Credit:Lynette Cook

26-05-17

IRAS13481-6124

A High-Mass Young Stellar Object driving a parsec-scale jet

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DIAS

EEstars-DIAS

UCD DUBLIN

Outline

1. **Introduction**
2. **Observations**
   - i) SINFONI
   - ii) CRIRES
   - iii) ISAAC
3. **Results**
   - i) On source
   - ii) Jet
4. **Conclusions**

Credit: A. Smith,
Institute of Astronomy, Cambridge.

Driving Source

What is going on here?
(base of the jet)

Not To Scale

Who is the dominant part?

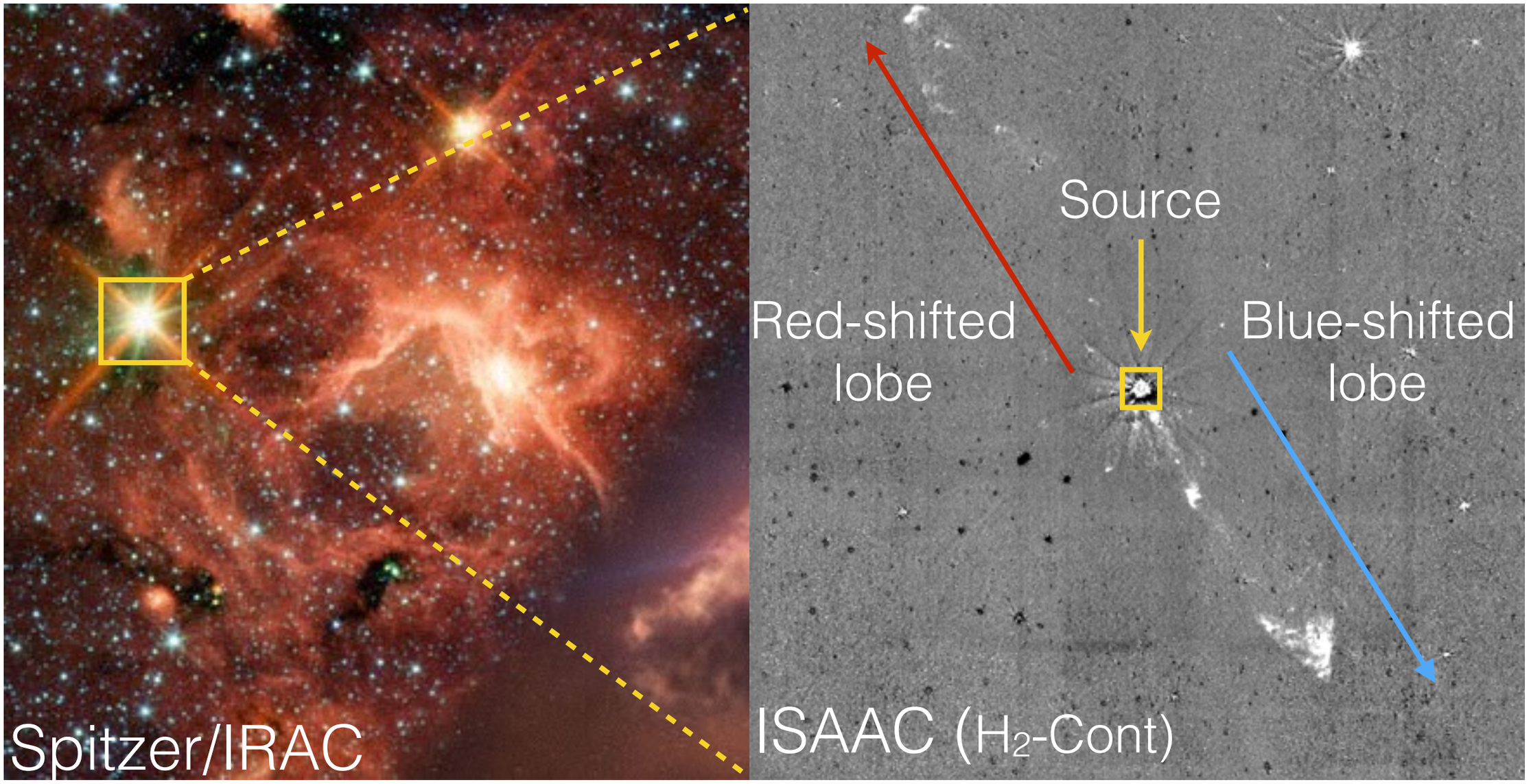
Radio thermal jet
(100s-1000s au)

Molecular and atomic jet
(from 1000s au to parsec scale)

