Multiple outflows, disk and jets in the S255 area of high mass star formation

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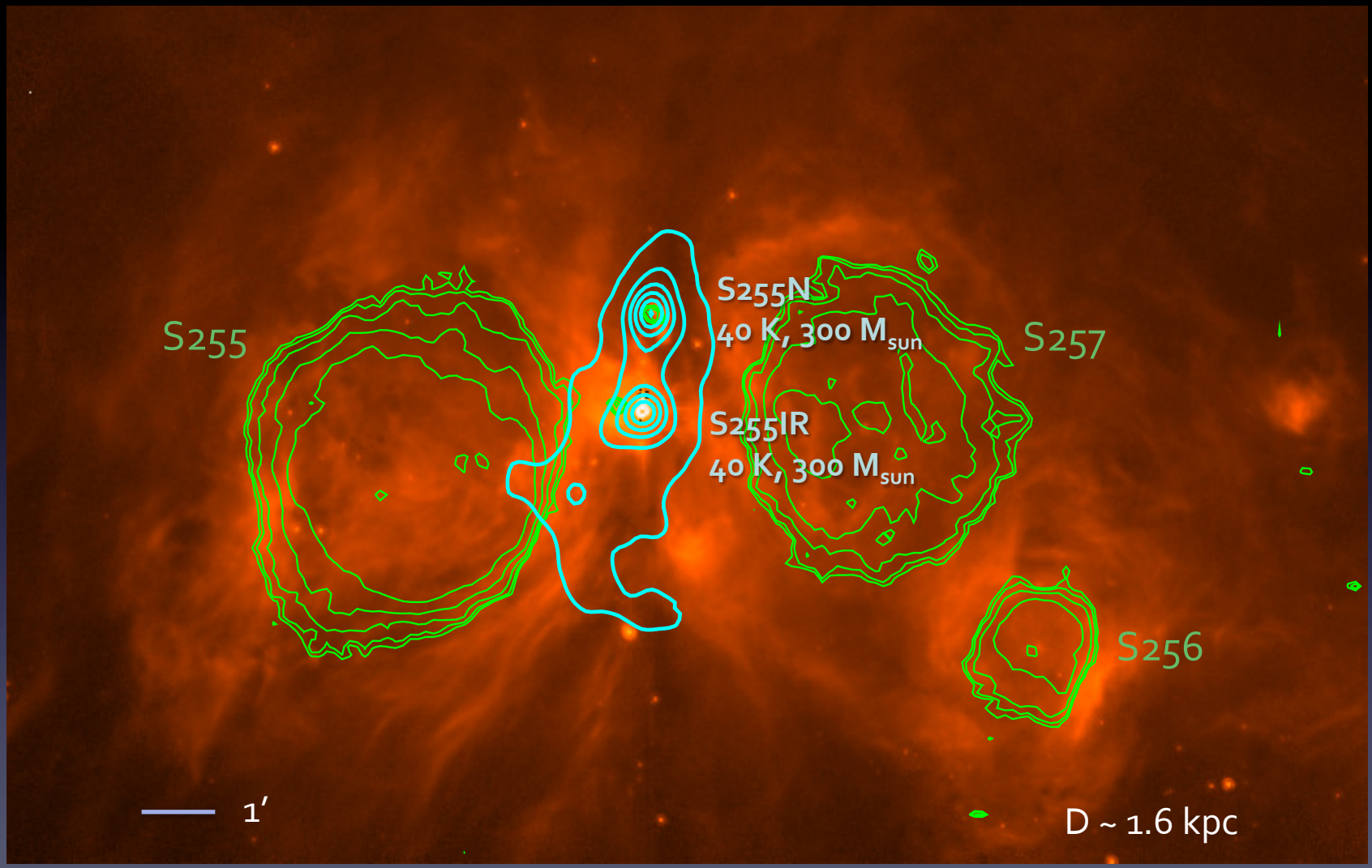
Outline

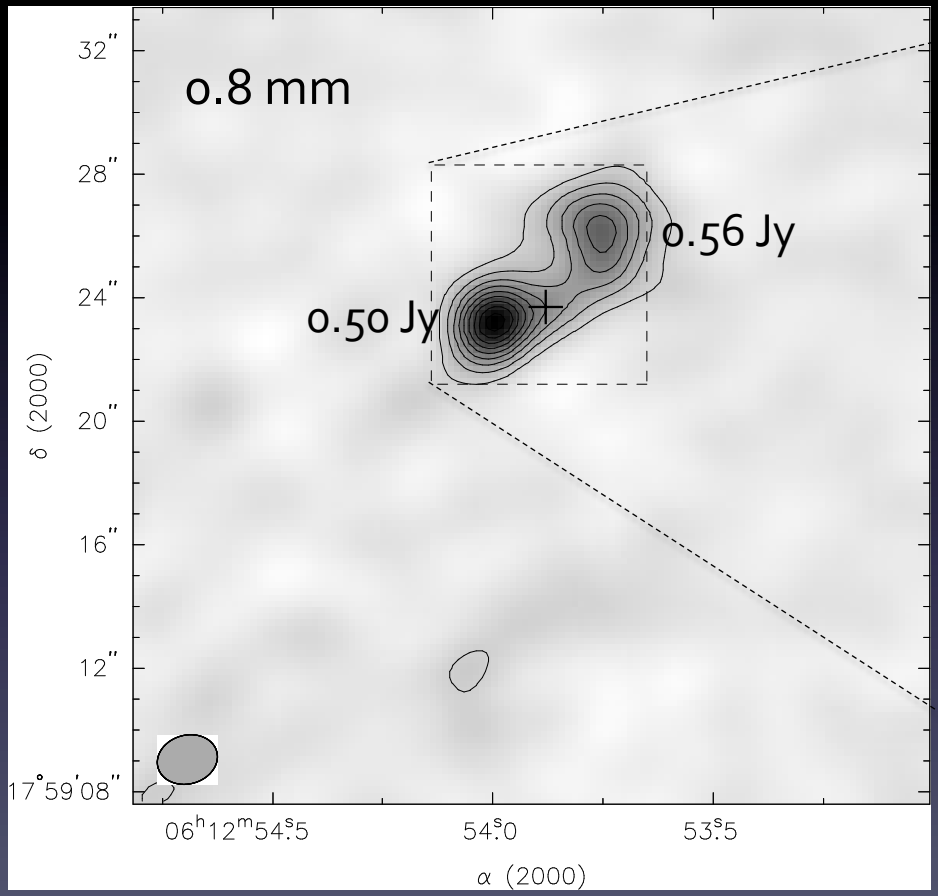
- General description of S255
- S255IR-SMA1
  - Kinematics
  - Physical properties
- Morphology and properties of the outflows
- Surroundings
- Very young outflows in the S255N area

