HI emission from red giants with the VLA

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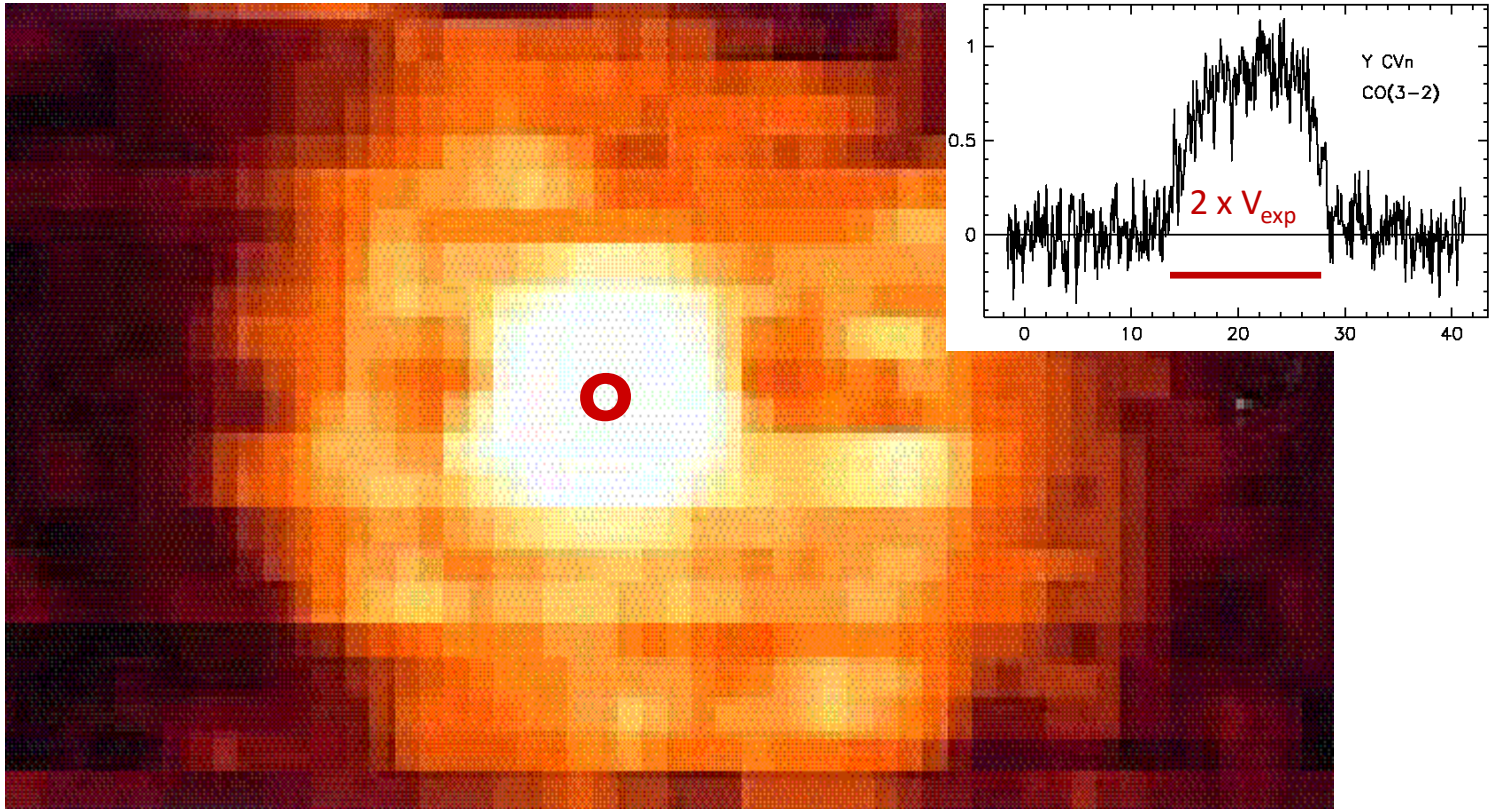
Betelgeuse 2016