Introduction

IRAS 13481-6124 ⇒

20 $M_\odot$
D~3.1 kpc
Spectral Type: O9
Age~6 x 10^4 yr



3.6 μm, 4.5 μm, 5.8 μm, 8.0 μm

Observations

VLT/SINFONI (on source)

$$\mathcal{R} \sim 4000$$

Spatial Resolution ~ 0.1”(AO) ~ 300 au

VLT/CRIRES (source + base of the jet)

$$\mathcal{R} \sim 50000$$

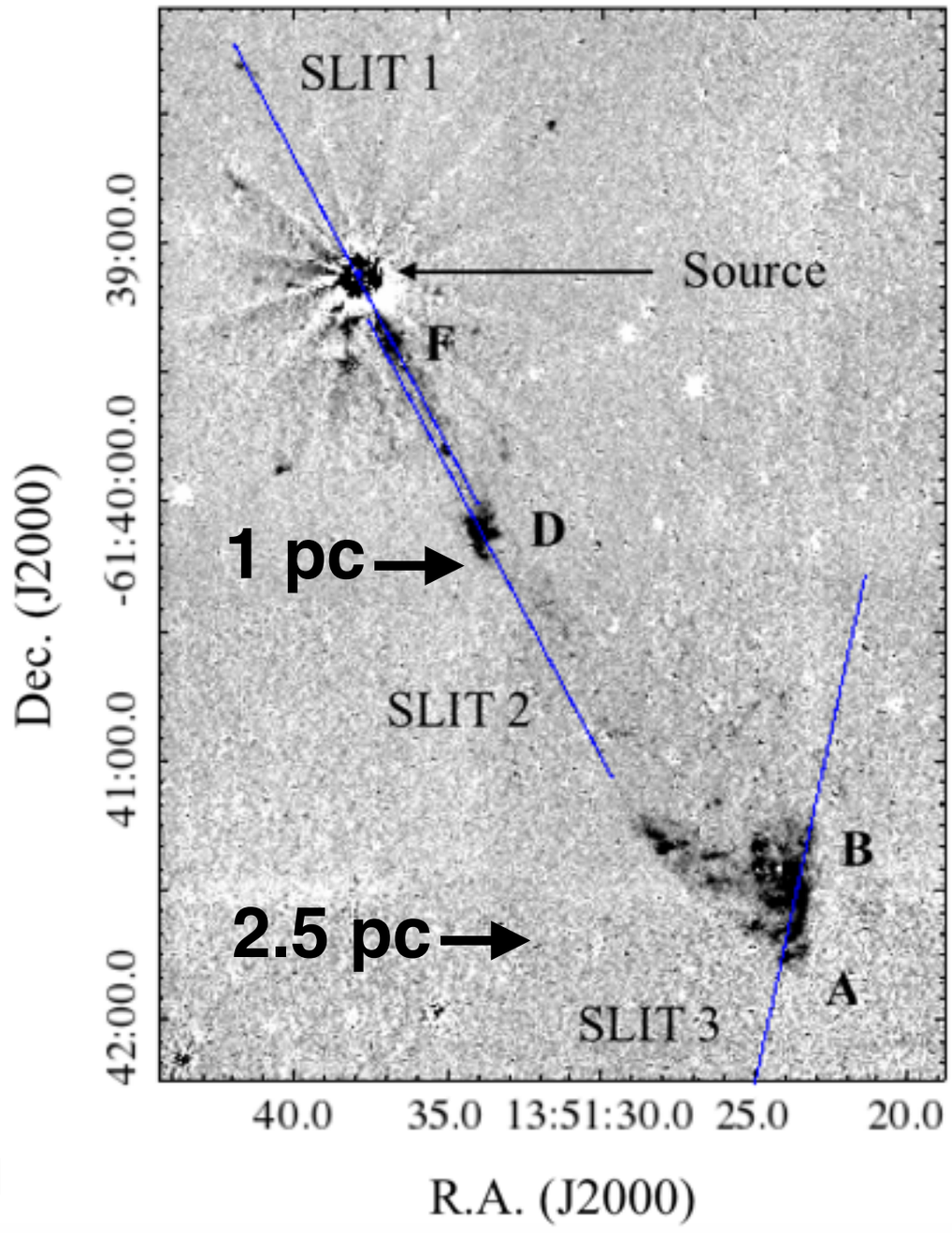
Spatial Resolution ~ 0.1”(AO) ~ 300 au

Spec-Astro precision ~ up to 2 mas ~ 6 au

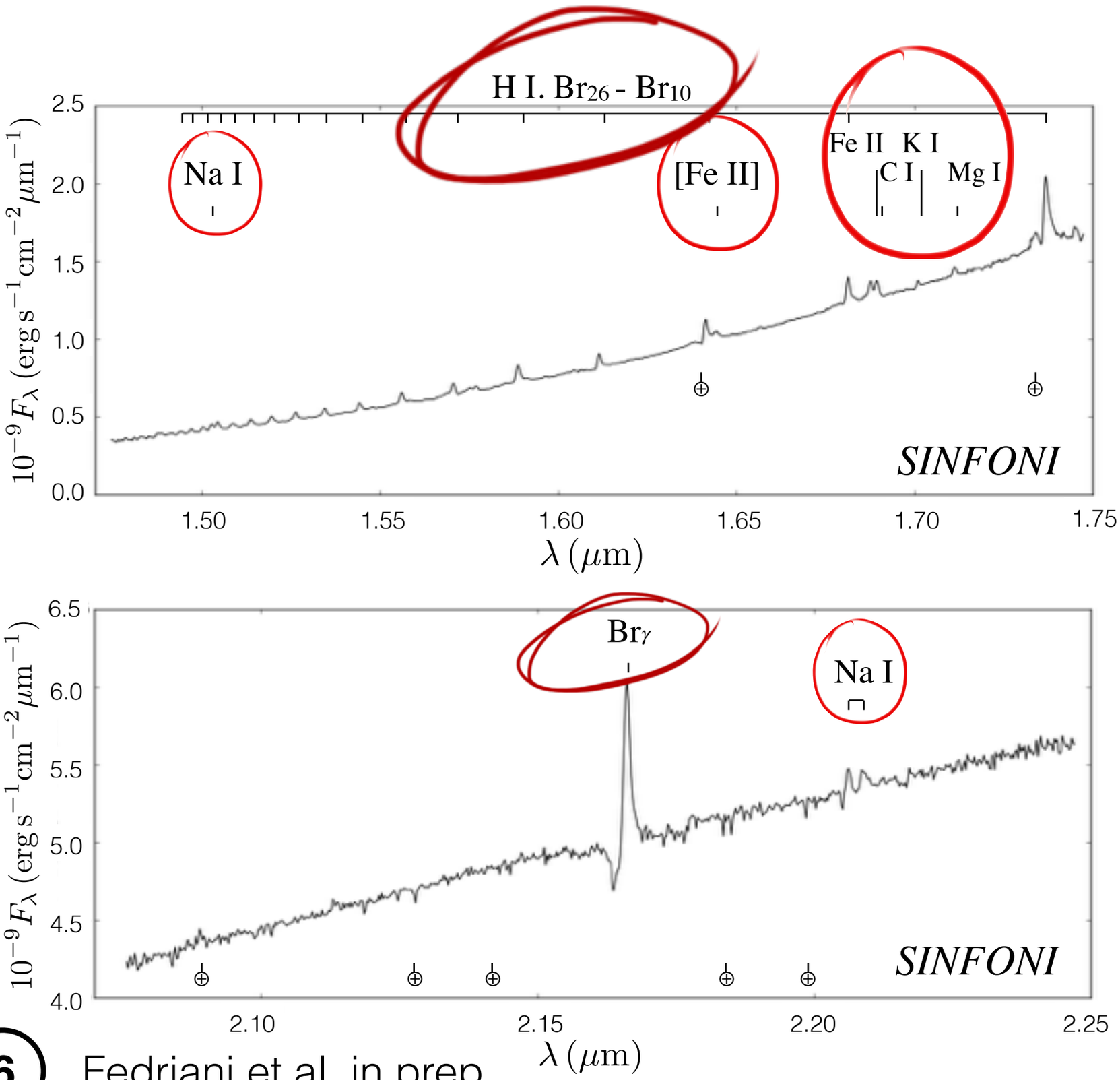
VLT/ISAAC (source + jet)

