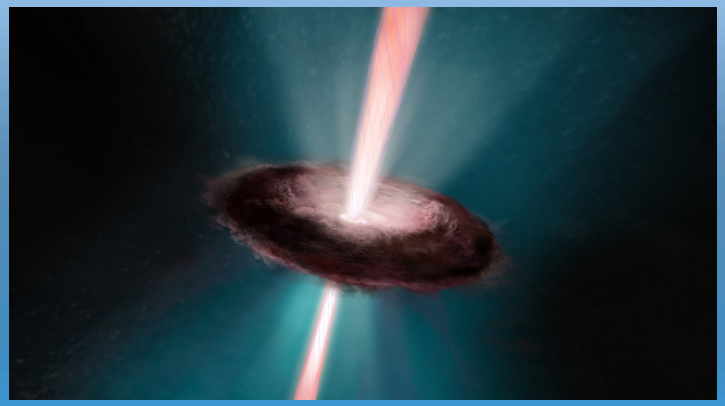
JETS FROM MASSIVE PROTOSTARS
clues from masers, radio and NIR imaging



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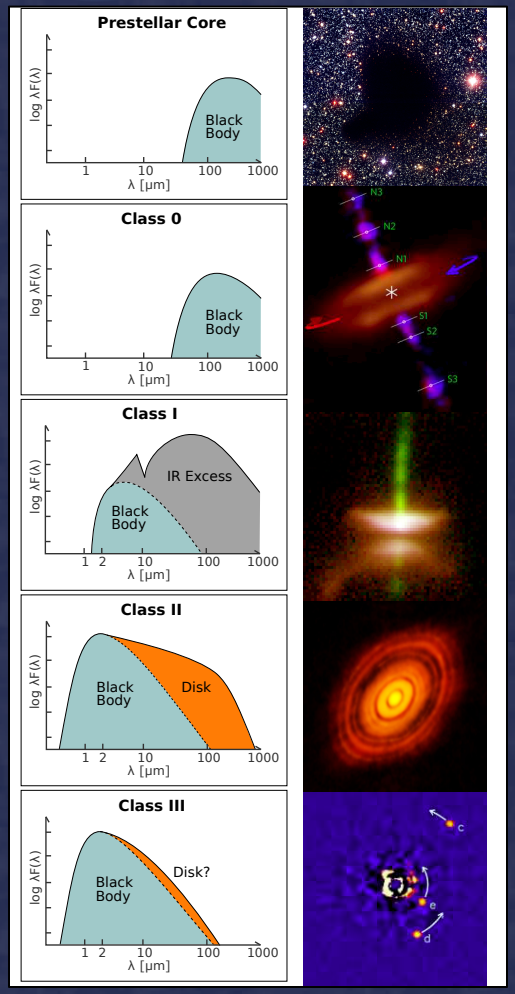
14th EVN Symposium Granada October 10, 2018

Context

Scenario for low mass star formation



→ angular momentum problem from core-collapse to proto-planetary disks;

→ evolution of circumstellar disks in solar-type stars from proto-stellar to planet formation phase;

→Accretion/ejection: jets, winds, outflows

-> initial condition for planets formation.

Context

High mass star formation : open questions

High-mass stars “switch on” while still accreting

→ Impact of radiation pressure and photoionization (thermal pressure from HII regions) on the circumstellar gas

Frequency of accretion disks ?

photoevaporated by UV ? fragmented by gravitational instabilities ?

Destroyed by tidal interaction with cluster members ?

Outflows :

- driven by radiation pressure ?
- driven by magneto-centrifugal mechanism ?
- outflow evolution ?

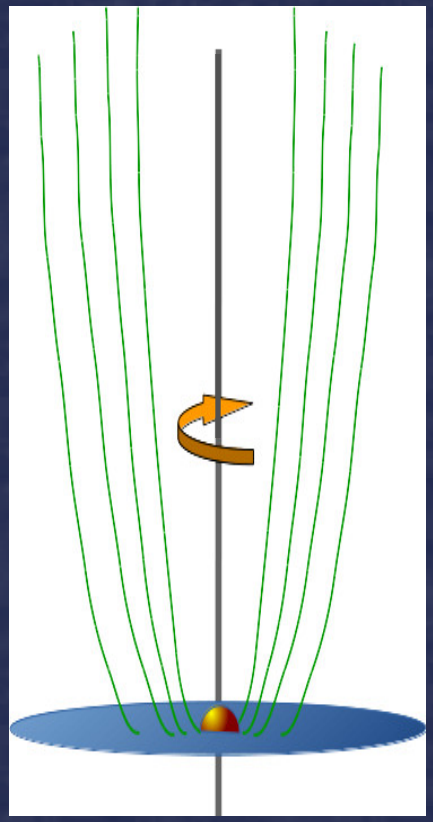
Observational difficulties :

