The interplay between molecular and ionized gas surrounding the massive embedded star AFGL 2591

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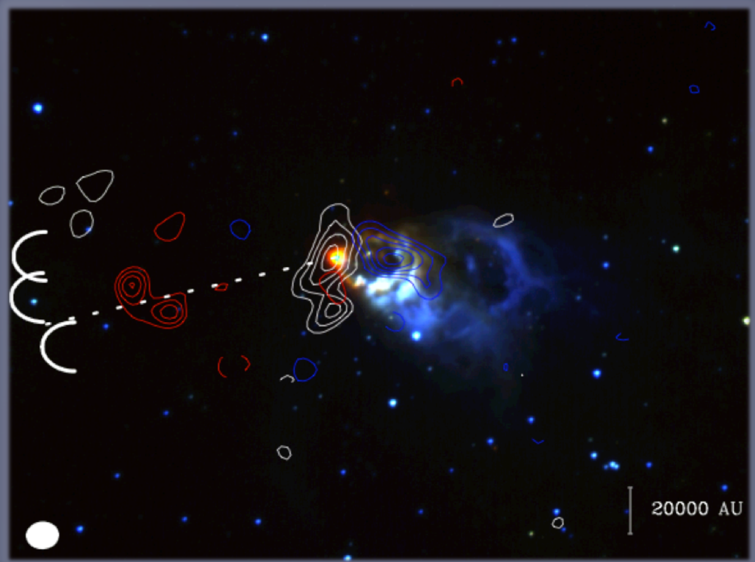
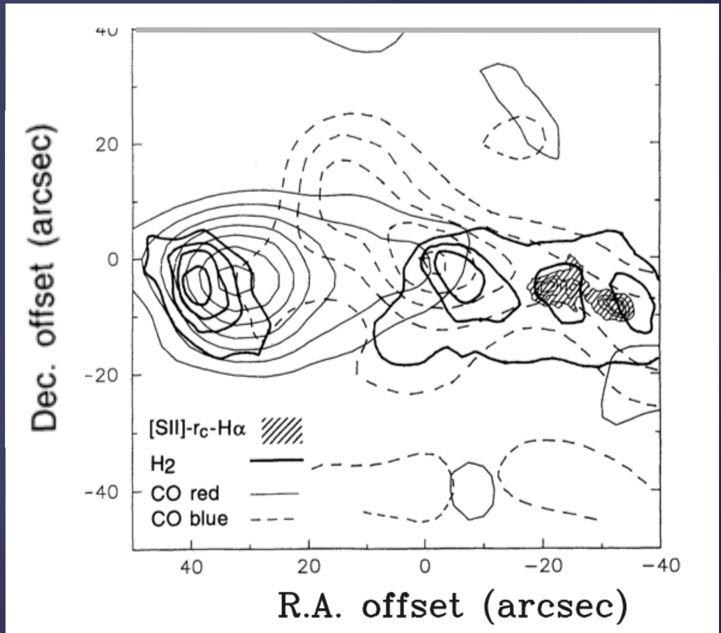
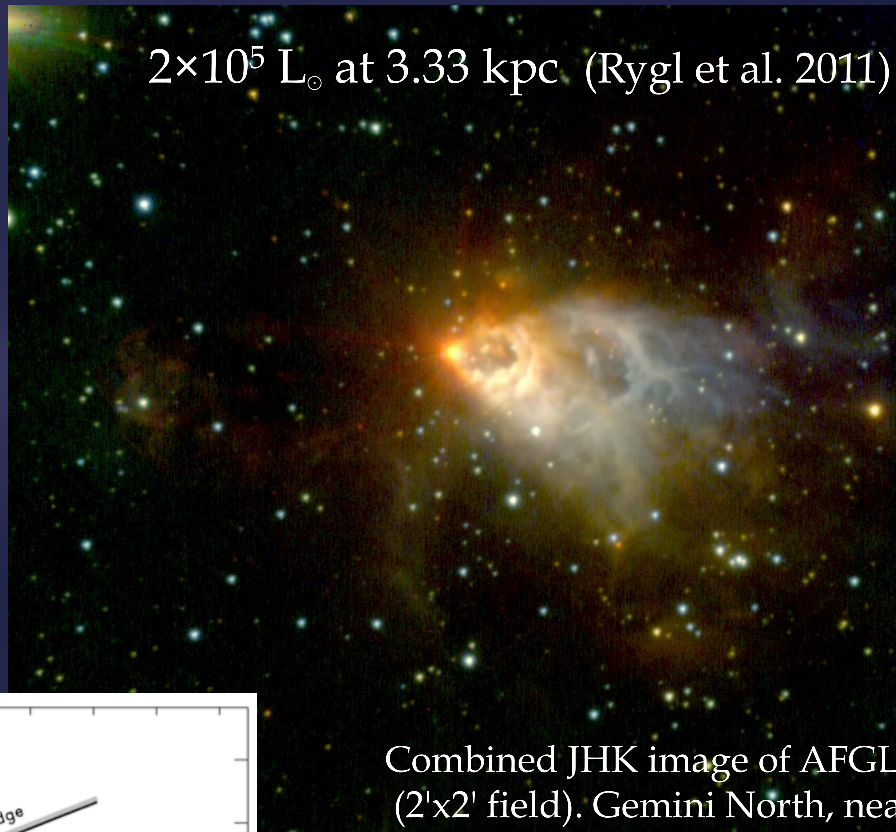