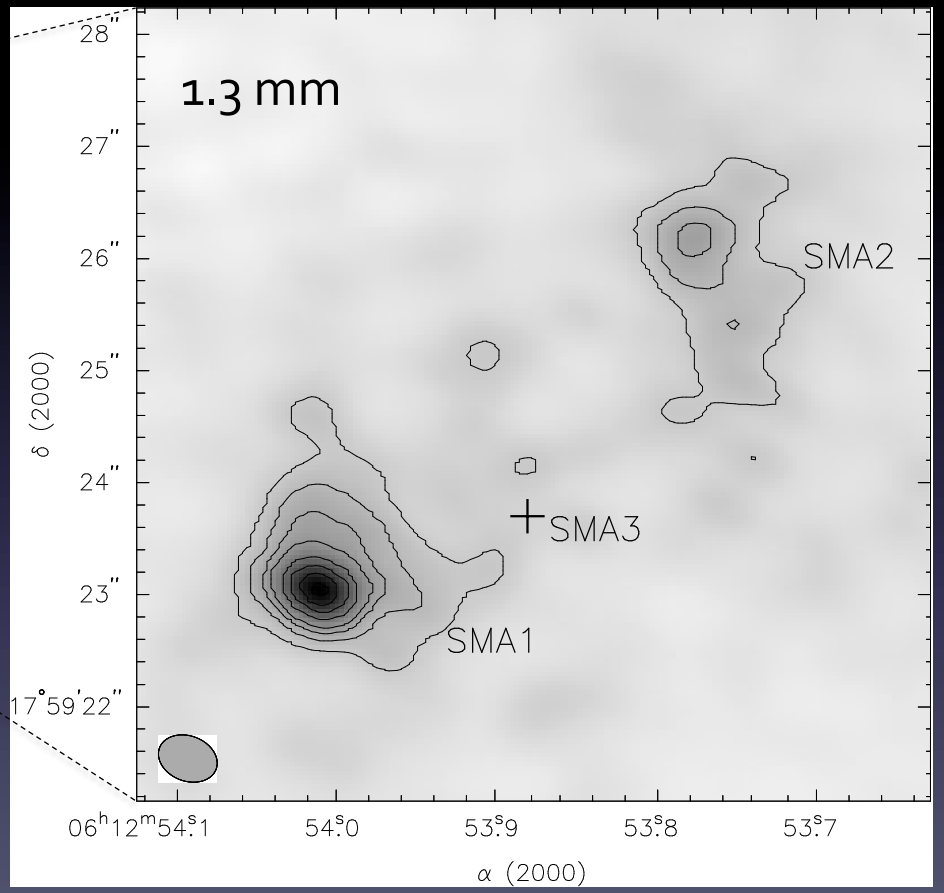
S255 star forming region



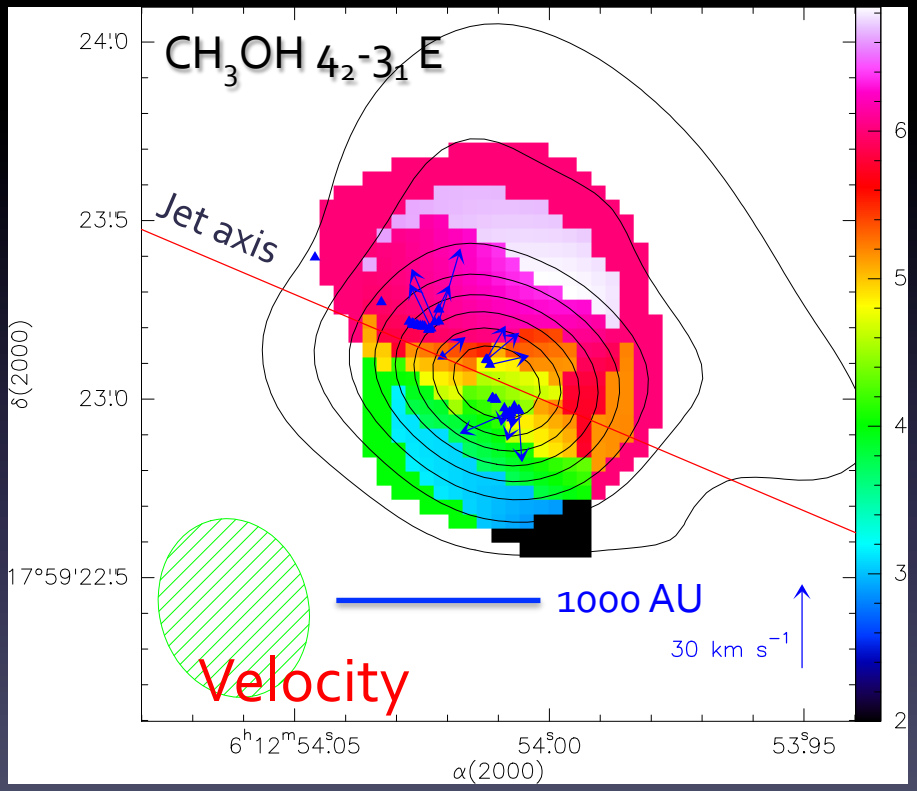
GMRT 610 MHz (green) and IRAM 30m 1.2 mm (cyan) contours overlaid on the Spitzer 8 μm image