dust, at low temperature, is emitting in the far-infrared

→ IRAS, ISO, Spitzer, Akari, and Herschel



Y CVn

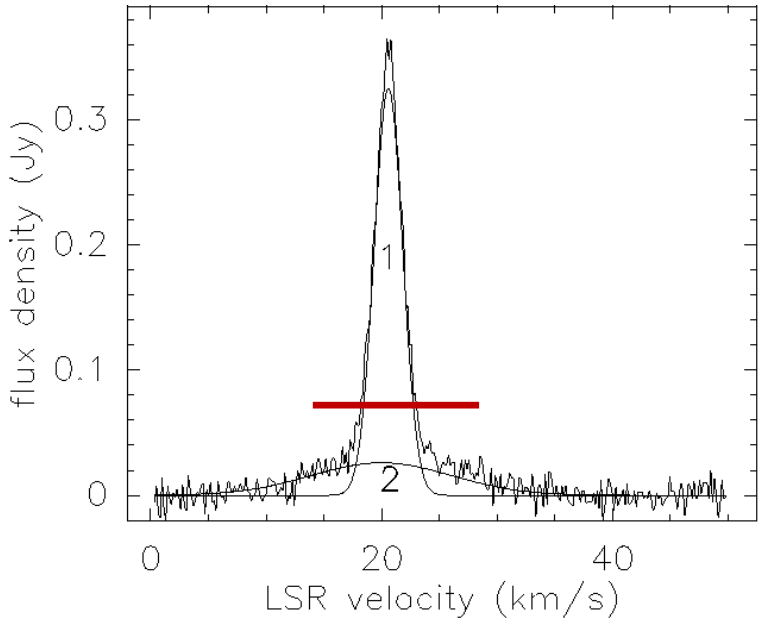
8 km s^{-1}

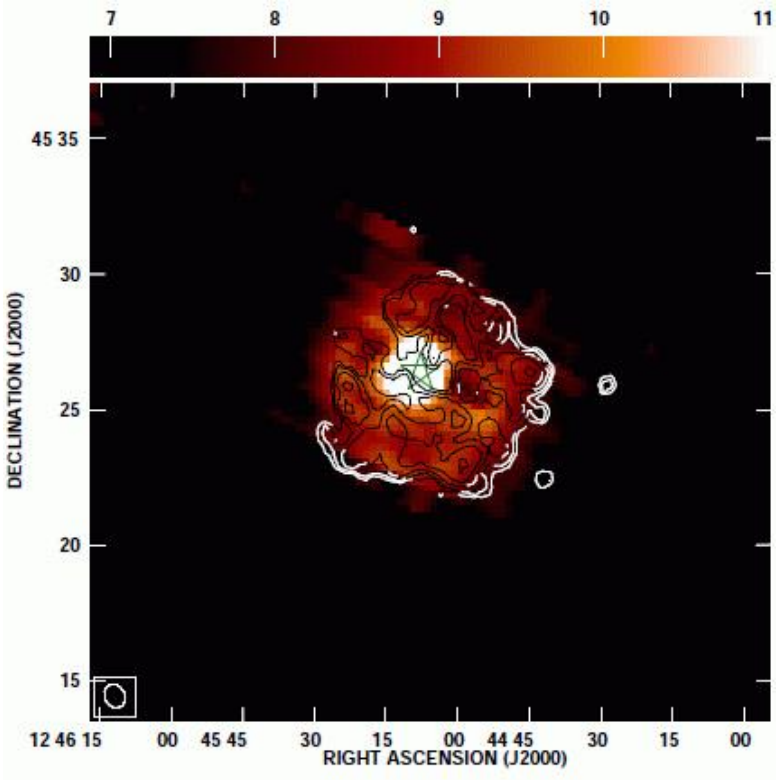
~1 x10^{-7} M_{sol} yr^{-1}

ISOPHOT 90 µm; dust detached shell of ~ 8 arcmin. diameter (~0.5 pc)

(Izumiura et al. 1996, A&A, 315, L221)

φ(CO) ~13 arcsec. (Neri et al. 1998, A&AS, 130, 1)





FWHM (HI) << 2 x V_{exp}

1. HI probes a region where the stellar outflow has been slowed down.

Matthews et al. 2013, AJ, 328, 797
(~ 50'' spatial resolution)