The massive embedded star AFGL 2591

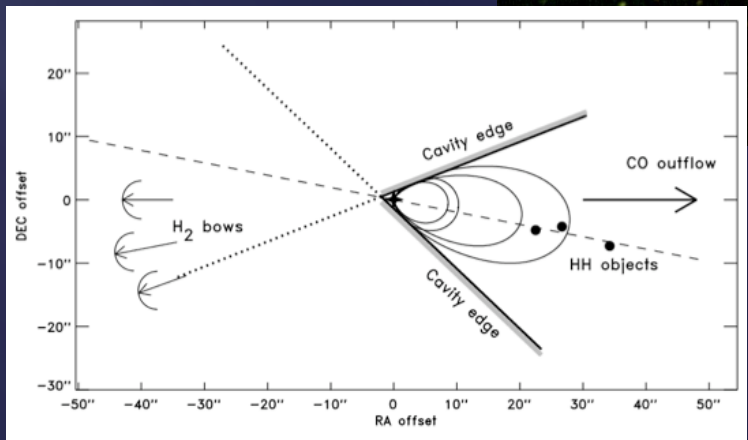
Hasegawa et al. 1995





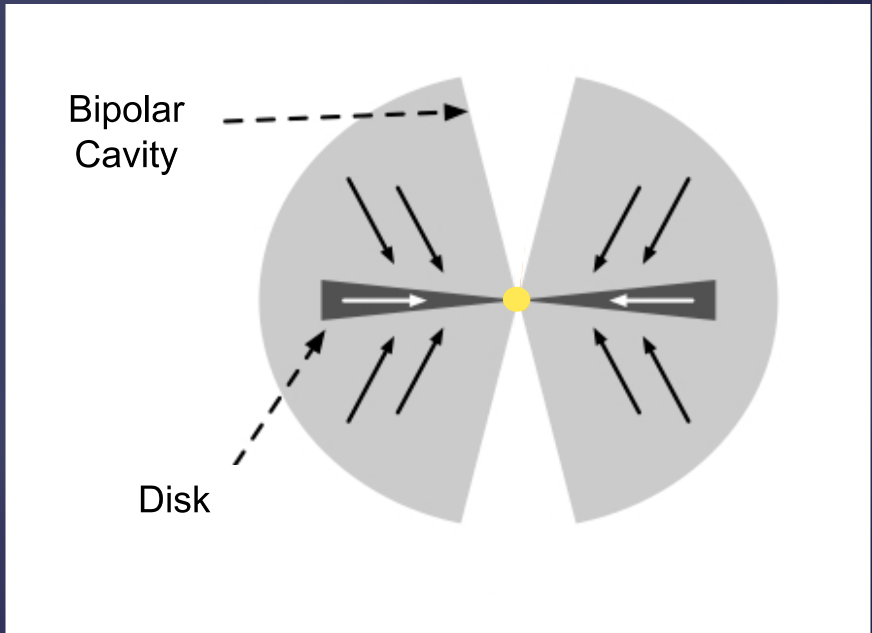
2×10^5 $L_\odot$ at 3.33 kpc (Rygl et al. 2011)

Combined JHK image of AFGL2591 (2'x2' field). Gemini North, near-IR commissioning image, 2001

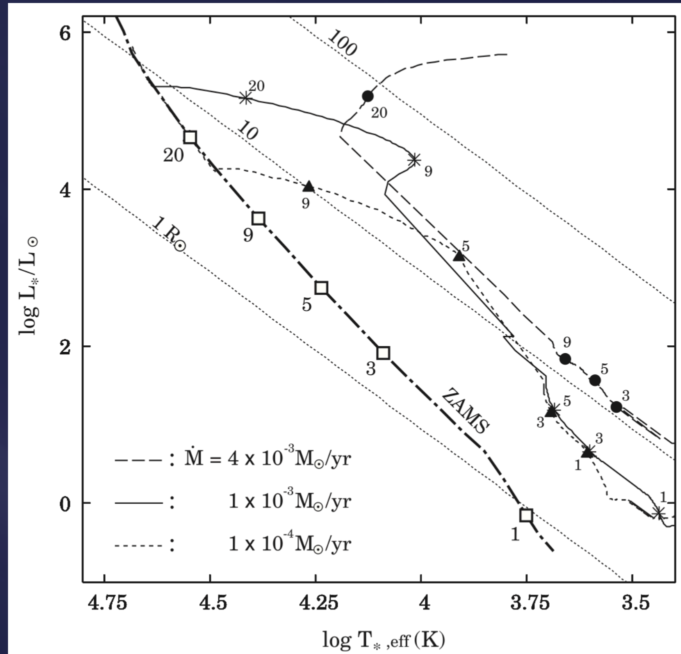


Schematic of AFGL2591 (Fig 5, Preibisch et al. 2003)

Modelling the dust geometry



The star formation "standard model"