$$\mathcal{R} \sim 10000$$

Spatial Resolution ~ 1”(seeing) ~ 1000 au



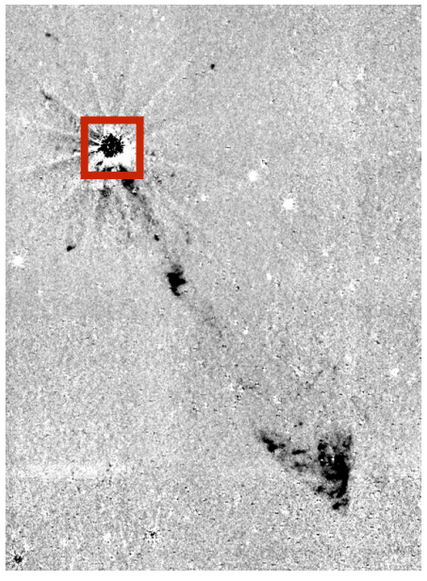
Results -on source-



NaI, Fe II, CI…
Circumstellar features

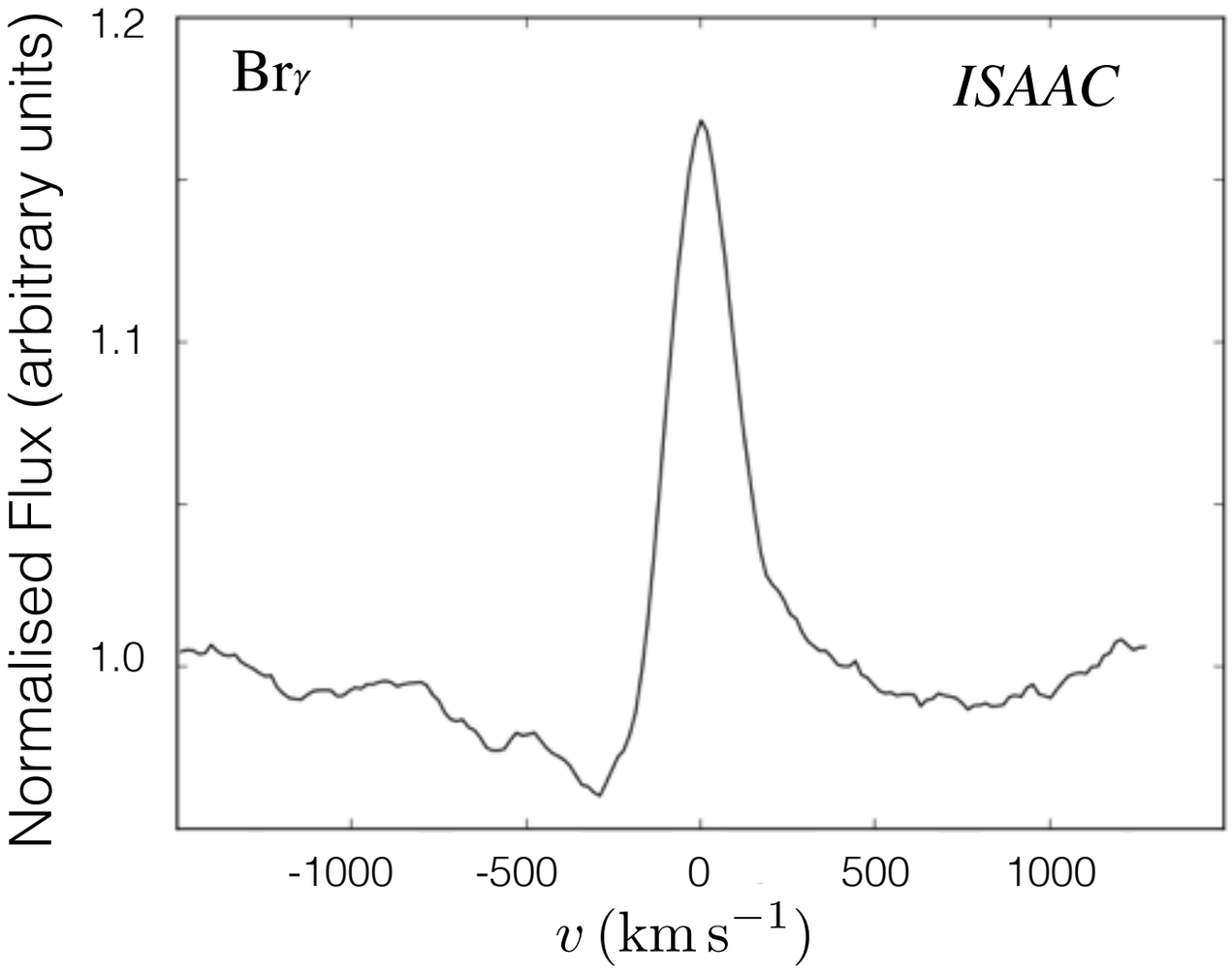
[Fe II] traces the base
of the jet
very close to the source

Brackett series
are observed to trace
accretion/ejection processes



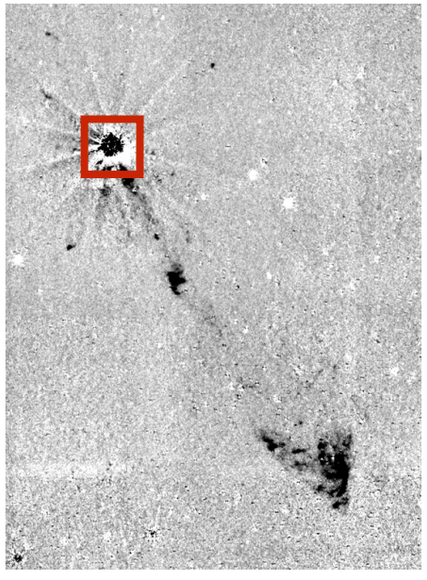
Fedriani et al. in prep.

Results -on source-



Brγ line mainly traces outflowing material (for this particular object)