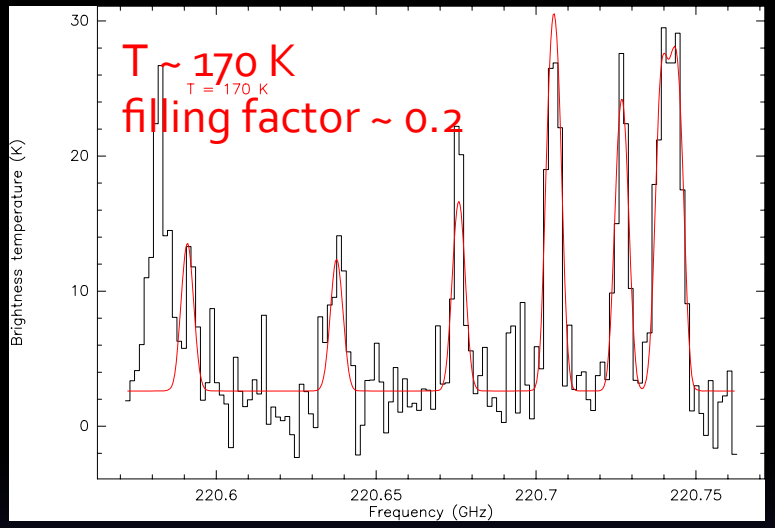
S255IR continuum

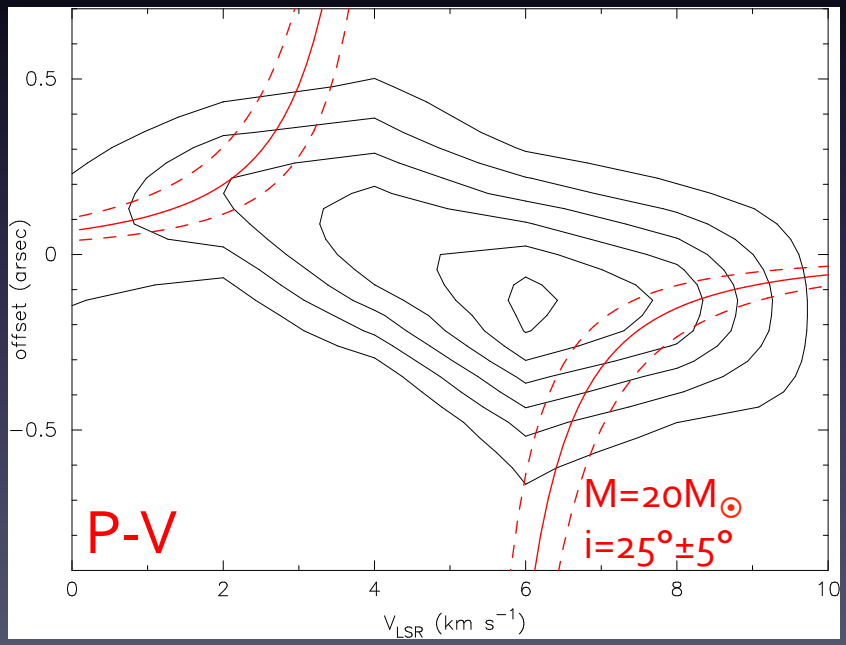




Rotating hot core

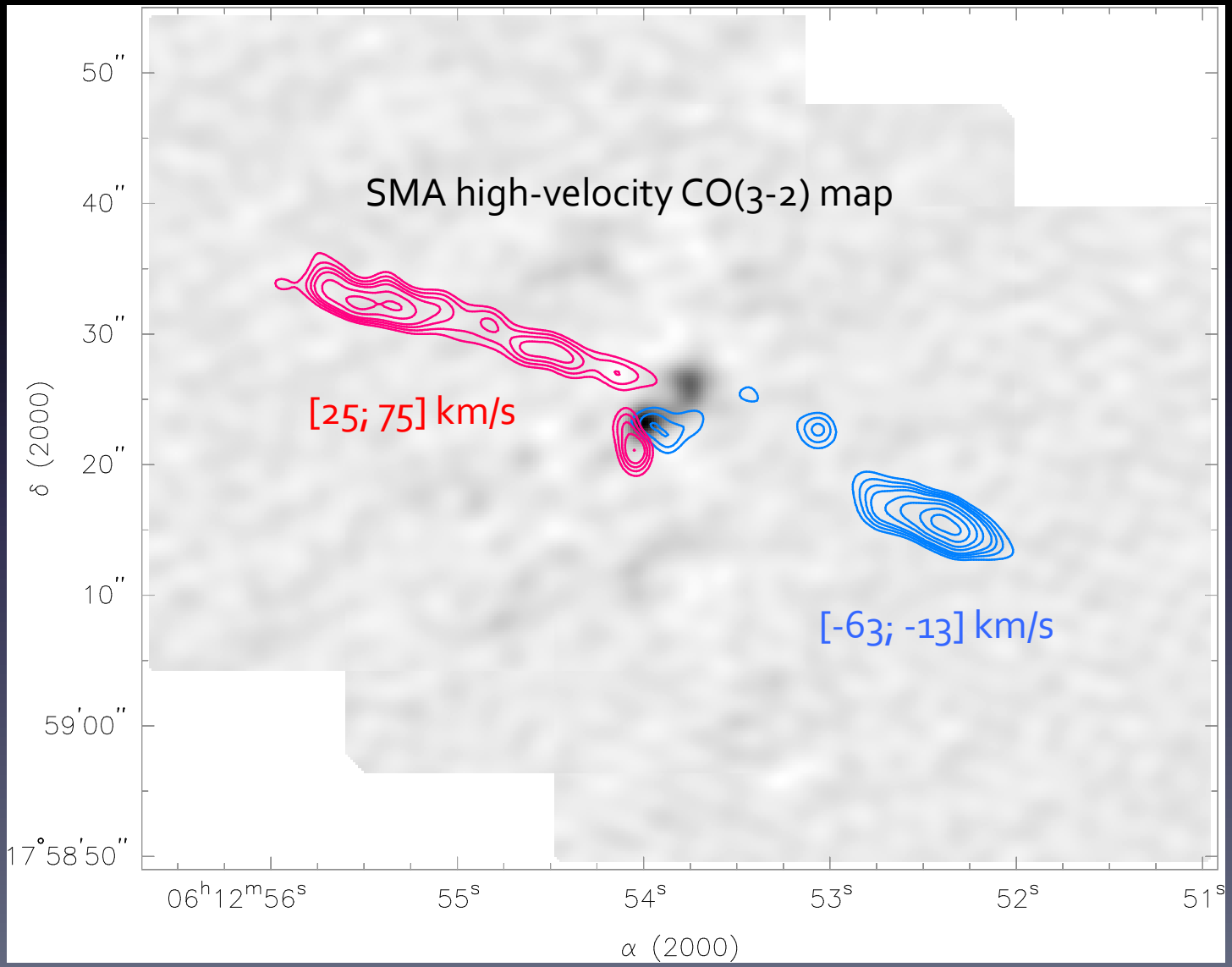




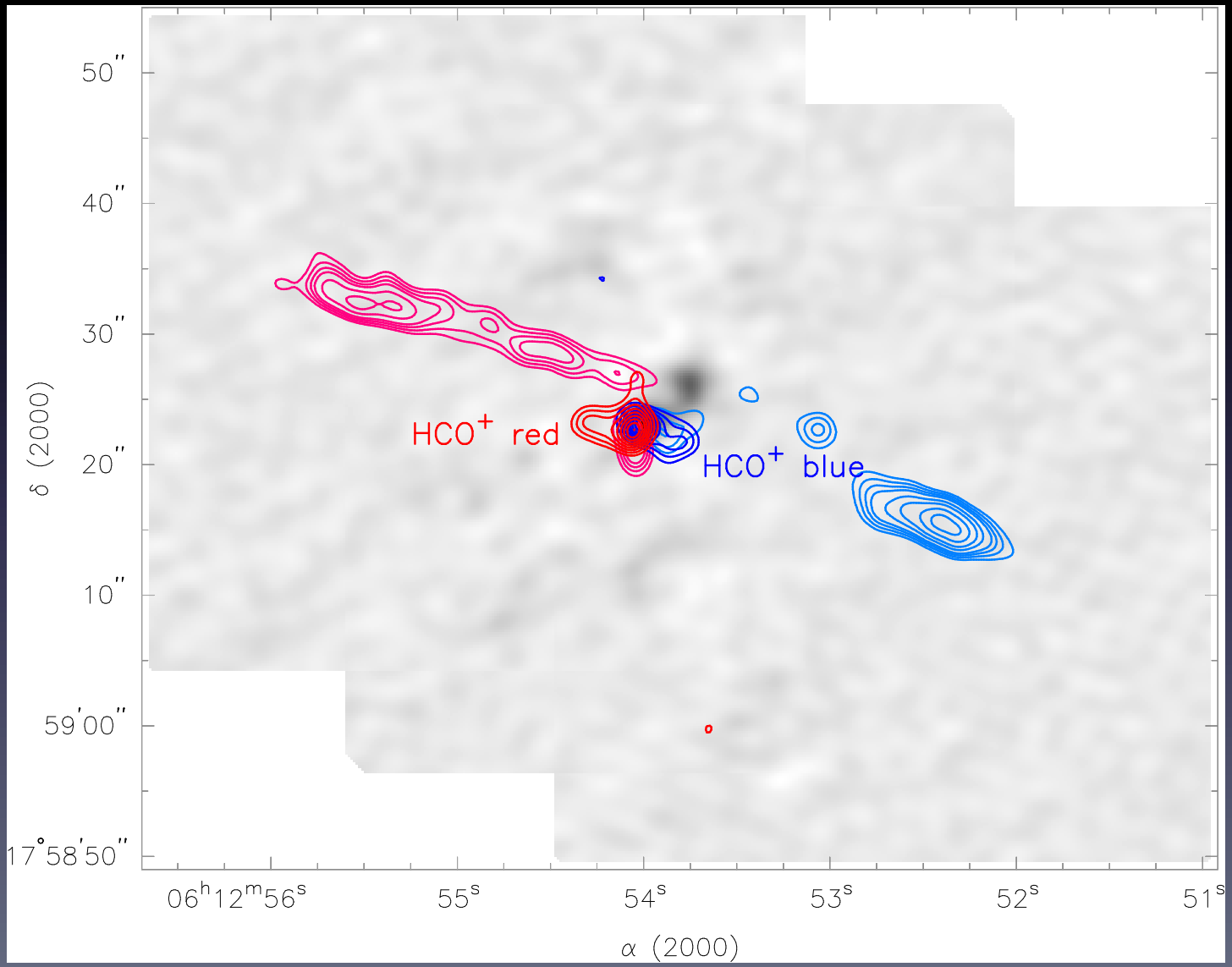