Hosokawa et al. 2010

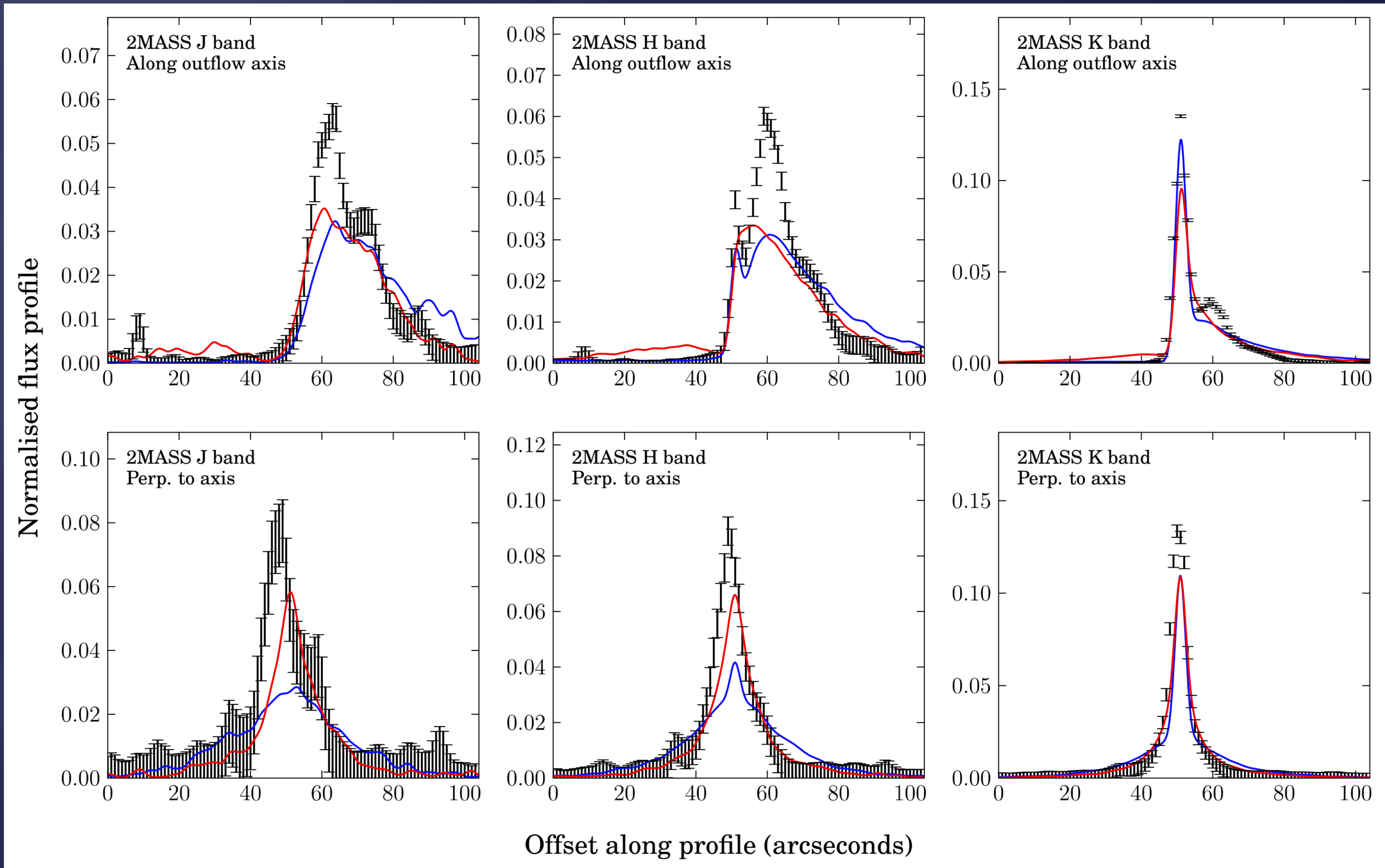
Modelled data using dust radiation transfer code Hyperion (Robitaille 2011)