Emission originated from ionised material

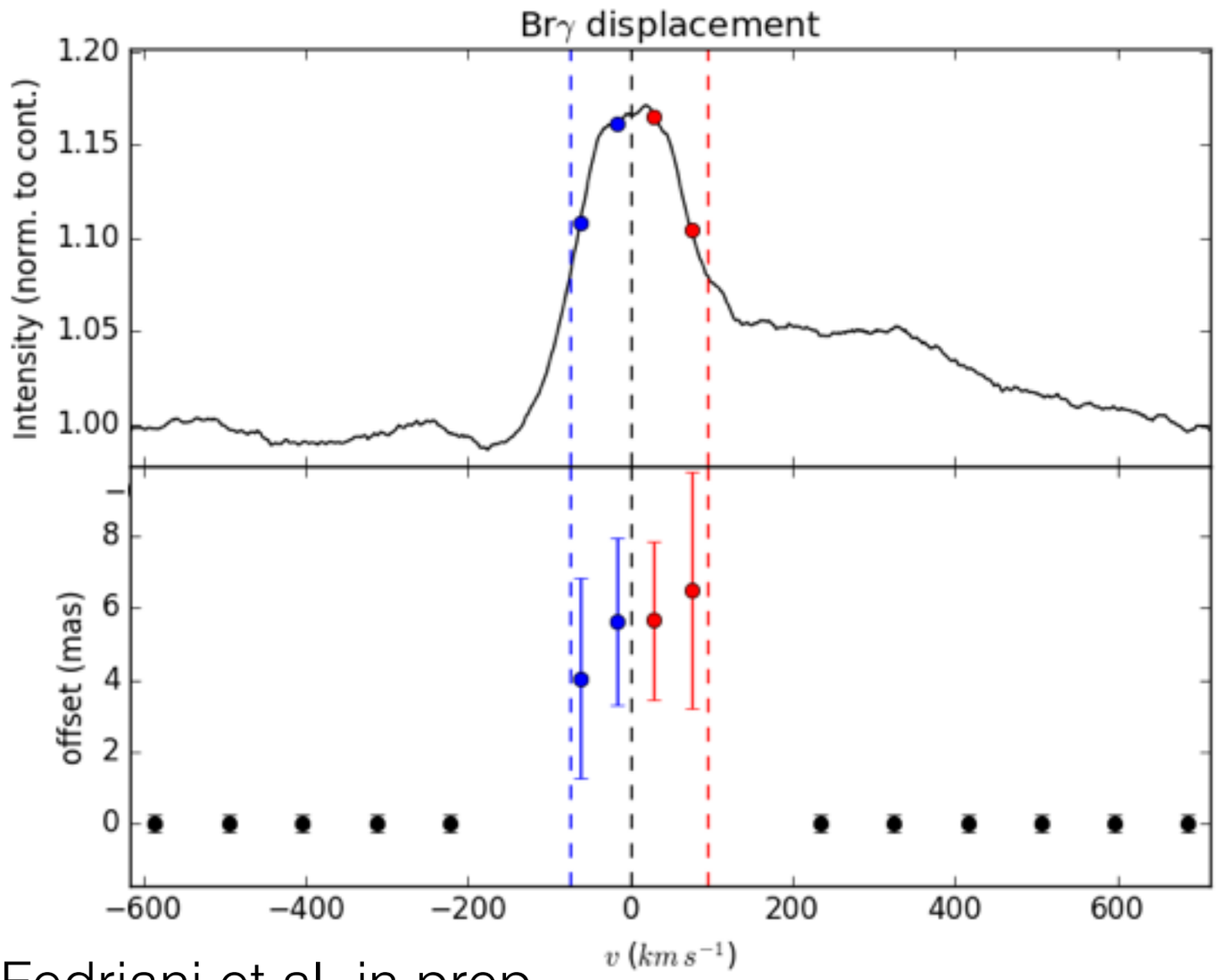


$v \sim -700\,\mathrm{km\,s^{-1}}$ terminal velocity

7 Fedriani et al. in prep.

Spectro-Astrometric results

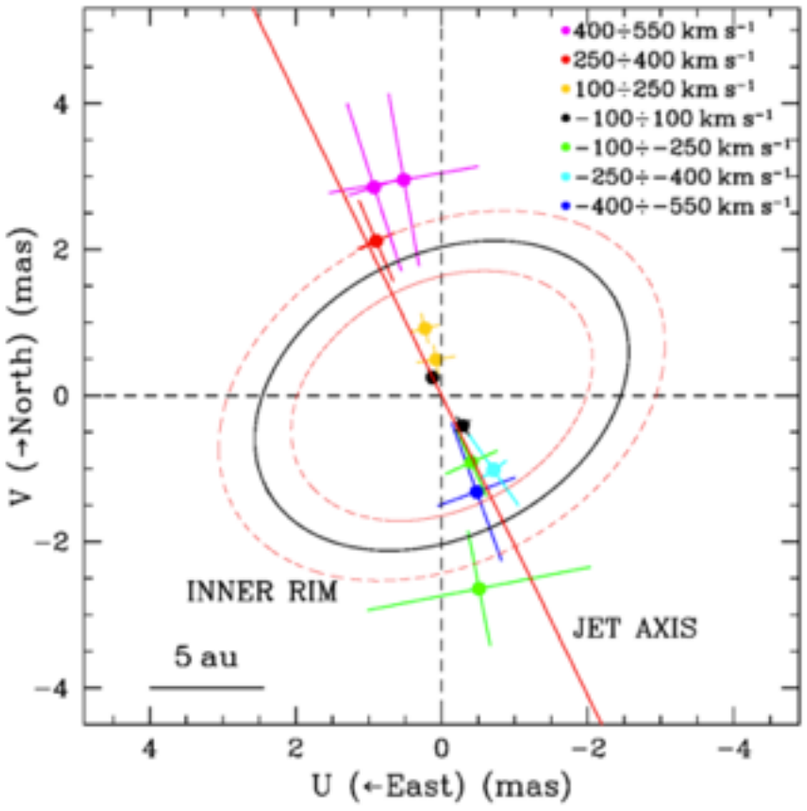
VLT/CRIRES



Fedriani et al. in prep.