Zinchenko et al. 2015

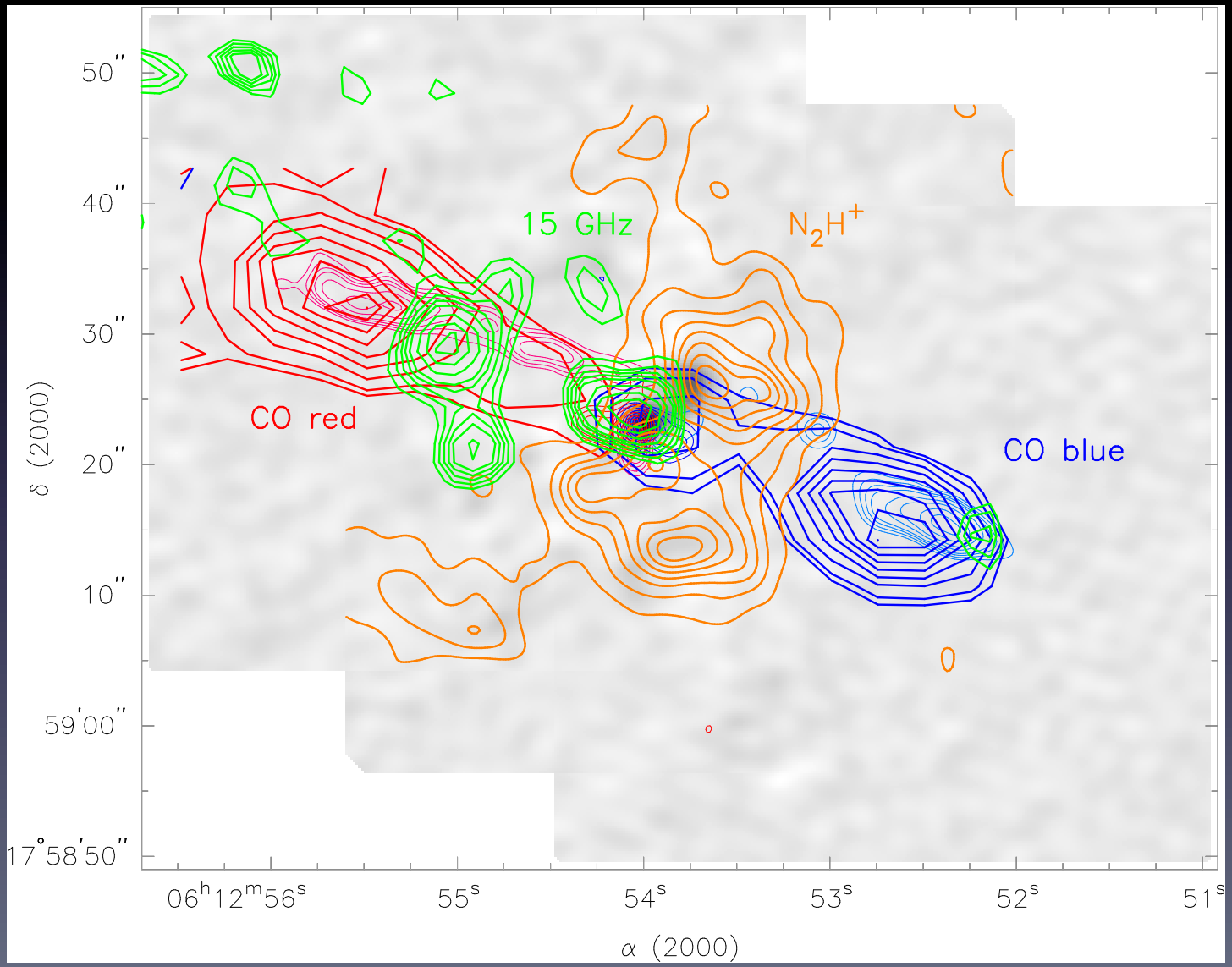
High velocity outflow in S255IR



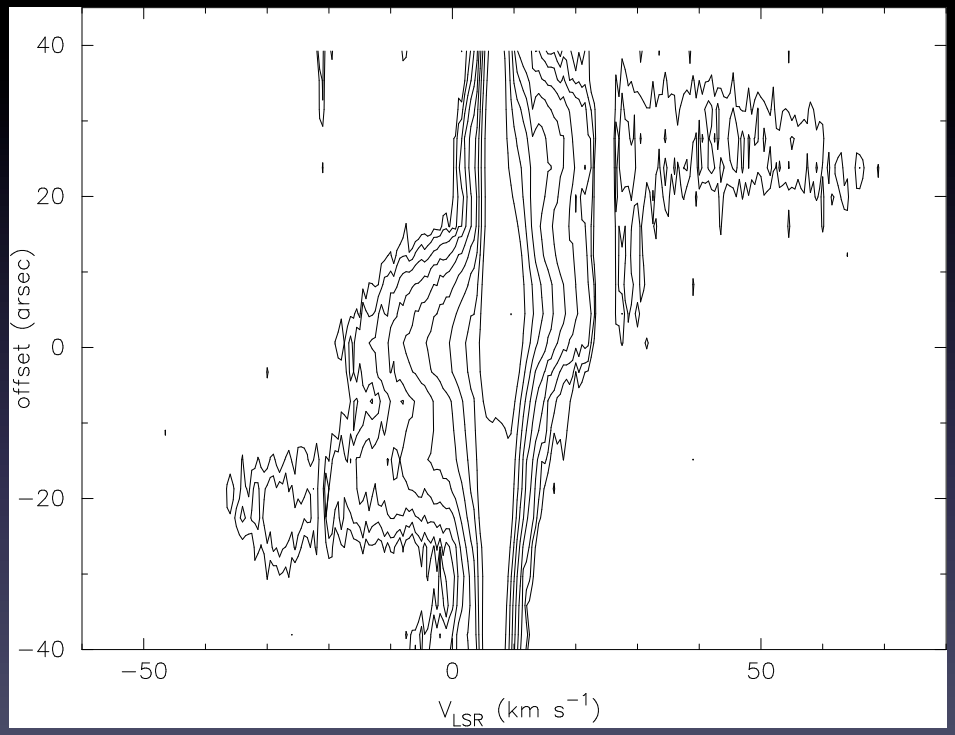
High velocity outflow in S255IR



High velocity outflow in S255IR