- large distance > kpc , high extinction
- formation in clusters = confusion

AIM

Characterize JETS from high mass stars

POETS : Protostellar Outflows in the EarliesT Stages



1000 au scale
LBT LUCI + AO
H2 emission
0.”2 – 1” @ 2.12 μm

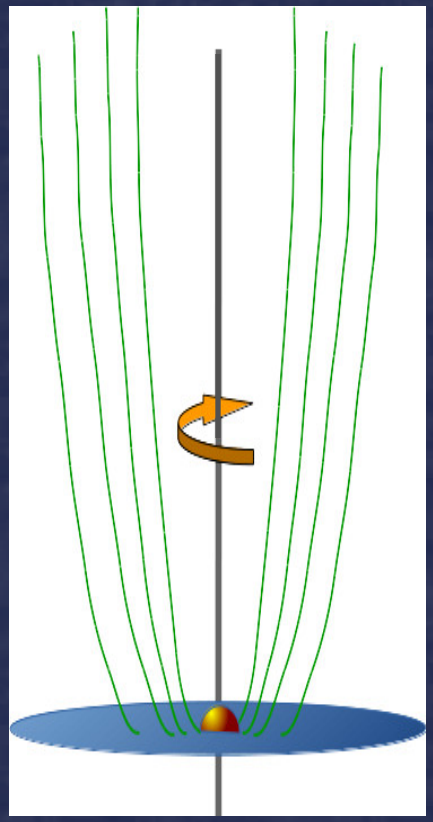
100 au scale
VLA 0.”4 @ 6 GHz
0.”2 @ 13 GHz
0.”1 @ 22 GHz

10 – several 100 au scale
EVN H_2O Masers

AIM

Characterize JETS from high mass stars

POETS : Protostellar Outflows in the EarliesT Stages



TARGETS : **36 sources selected from the BESSEL survey**

11 published in continuum + masers
Moscadelli+ 2016

6 studied in continuum + masers + H2
Massi+ 2018 in prep

Other 25 published in continuum
Sanna+ 2018

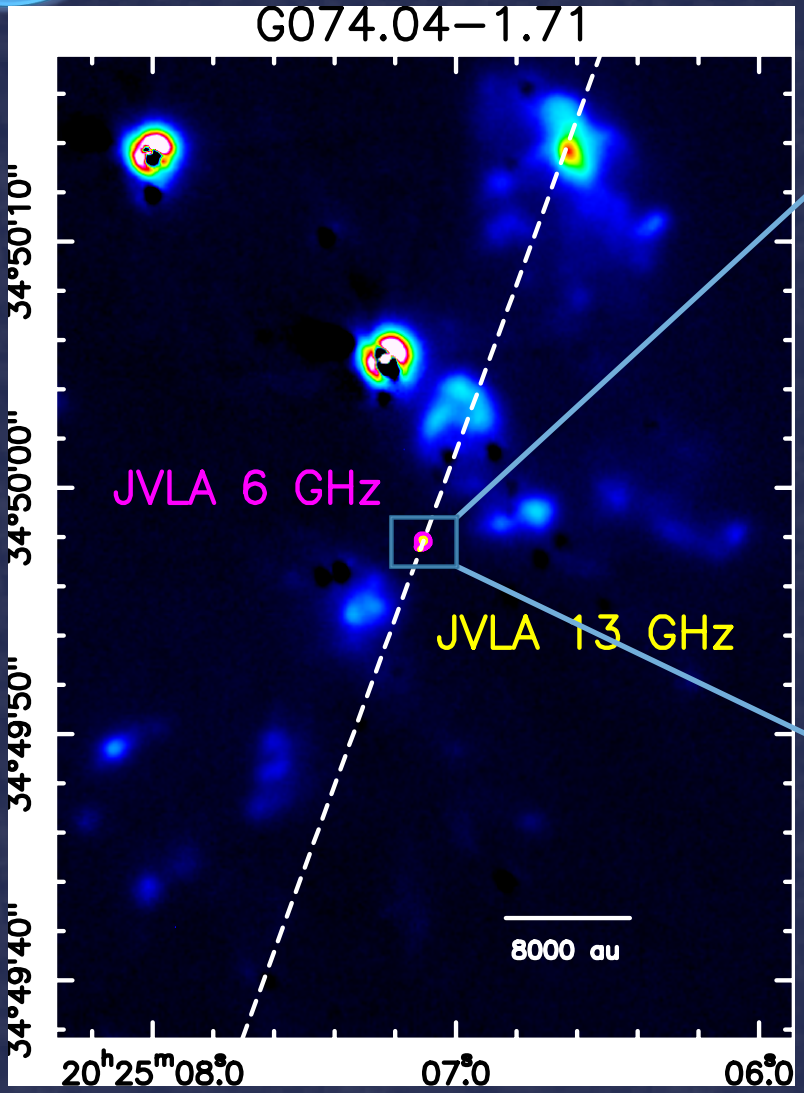
ADVANTAGES : High resolution – Multiple scales --
Velocity information – source identification