offset dimension:
4-6 mas
12-20 au

VLTI/AMBER

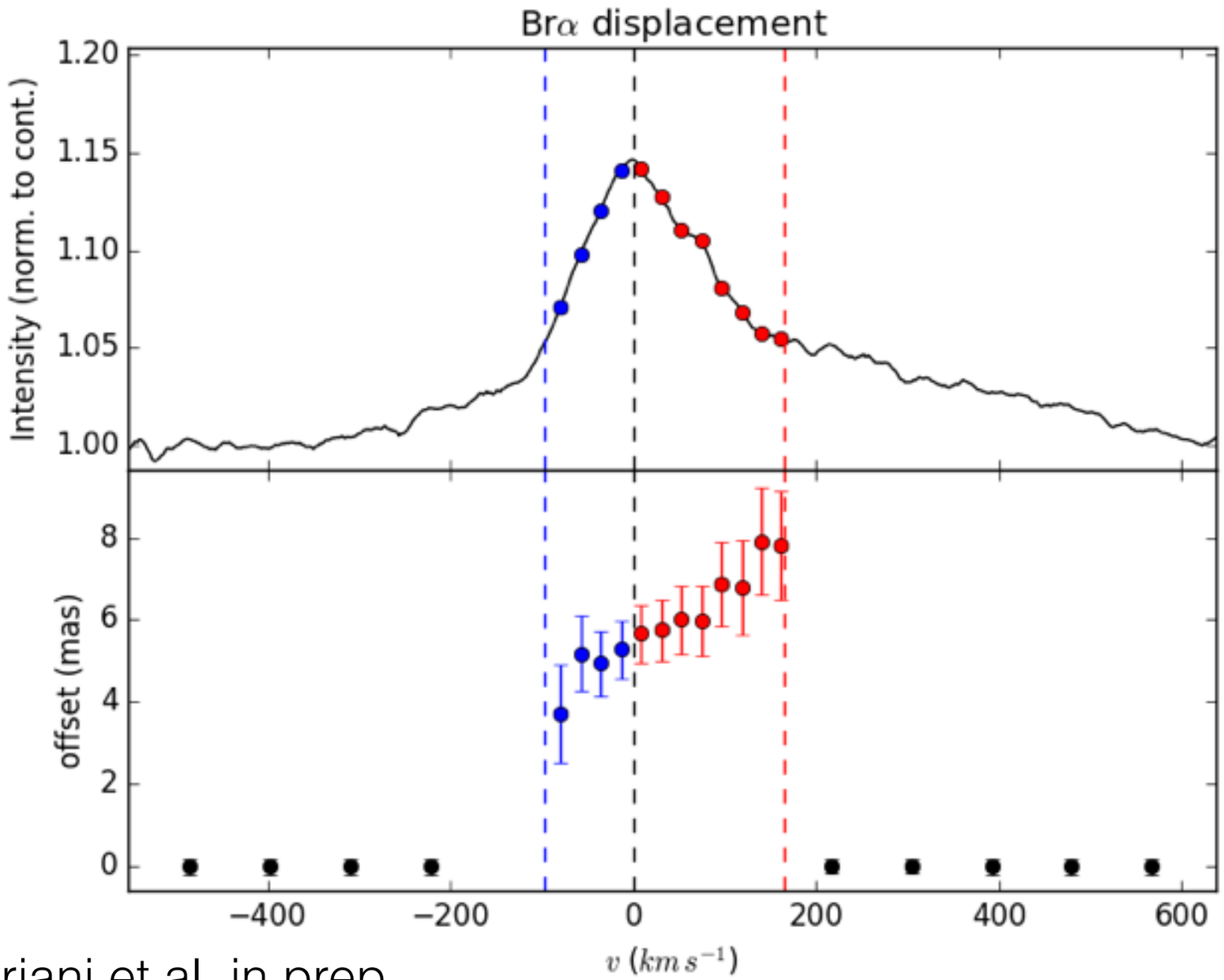


Caratti o Garatti et al. 2016

$$\lambda_{\mathrm{Br}\gamma} = 2.166\,\mu\mathrm{m}$$

$$\mathrm{Br}\gamma \rightarrow n_{\mathrm{up}} - n_{\mathrm{low}} = 7 - 4$$

Spectro-Astrometric results



Fedriani et al. in prep.