The position velocity diagram for the IRAM-30m CO data

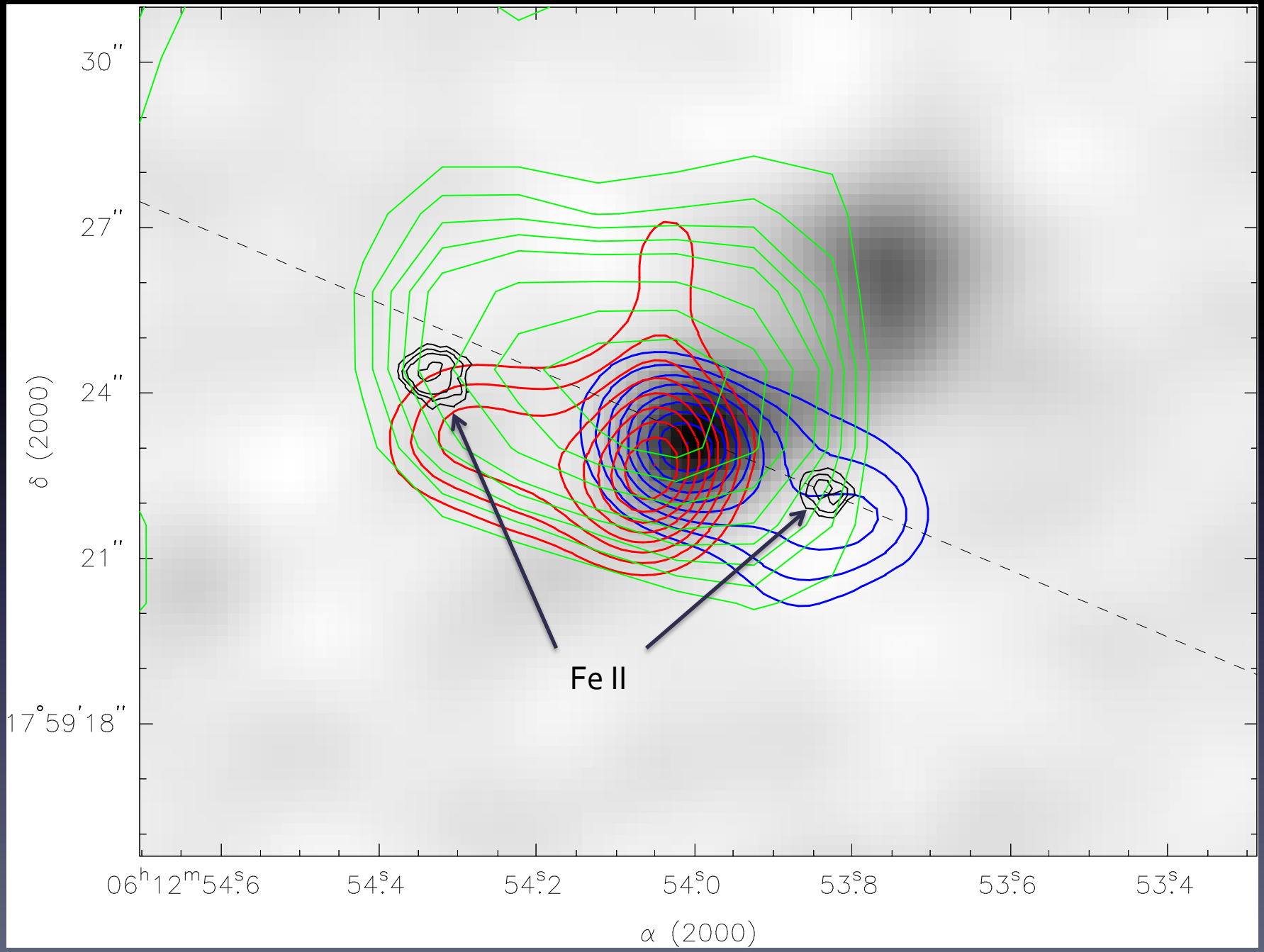


Molecular outflow properties predicted by different models

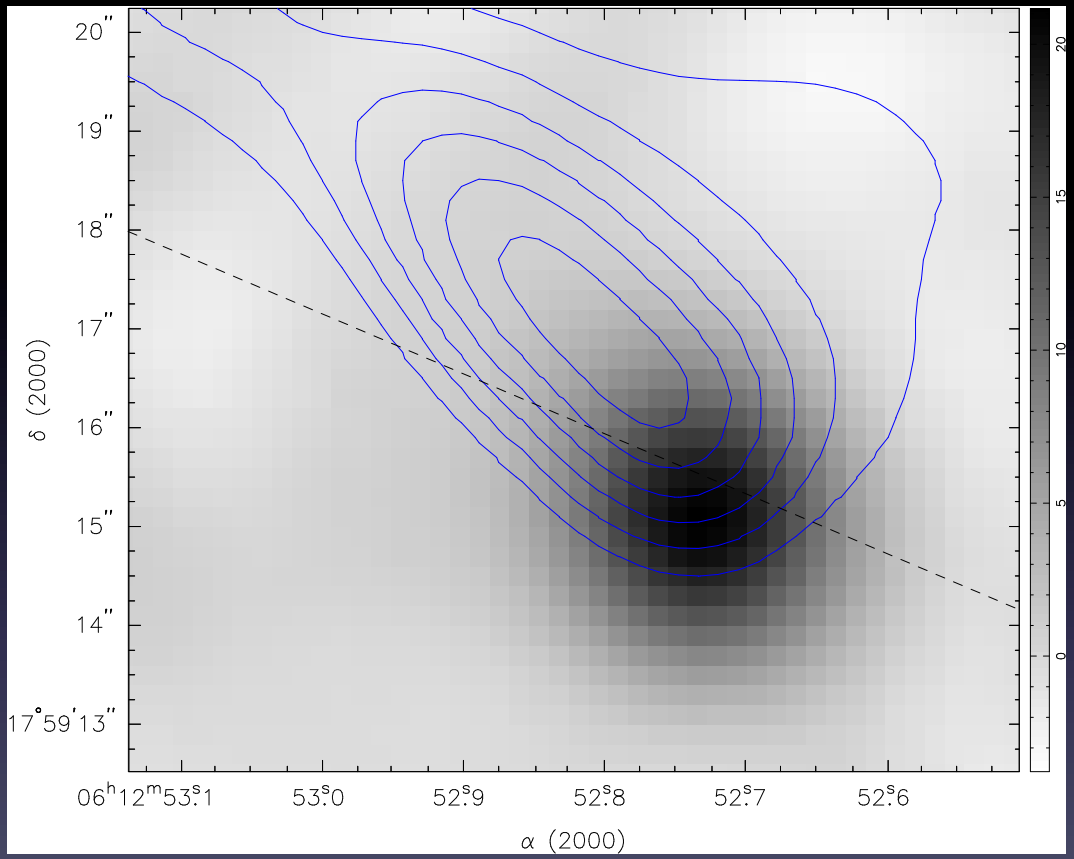
Model	Wind	Predicted property of molecular outflow along axis: Morphology	Velocity	Temperature	Momentum[a]
			v →	T →	P →
Turbulent Jet					
Jet Bow Shock					
Wide-angle Wind					
Circulation					