Optimisation routine for fitting: genetic code described in Johnston et al. 2011

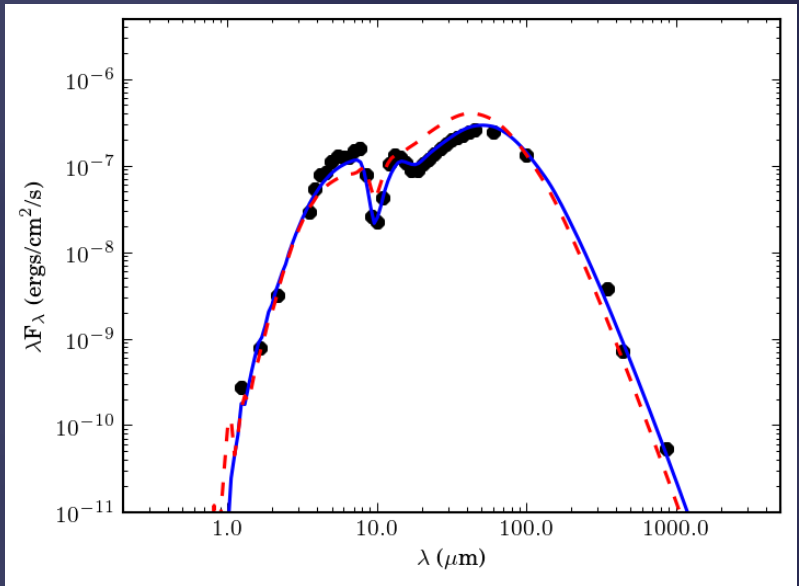
Best fitting image profiles

with disk

without disk

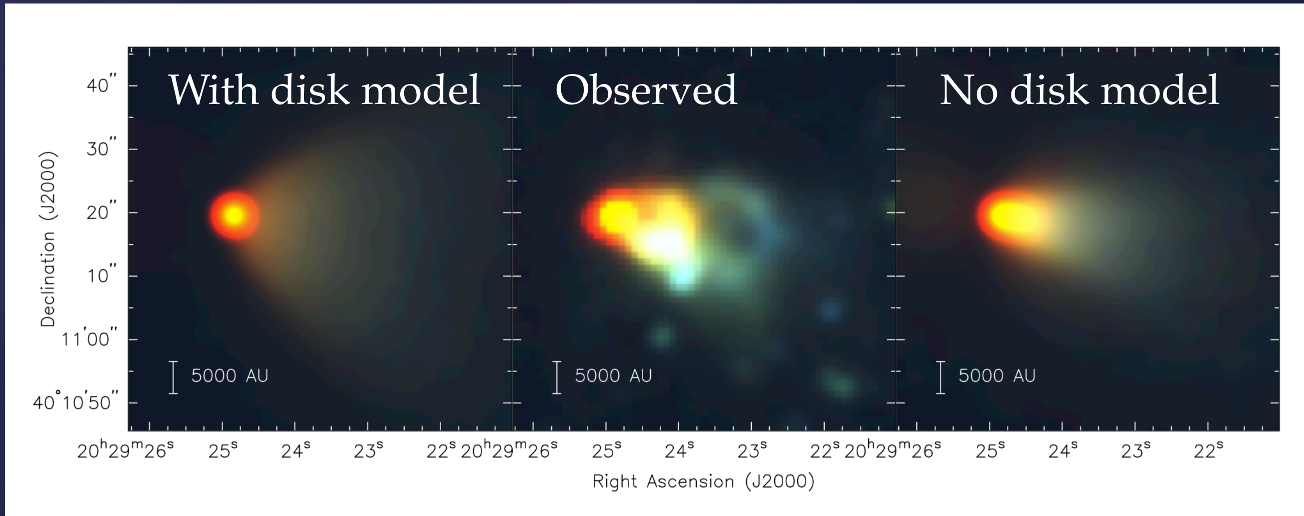