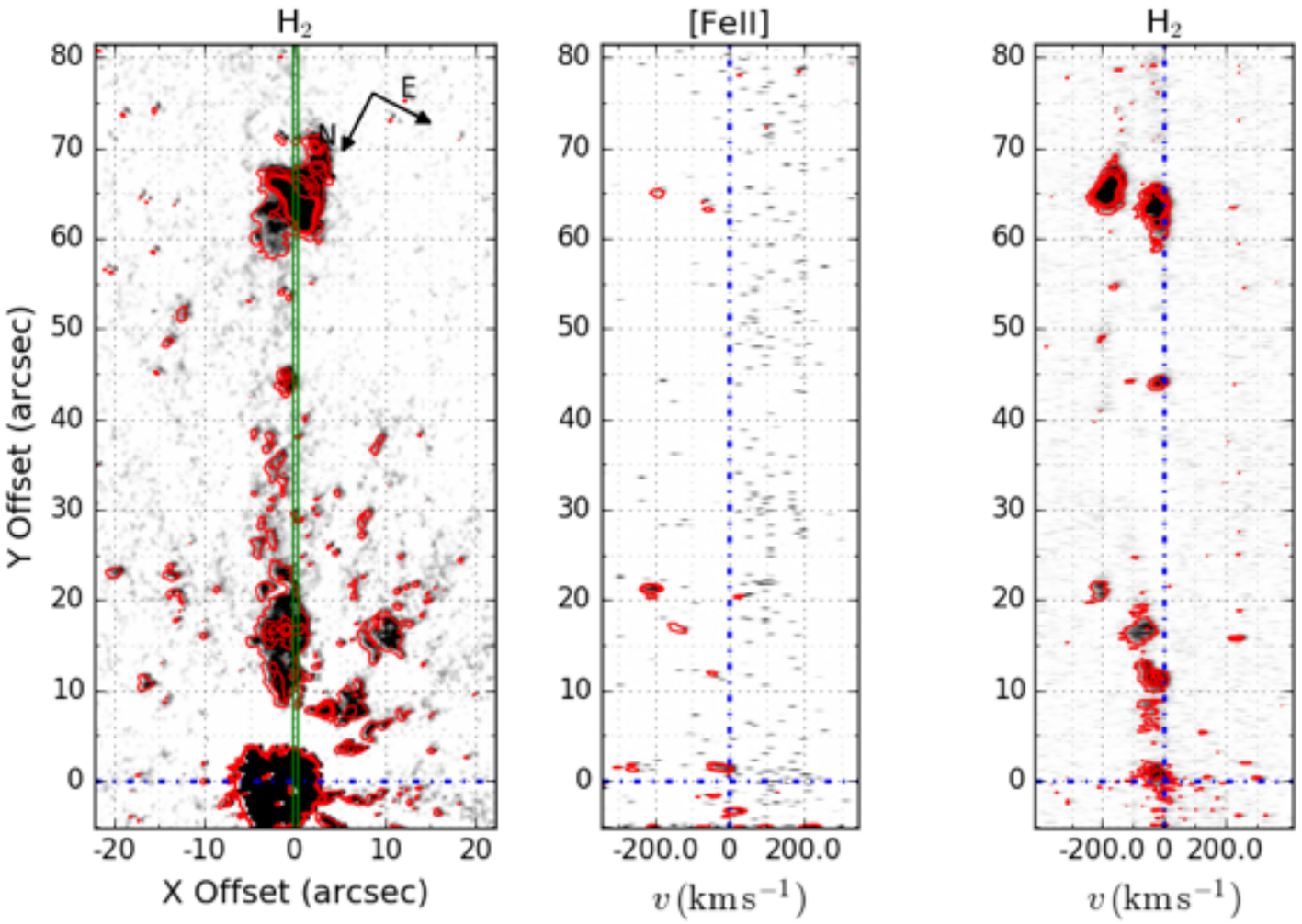
offset dimension:
4-8 mas
12-25 au

Brγ and Brα emitting region come from a roughly similar region of the radio jet

$$\lambda_{\mathrm{Br}\alpha} = 4.052\,\mu\mathrm{m} \qquad \mathrm{Br}\alpha \rightarrow n_{\mathrm{up}} - n_{\mathrm{low}} = 5 - 4$$

Kinematic and Dynamic properties of the jet

Results -parsec scale jet-



[Fe II] emission is produced by shocked material
v~ -350 to -150 km s^{-1}

From 5" on, H_2 emission is produced by shocks
v~-150 to few km s^{-1}

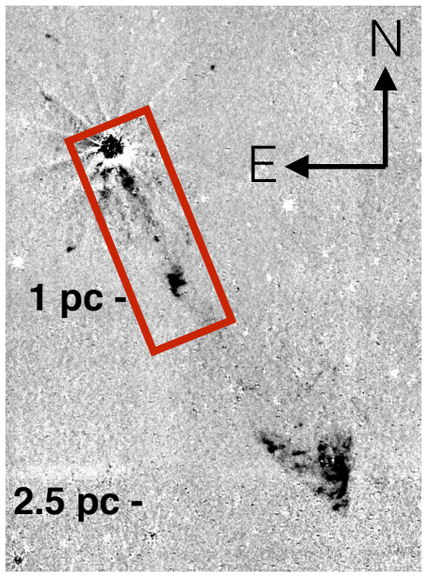
$$\dot{M}_{\rm ejec} \sim 10^{-4}\,{\rm M}_\odot\,{\rm yr}^{-1}$$

(from H_2)