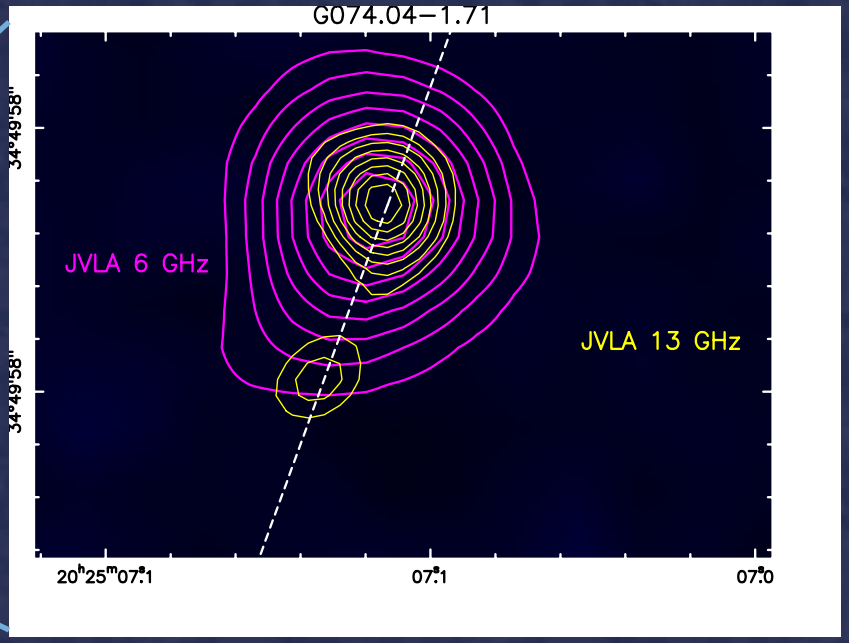
Sample will be completed in 2018/2019

Source

G074.04-1.71

d =1.6 kpc, L=4 10^2 L_{sun}





Massi+ 2018 in prep

Source

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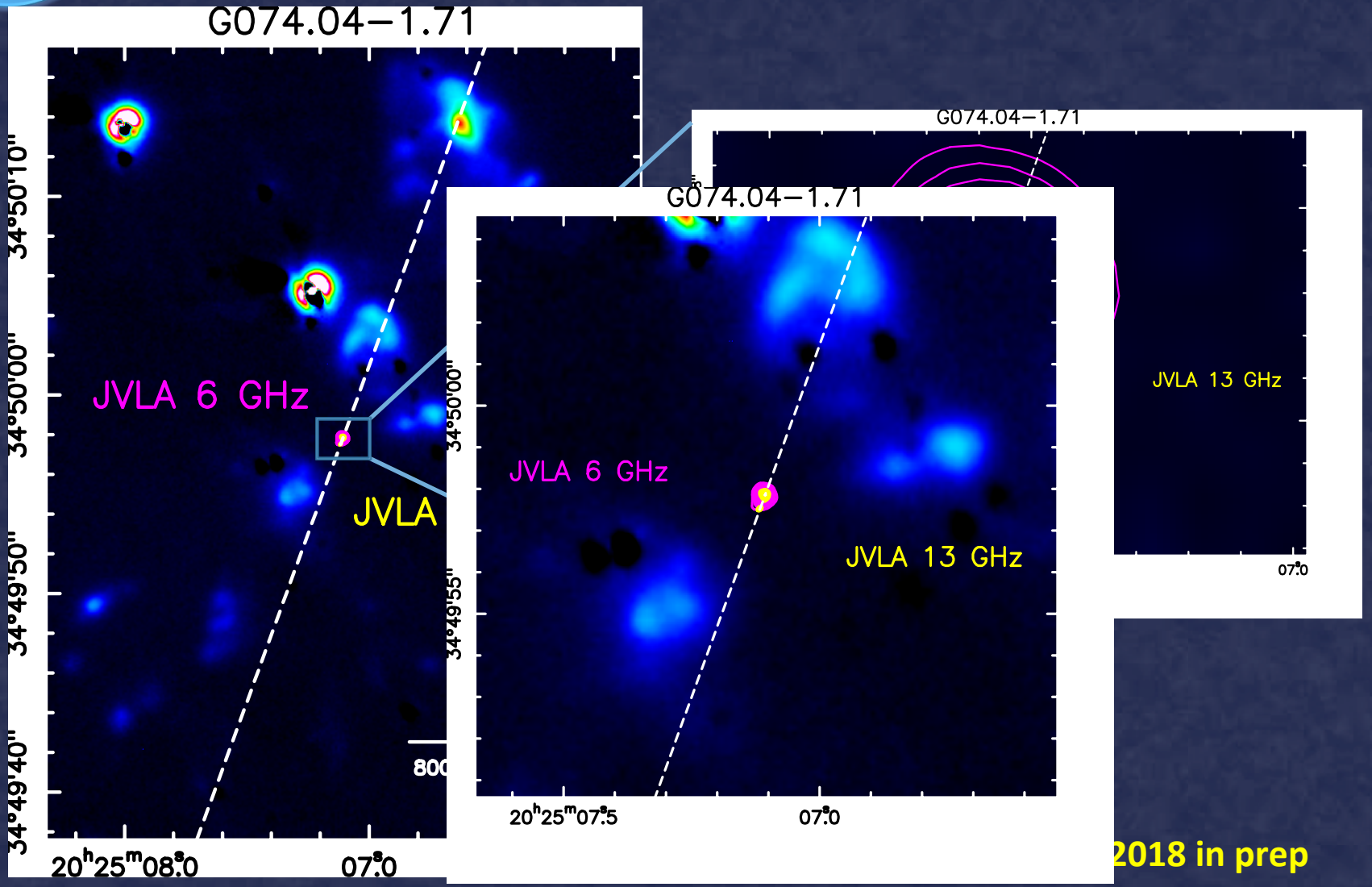
d =1.6 kpc, L=4 10^2 L_{sun}