[a] Assuming an underlying density distribution of r^{-1} to r^{-2}.

Arce et al. 2007

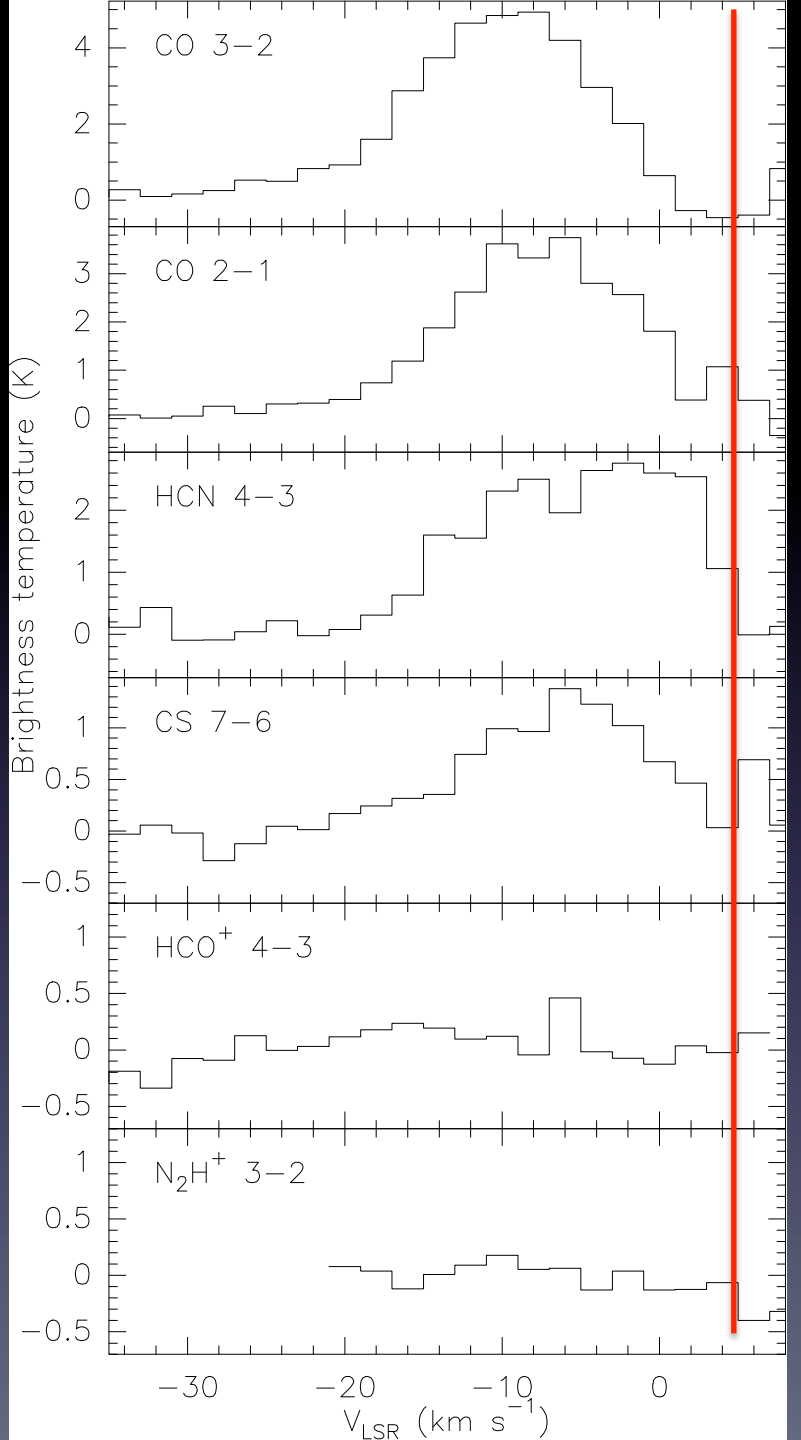

30''
27''
24''
21''
δ (2000)
17°59'18''
06h12m54s.6
54s.4
54s.2
54s.0
53s.8
53s.6
53s.4
α (2000)
Fe II

