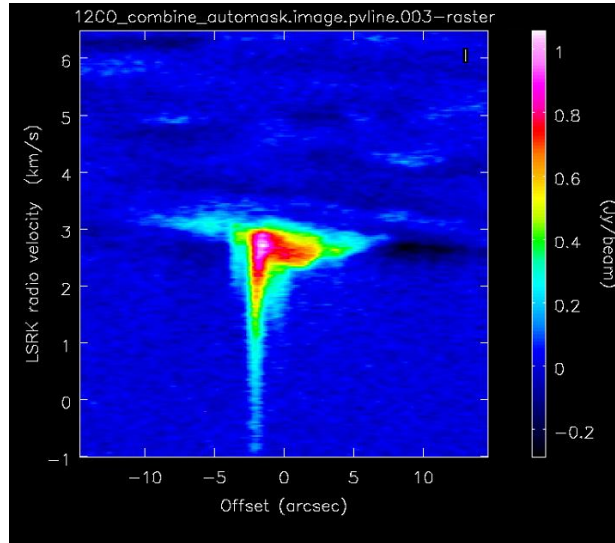
12m, 7m, 12m+7m image of C18O line – mom1



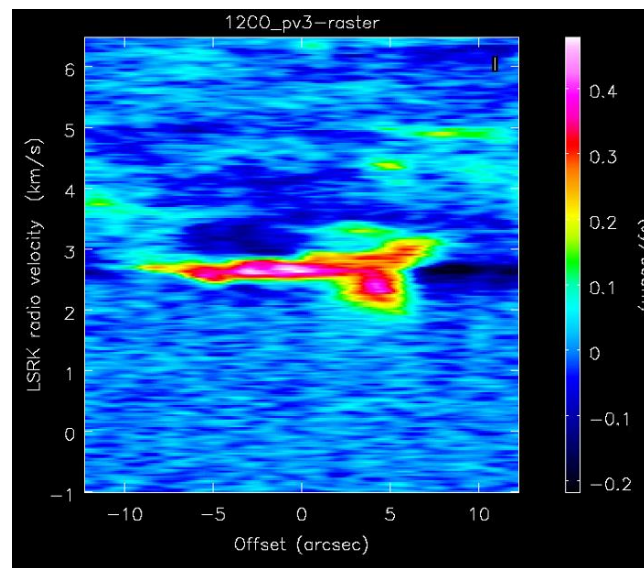
12CO (mom1 raster + mom0 contour)