Best fitting SED and images

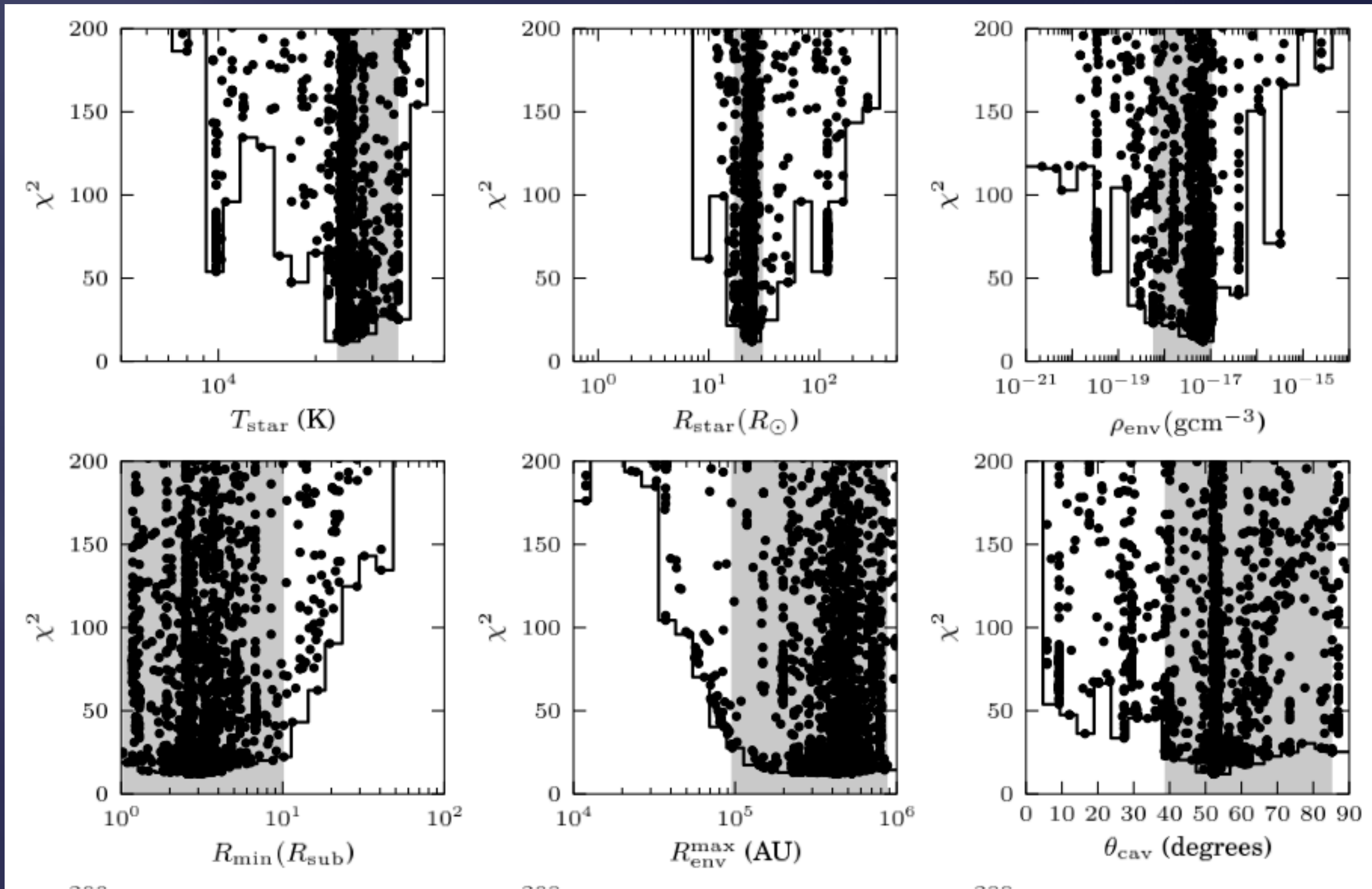


The best-fitting SEDs:
envelope without disk
envelope plus disk

2MASS observed
and model images