V_{cent} (HI) ~ V_{star}

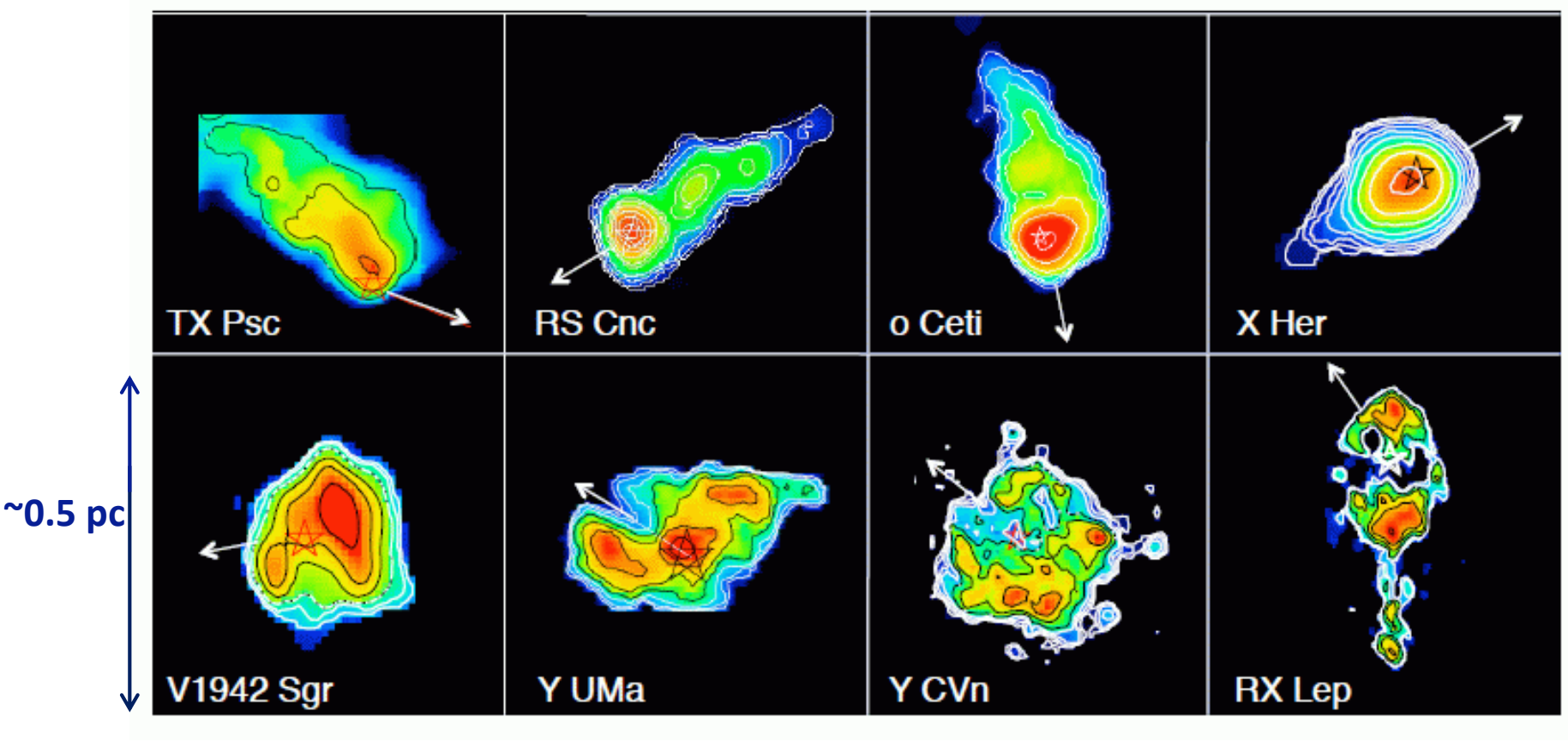
2. This region shares the same space velocity as the central star.

→ HI reveals a quasi-stationary shell around the central star

Before being injected into the ISM the stellar matter is slowed down

VLA observations show a wide variety of different situations

(Matthews & Reid 2007; Matthews et al. 2008, 2011, 2013)