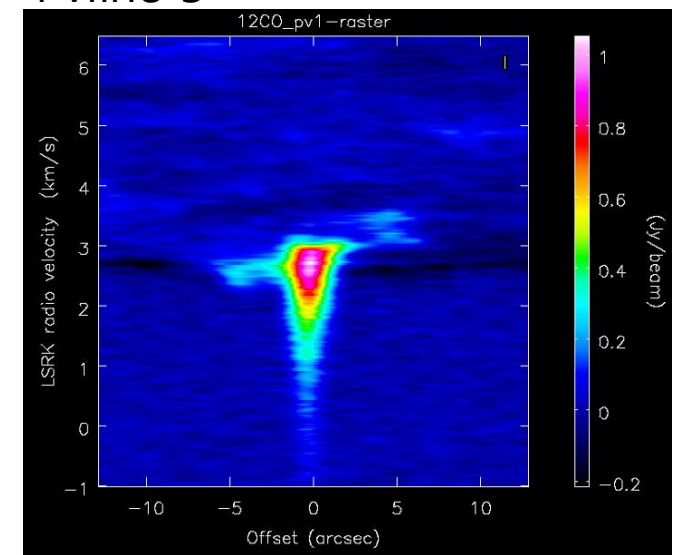
Pvline 1



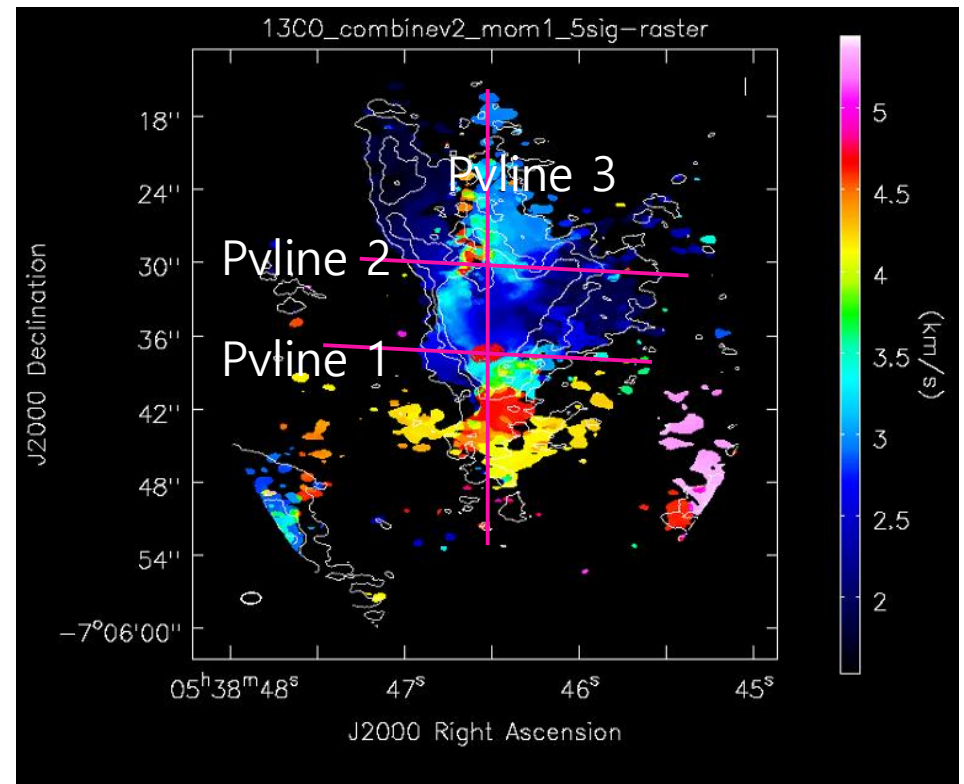
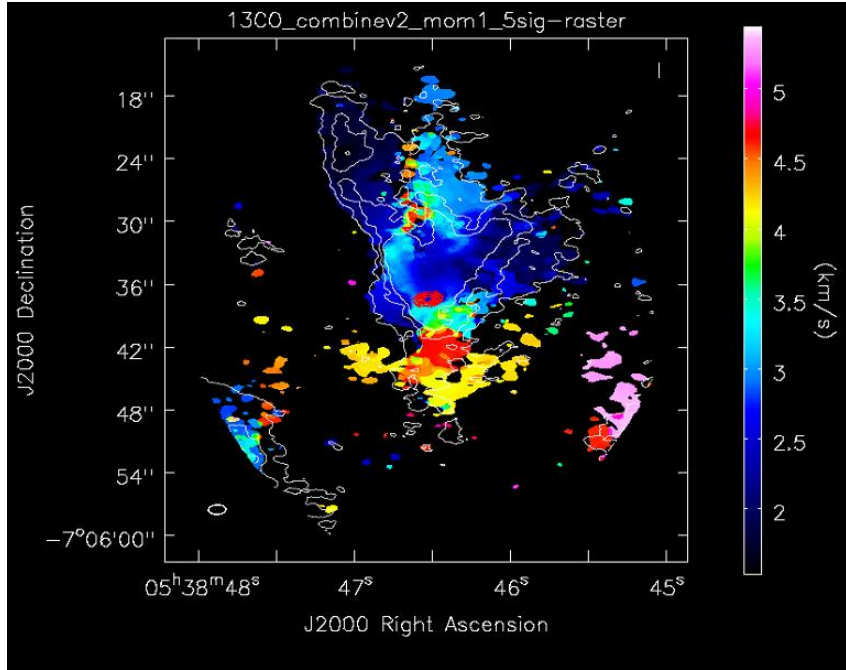
Pvline 2



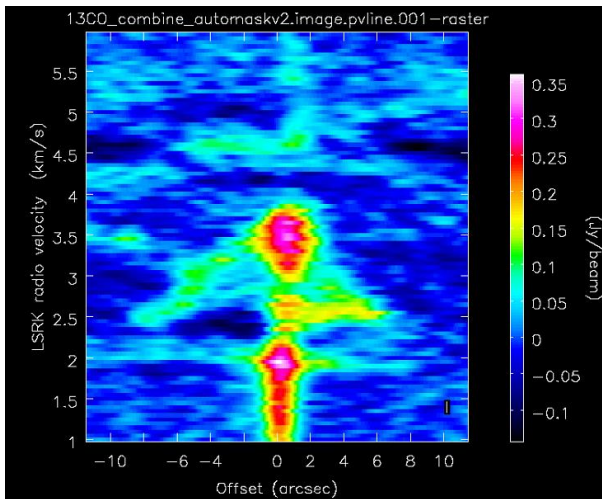
Pvline 3



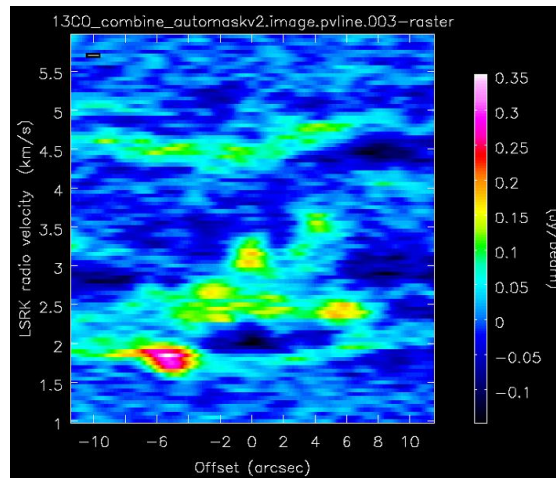
^{13}CO (mom1 raster + mom0 contour)