How well constrained are the parameters?



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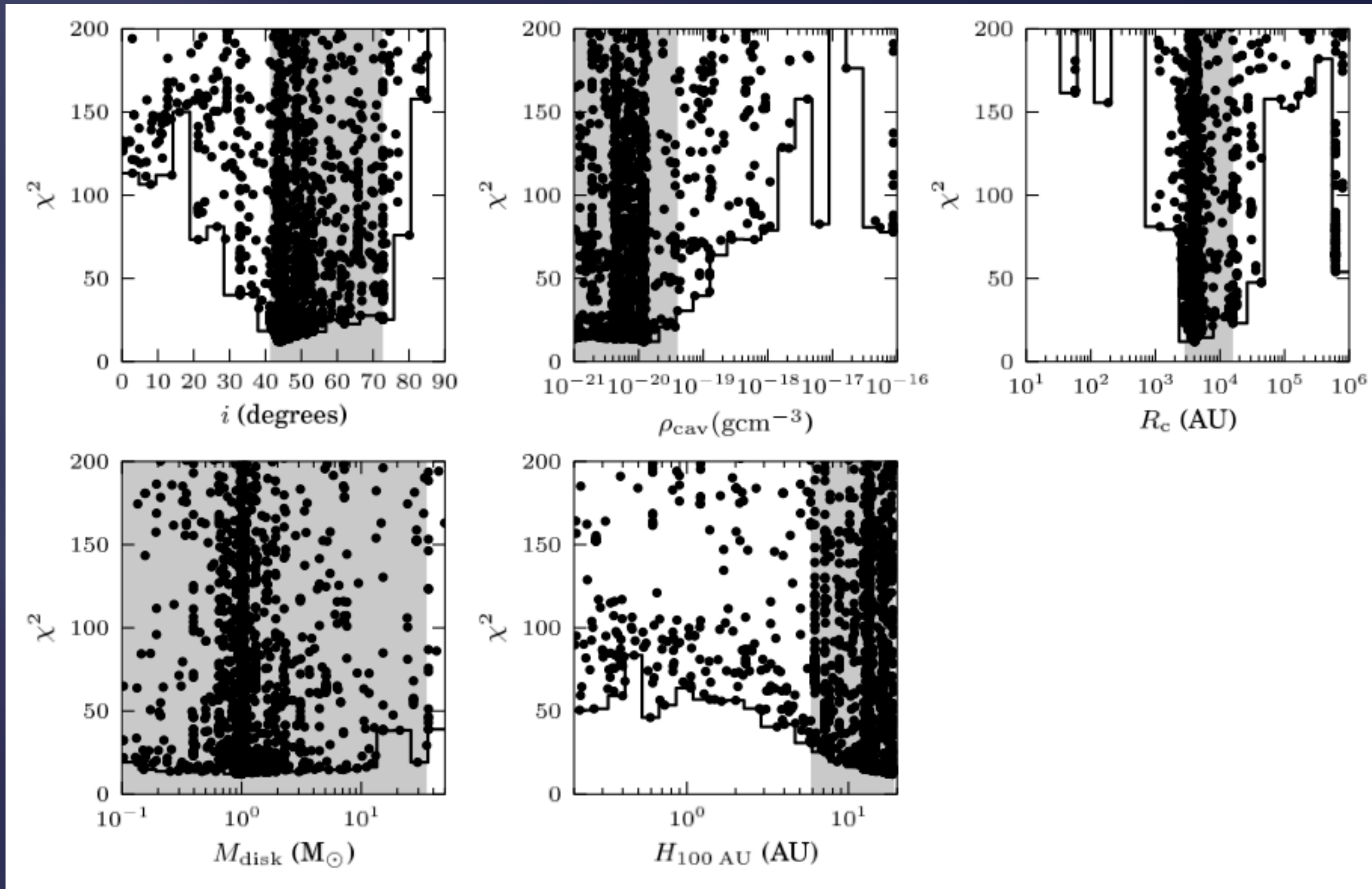
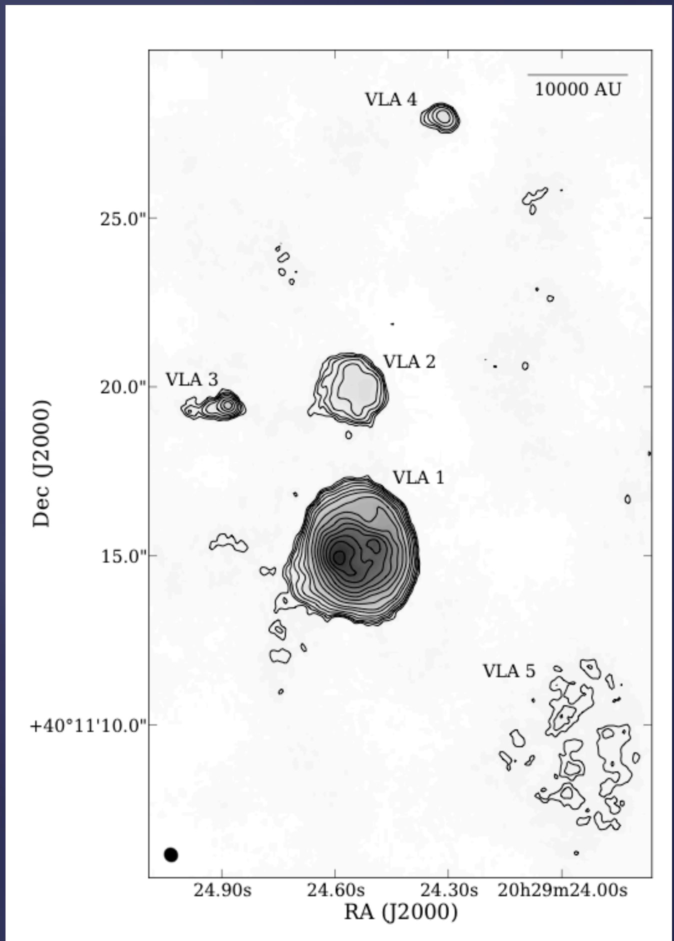
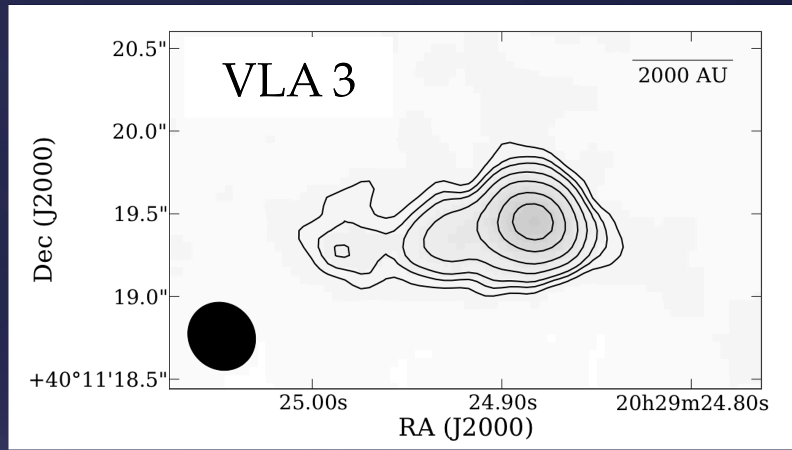