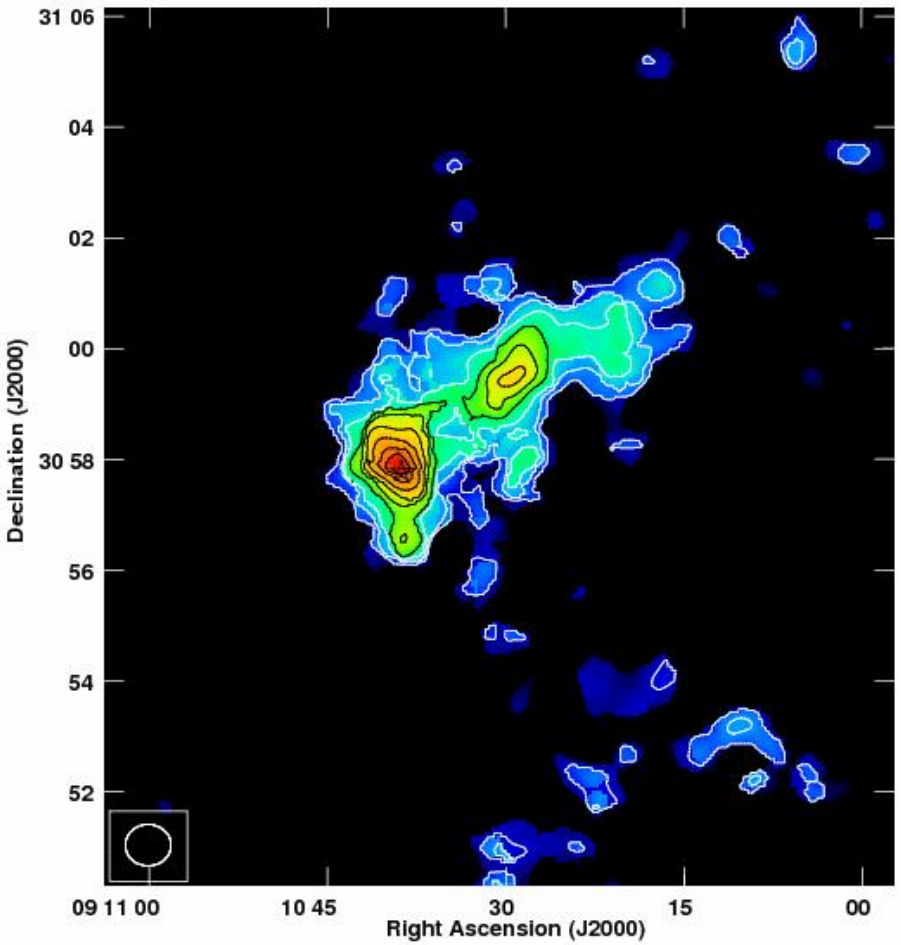


However, always a narrow spectral line (3-5 kms^{-1}), with sometimes a gradient in the centroid velocity (extreme case of Mira ~ 15 kms^{-1} /degree)

RS Cnc (Hoai et al. 2014, A&A, 565, A54)