Dense high velocity clump

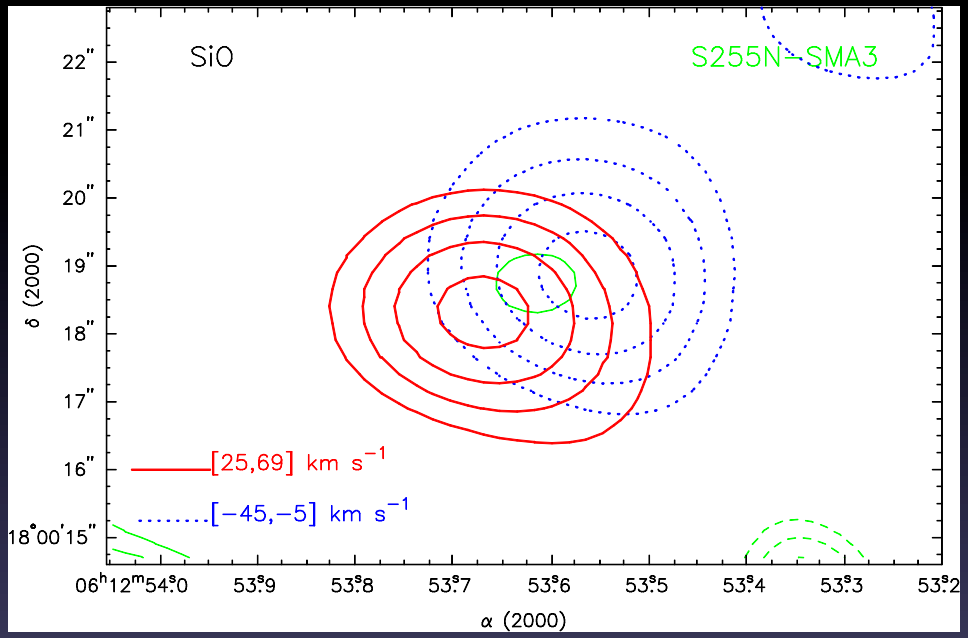


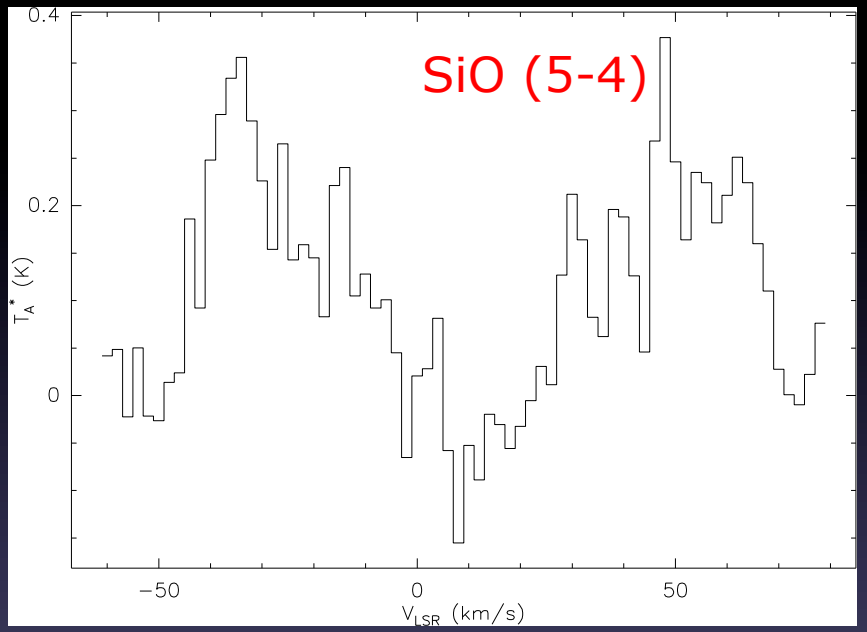
Grey-scale image – CS(7-6)
Contours – CO(3-2)

$n > 3 \times 10^6$ cm^{-3}, gravitationally unbound



Very young outflows in the S255N area





Parameters of the Outflows in S255N-SMA3 and S255N-SMA5 (Mass, Momentum, Energy, Size, Age, Mass Loss Rate, and Mechanical Force)

Name	M ($M_\odot$)	P ($M_\odot$ km s^{-1})	E (erg)	Size (pc)	t (yr)	$\dot{M}$ ($M_\odot$ yr^{-1})	F ($M_\odot$ km s^{-1} yr^{-1})
S255N-SMA3	0.003	0.15	8×10^{43}	0.009	200	2×10^{-5}	8×10^{-4}
S255N-SMA5	0.012	0.36	10^{44}	0.012	400	3×10^{-5}	9×10^{-4}

Summary

- The hot (T ~ 150 K) dense (n > 6 10^8 cm^{-3}) core in S255IR-SMA1 probably represents a fragmented (the filling factor ~ 0.2) protostellar disk around the massive (20 $M_\odot$) star with a size of ~500 AU. The mass of the clump is significantly lower than the mass of the central star.
- The CO outflow morphology obtained from combination of the SMA and IRAM-30m data is significantly different from that derived from the SMA data alone. The CO emission detected with the SMA traces only one boundary of the outflow and leads to a rather distorted picture.
- The outflow is most probably driven by jet bow shock. There are signs of episodic ejections.
- The outflow strongly affects the chemical composition of the surrounding medium. The N_2H^+ molecules are destroyed.
- Very young outflows (a few hundred years only) are detected in the S255N area.

Publications

- I. Zinchenko, S.-Y. Liu, Y.-N. Su, S. V. Salii, A. M. Sobolev, P. Zemlyanukha, H. Beuther, D. K. Ojha, M. R. Samal, and Y. Wang. The Disk-outflow System in the S255IR Area of High-mass Star Formation. The Astrophysical Journal, Volume 810, Issue 1, article id. 10, 18 pp. (2015)
- I. Zinchenko, S.-Y. Liu, Y.-N. Su, S. Kurtz, D. K. Ojha, M. R. Samal, and S. K. Ghosh. A Multi-wavelength High-resolution study of the S255 Star-forming Region: General Structure and Kinematics. The Astrophysical Journal, Volume 755, Issue 2, article id. 177, 19 pp. (2012)

THANK YOU!