Collimated ionized jet towards VLA3



Contours are -3, 3, 4, 5, 7, 10, 15, 20, 30, 40, 50… 100 × RMS noise
RMS noise = 30 μJy beam^{-1} . Greyscale: -0.03 to 3.77 mJy beam^{-1}
(1.2 × peak value). Synthesized beam: 0.43 × 0.40", PA = 43°



Deconvolved length = 1.2″ (4000AU at 3.33 kpc)
Spectral index of VLA3 ~ 0.51

Momentum transport rate of ionized jet (Reynolds 1986):
$5.4 \times 10^{-3}\ M_{\odot}\ yr^{-1}\ kms^{-1}$

Momentum transport rate of large-scale outflow (Hasegawa & Mitchell 1995):
$8.3 \times 10^{-3}\ M_{\odot}\ yr^{-1}\ kms^{-1}$

Required momentum transport rate of jet for emission to be from shocks (Curiel et al. 1989):
$3.4 \times 10^{-2}\ M_{\odot}\ yr^{-1}\ kms^{-1}$

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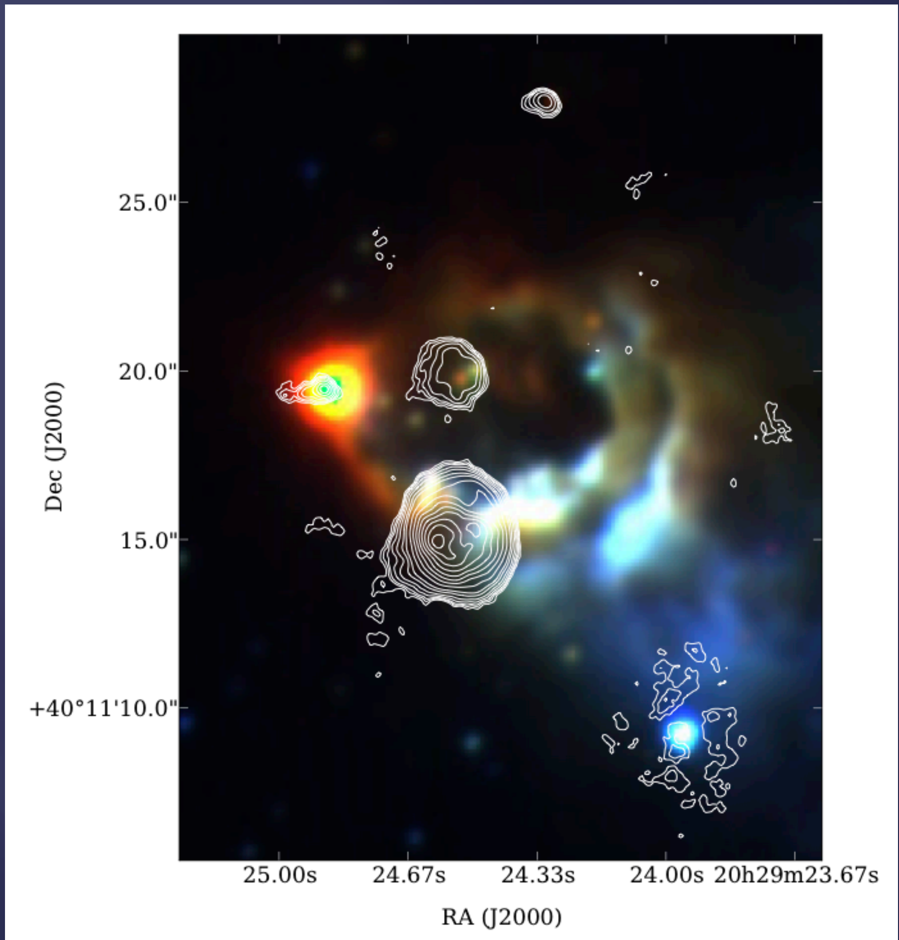

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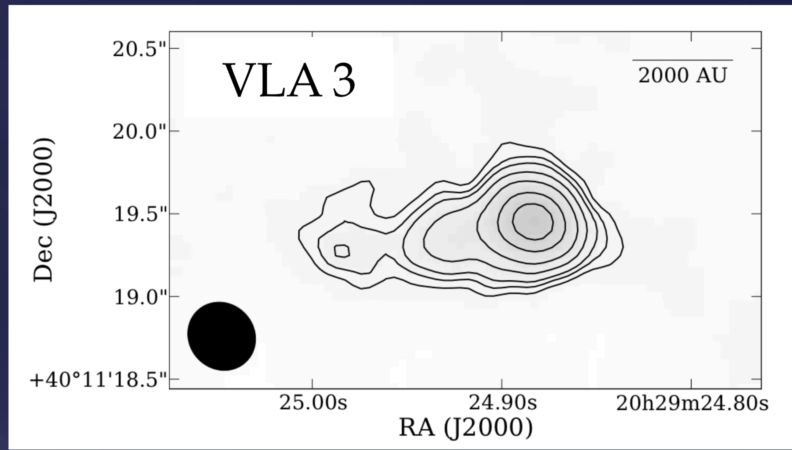

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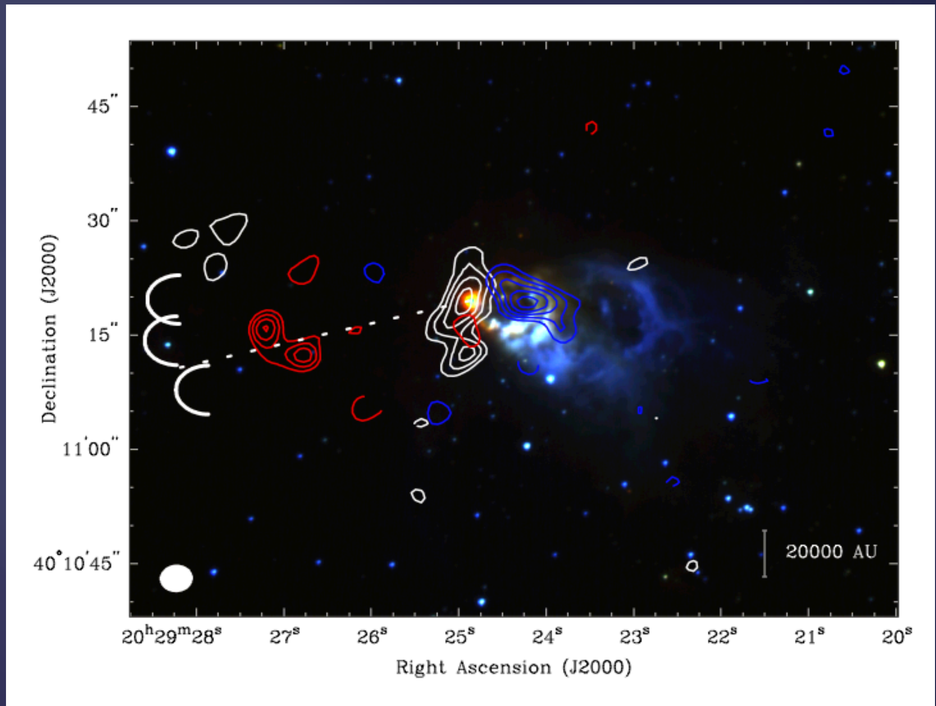
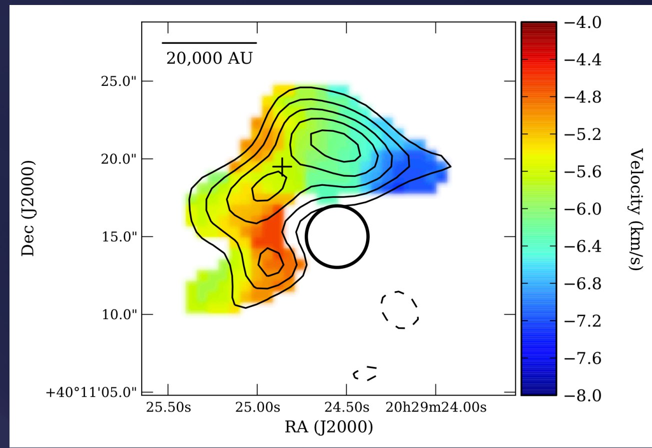
$C^{18}O$ (1-0) tracing the outflow and inner envelope