$V_{lsr}(*)$= 7 kms^{-1}
d = 143 pc

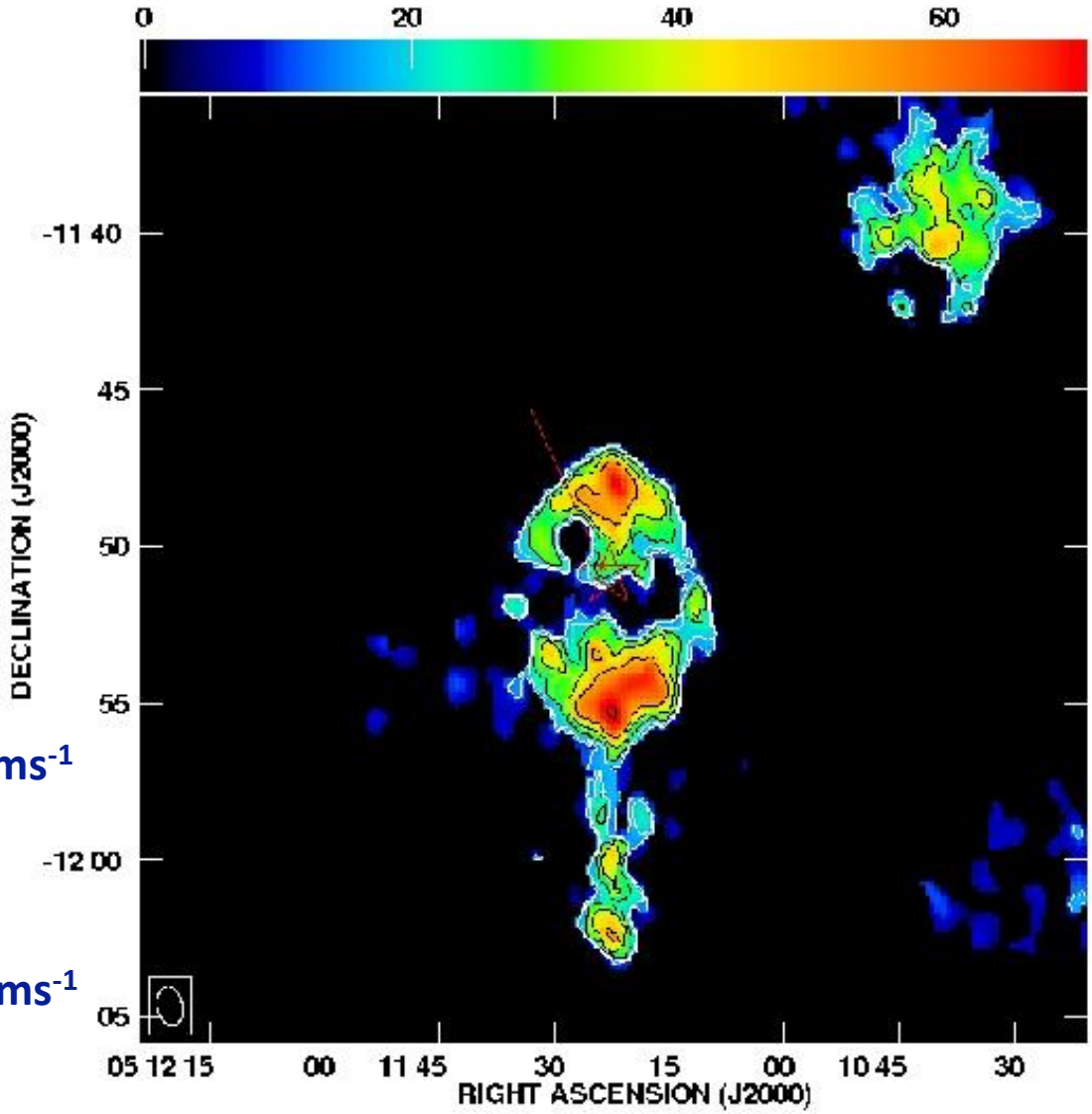
$V_{3D}(*)$= 15 kms^{-1}



length~6' (0.25 pc)

Head-tail morphology with indices of vortices
Injection of stellar matter into the ISM ?
→ need for high spectral resolution

RX Lep (Matthews et al. 2013, AJ, 145, 97)



V_{lsr}(*)= 29 kms^{-1}
d = 149 pc

V_{3D}(*)= 57 kms^{-1}

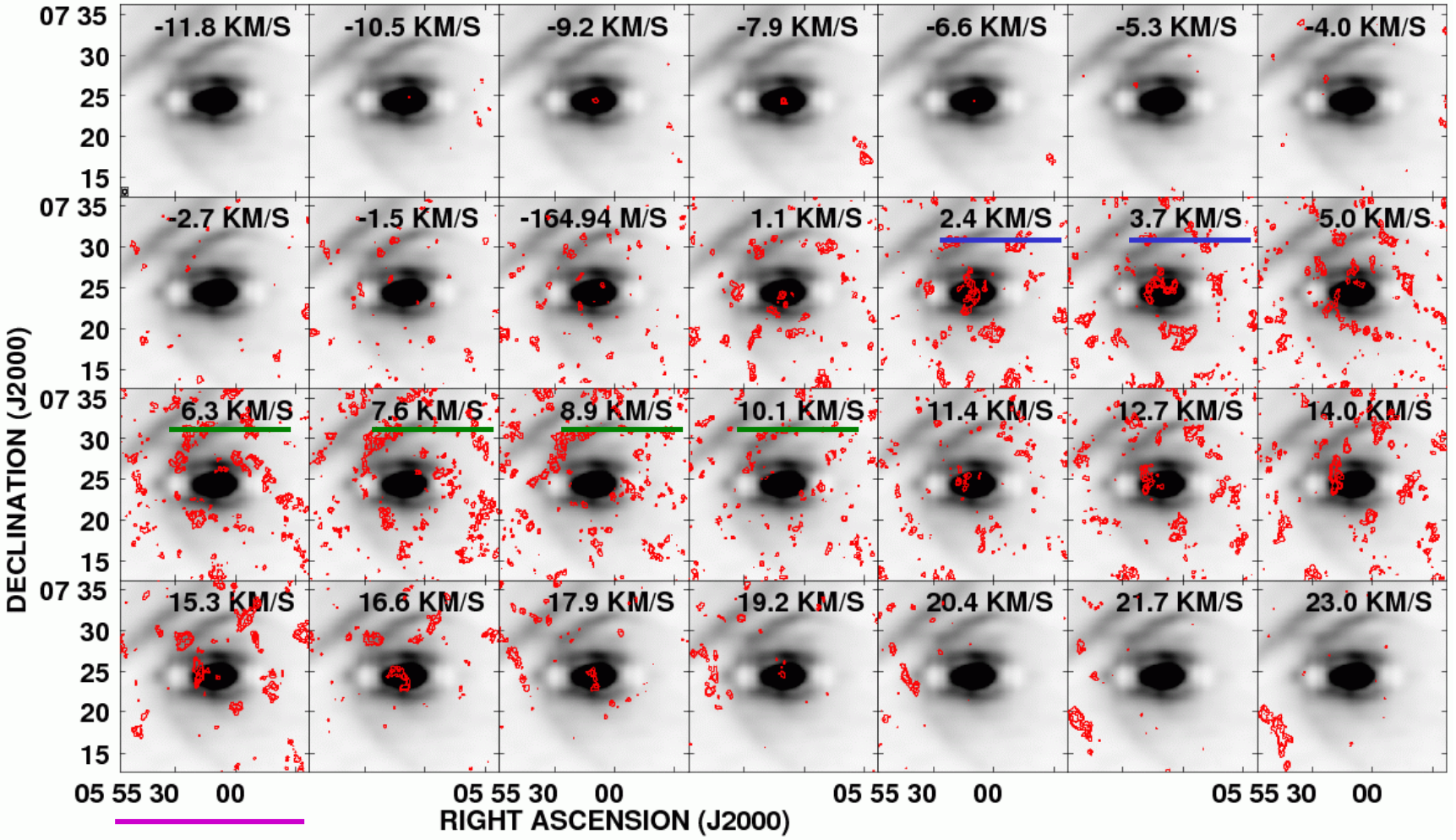
broken ring + tail
length~18' (0.75 pc)

Suspicion of a bipolar outflow at center
that may shape the extended static shell (Hoai et al. in prep.)