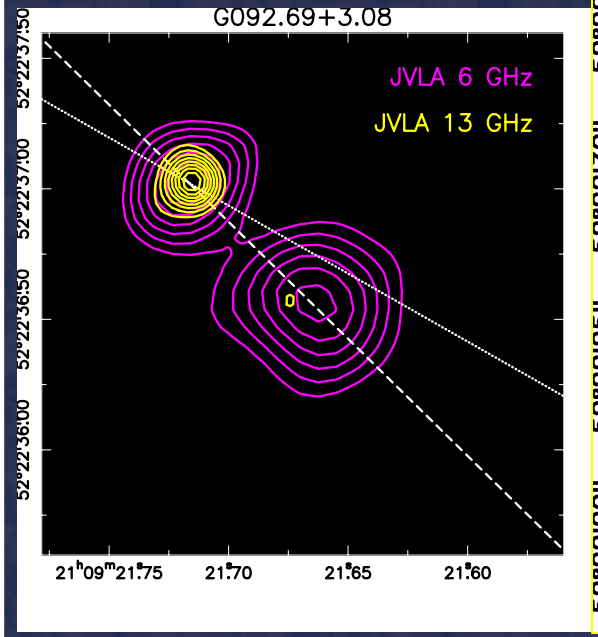


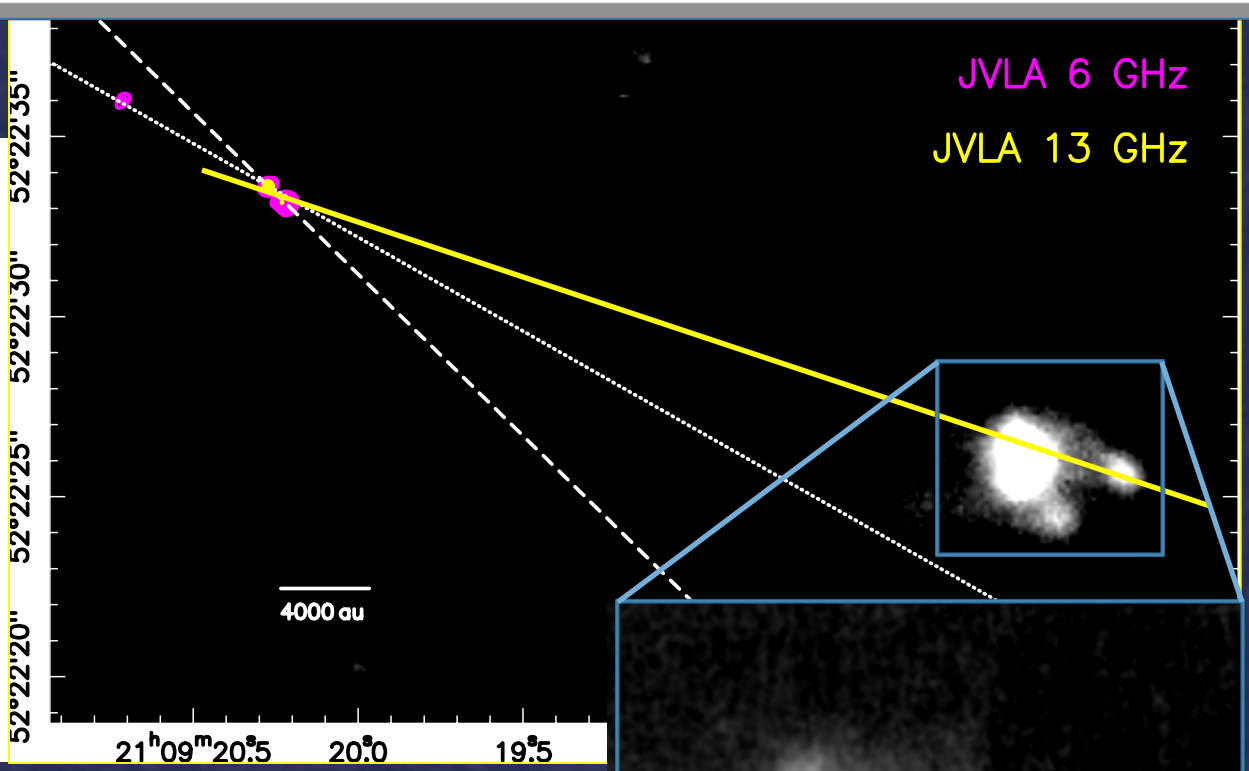
2018 in prep