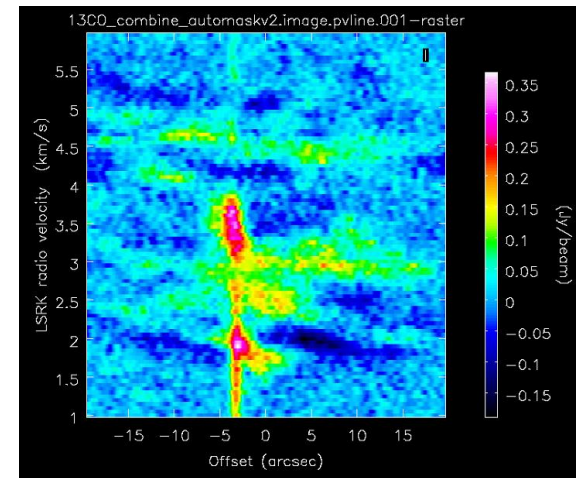
Pvline 1



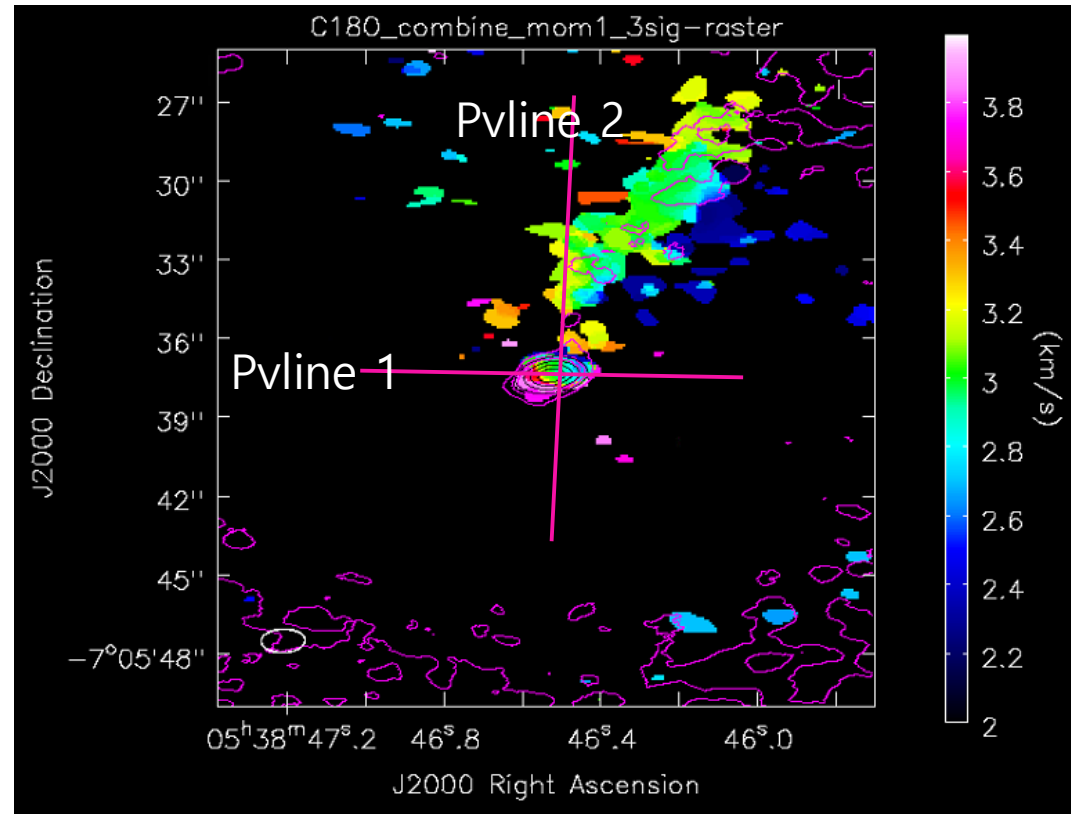
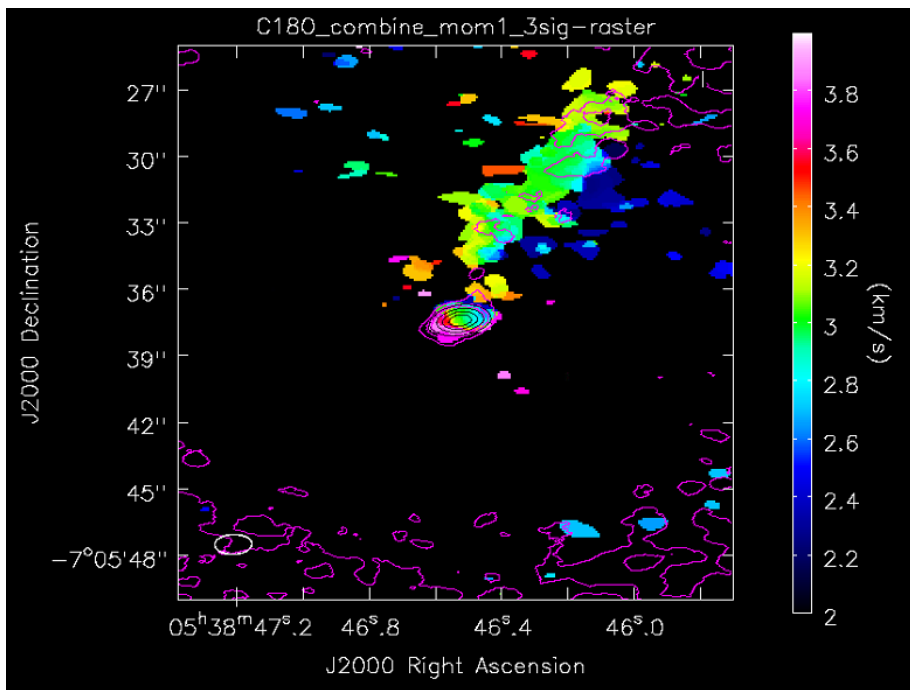
Pvline 2