$$\dot{M}_{\rm ejec} \sim 10^{-5}\,{\rm M}_\odot\,{\rm yr}^{-1}$$

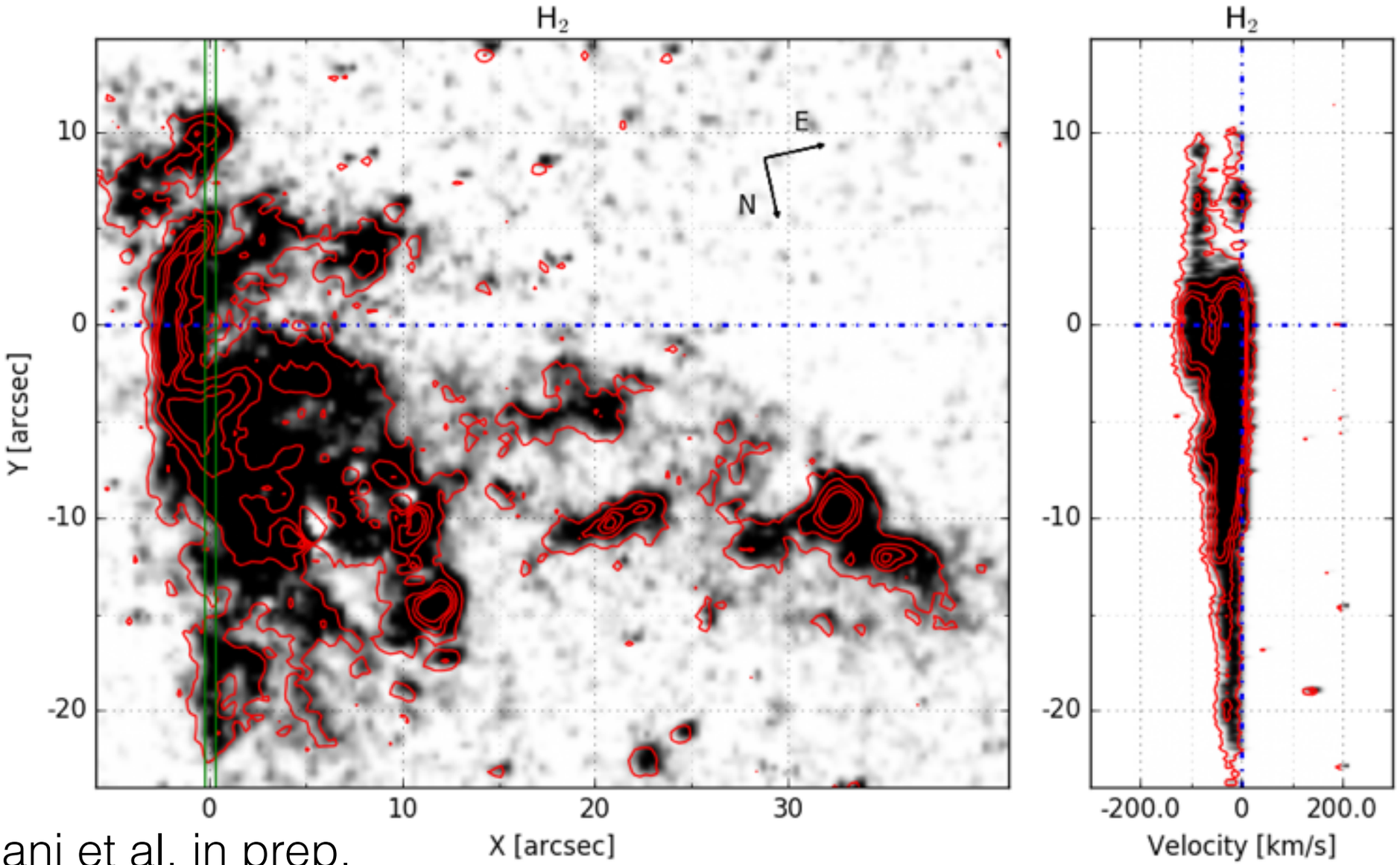
(from radio, Purser et al. 2016)

ionisation fraction ~10%



Fedriani et al. in prep.

Results -parsec scale jet-



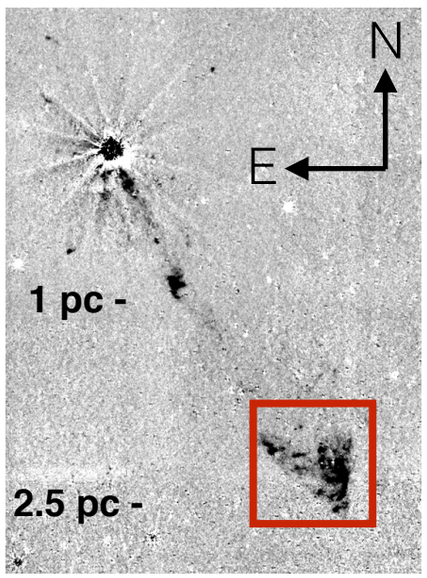
Fedriani et al. in prep.

Dynamical time for Knots A+B

$\tau_{\rm dyn} \sim 35000\,{\rm yr}$

Inferred age of the star from SED modelling

$\sim 60000\,{\rm yr}$



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Conclusions

Strong Brγ emission from the jet and the wind probes ejection and, indirectly, the existence of an accretion disk.

For the first time spectro-astrometry has been made in the Brα line, showing the potential of this technique for HMYSOs studies.

Comparison between the NIR and the radio jet suggests that the NIR jet is tracing the bulk of the ejecta whereas the radio jet just a small fraction.

Radio thermal jet
(100s-1000s au)

Molecular and atomic jet
(from 1000s au to parsec scale)

Credit: A. Smith,
Institute of Astronomy, Cambridge.

Conclusions

Physical, kinematic and dynamical properties inferred from observations indicate that the formation process of IRAS13481-6124 is likely a scaled-up version of low-mass counterparts.

Thank you!