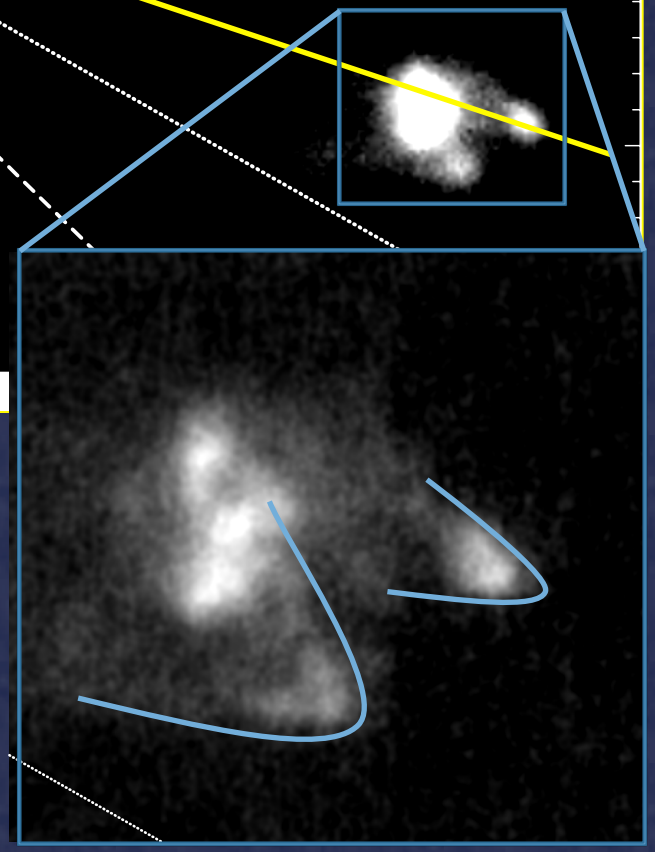
Source

G092.69+3.08

d =1.6 kpc, L= 5 10^3 L_{sun}