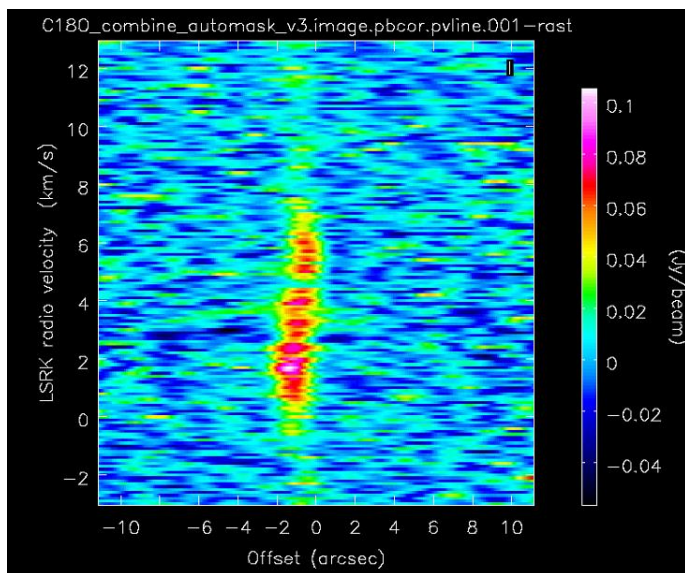
Pvline 3



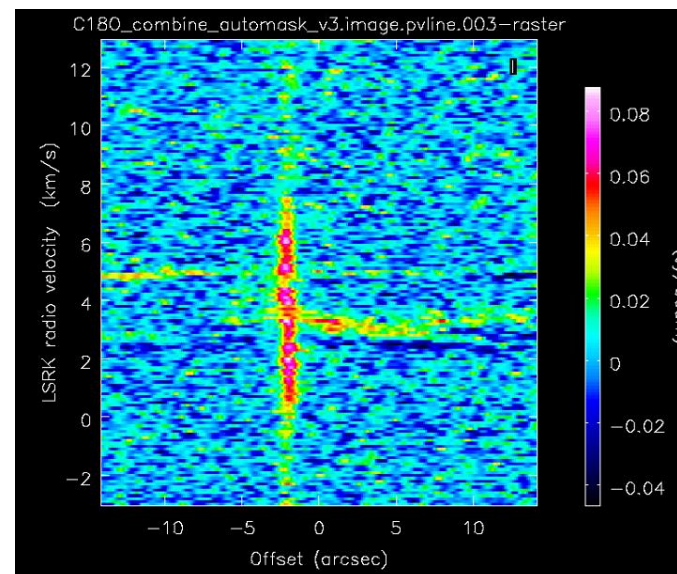
C18O (mom1 raster + mom0 contour)



Pvline 1



Pvline 2



Conclusion

- Combination of 12m & 7m covers both high spacial resolution and wide range of HOPS 136
- HOPS 136 clearly shows bipolar outflow
- Derived disk mass(gas+dust), which is 0.0335Msun
- ^{12}CO shows outer region of outflow, while CO isotopologues(^{13}CO , C^{18}O) showed more inner region of outflow, because they are optically thinner than ^{12}CO
- Also PV diagram shows the shape of outflow.