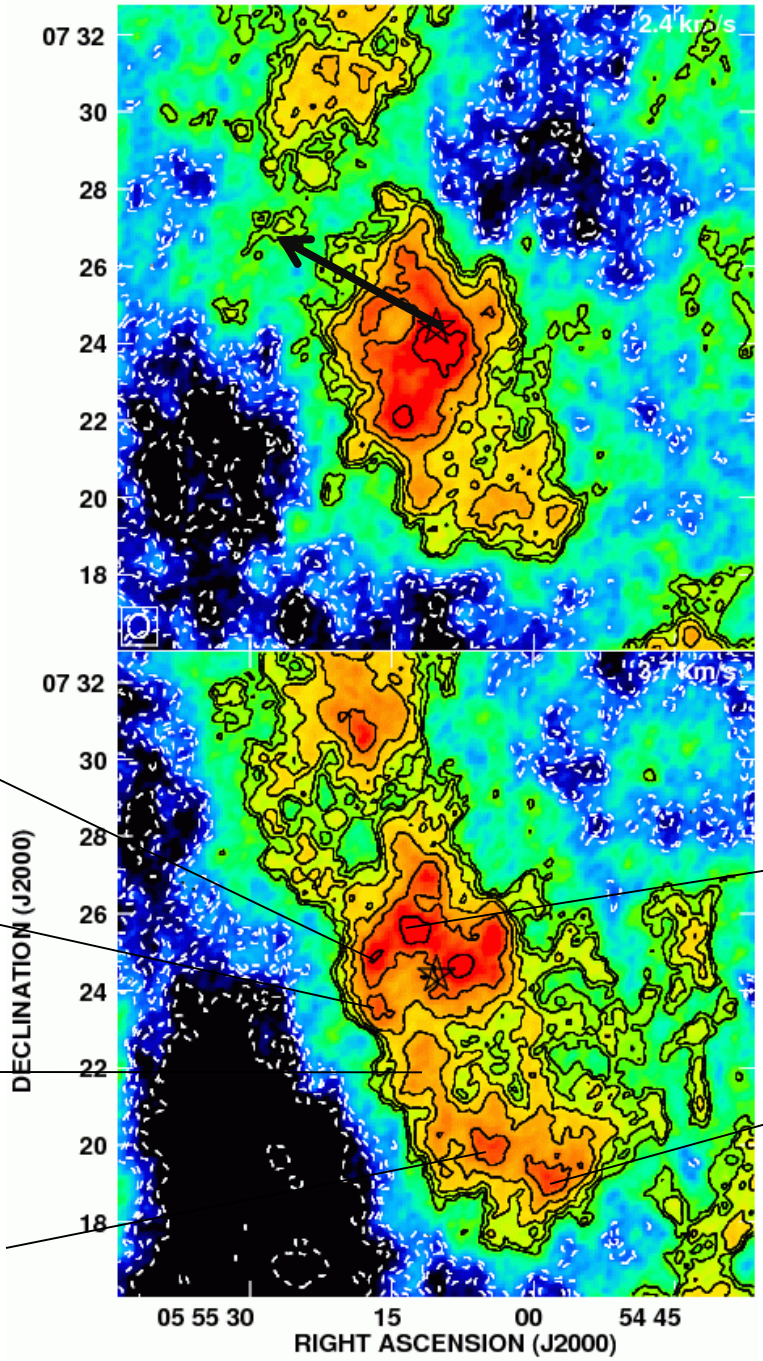
α Ori, VLA C+D, baselines > 0.4 kλ (0.084 km)

background : IRAS image at 60 µm

V_{CO} = 3.7 km/s



Le Bertre et al. (2012, MNRAS, 422, 3433)



4'

17'