Gemini North three-colour JHK image overlaid with contours of $C^{18}O$ emission

RED: -4.0 to -3.3 kms^{-1}
BLUE: -8.0 to -7.0 kms^{-1}
WHITE: 5.0 kms^{-1} (central channel)
Synthesized beam : 4.5 × 3.6", P.A. 93°.

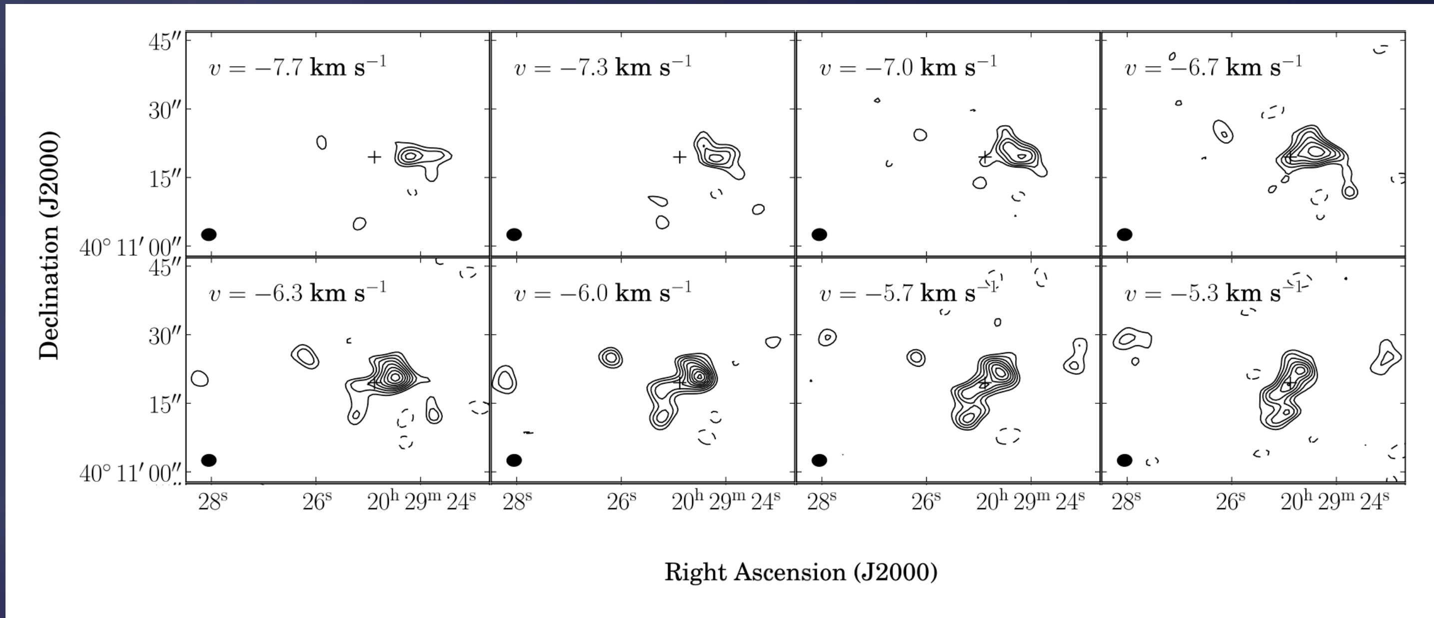


$C^{18}O$ intensity-weighted first moment map

Contours: $C^{18}O$ integrated map from -2.3 to -8.7 kms^{-1}
Synthesized beam: 4.5 × 3.6", P.A. 93°

$C^{18}O$ (1-0) tracing the outflow and inner envelope

$C^{18}O$ channel map at 0.3 kms^{-1} resolution between -7.7 and -5.3 kms^{-1}



Map rms σ =0.1 Jy $beam^{-1}$
Contours at -3, 3, 4, 5, 6, 7, 8, 9, 10, 11 × σ
v_{LSR}~ -5kms^{-1}

Peak flux = 1.1 Jy $beam^{-1}$
Synth. Beam: 4.5 × 3.6", P.A. 93°

At higher velocities outflow is more collimated

Take away message:

Massive stars can form in a similar manner to low-mass stars

Caveats (and possibly clues):

Formation is not isolated!

Formation on cluster scales