2.4 km s^{-1}

3.7 km s^{-1}

1

2

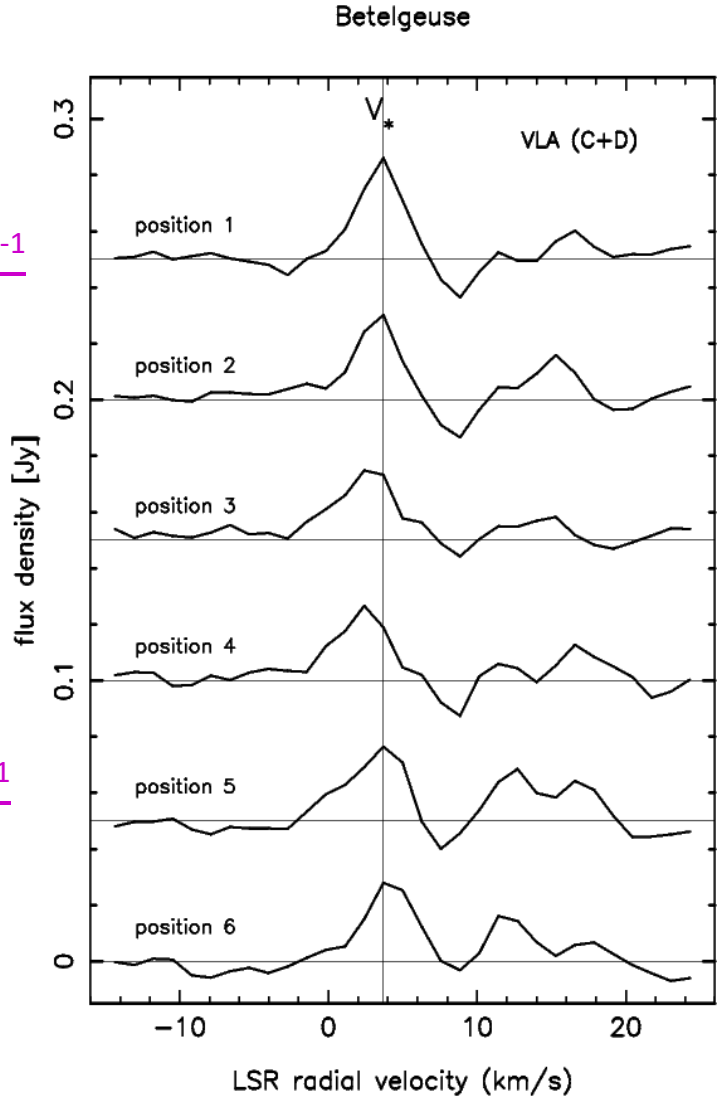
3

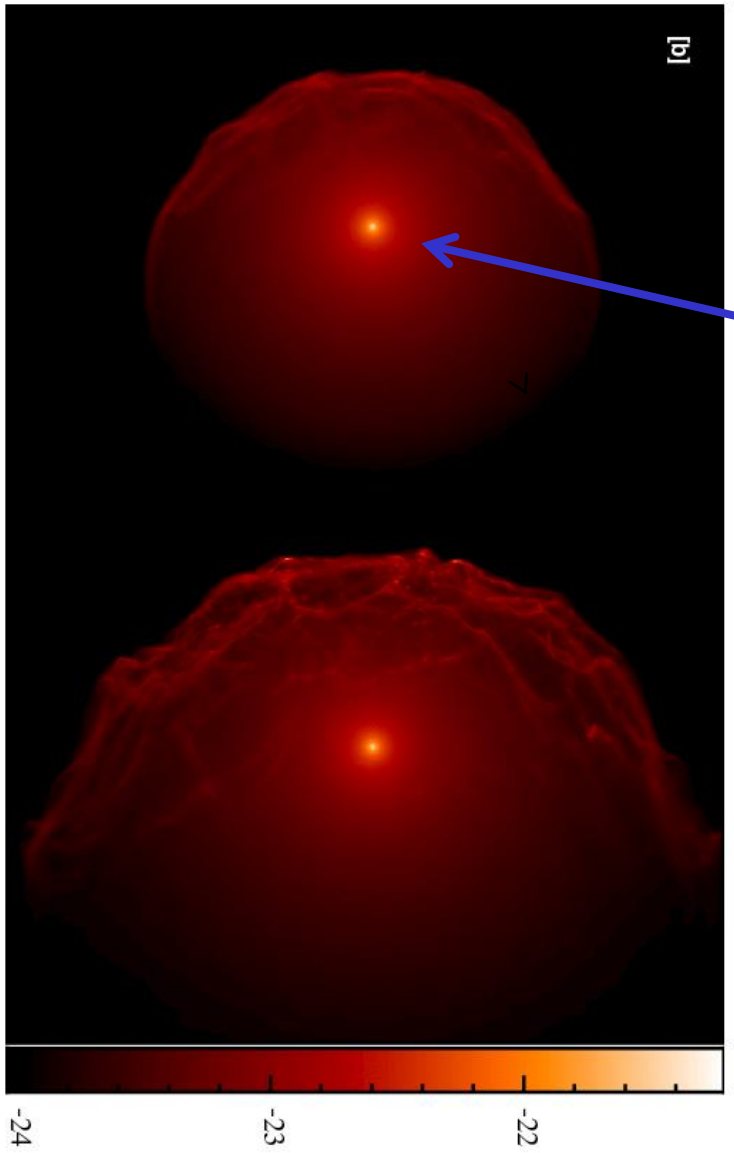
4

5

6

Φ = 34 arcsec





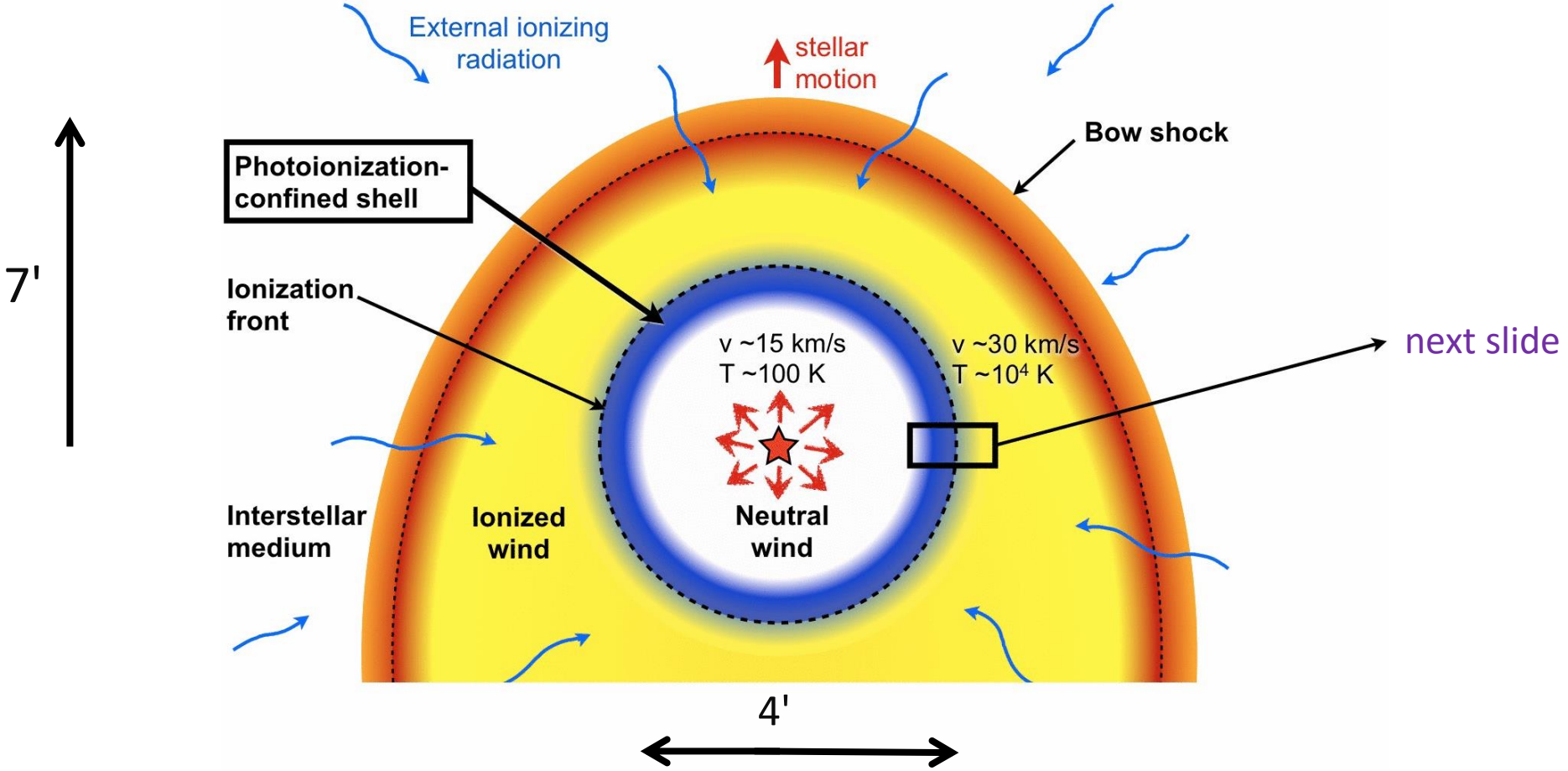
Mackey et al. 2014

UV radiation from
Orion HII region

Mohamed et al. (2013, Betelgeuse2012)

Mackey et al. 2014, Nature, 512, 282 (arXiv:1408.2522)

PICO (PhotoIonization COnfined) -HI- shell



Mackey et al. 2014

PICO shell : quasi-stationary atomic shell at ~2' from the central star