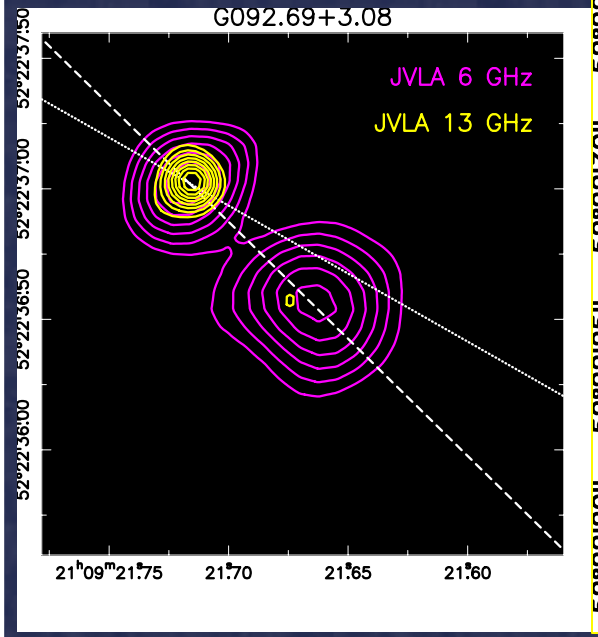
AO image in H_2

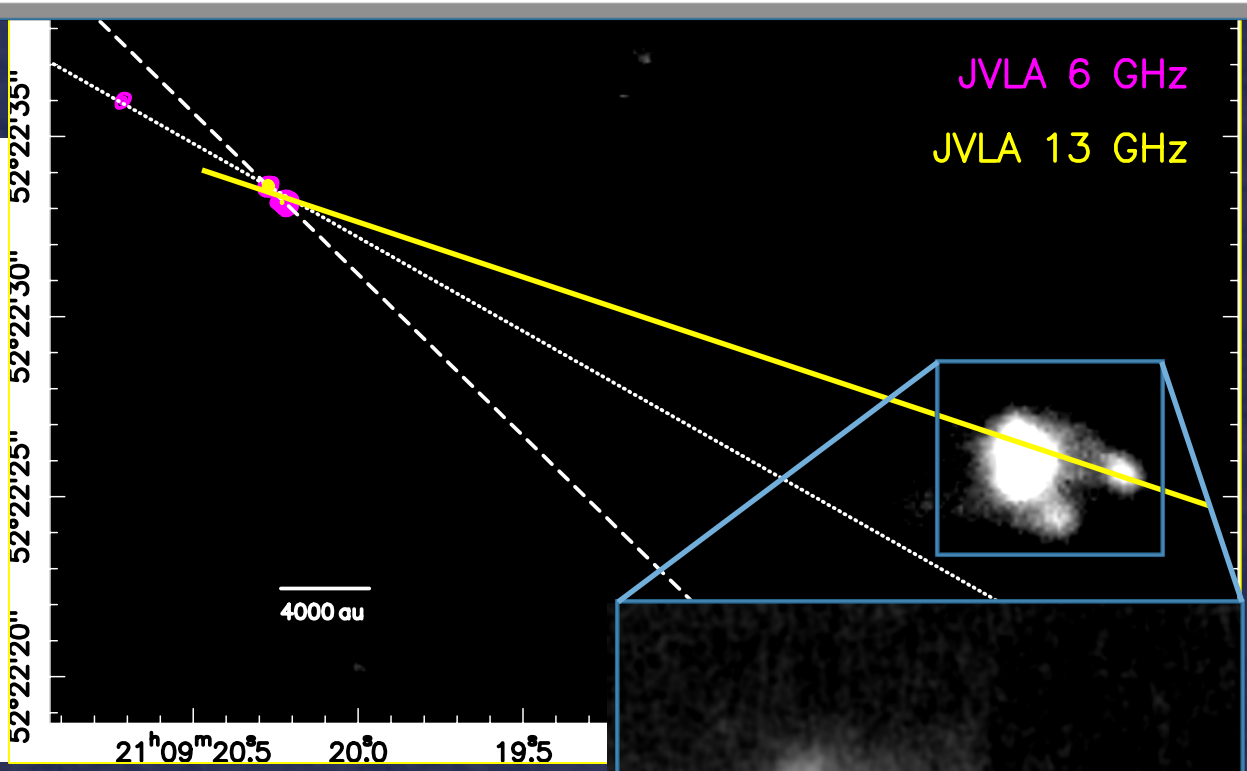
Massi+ 2018 in prep

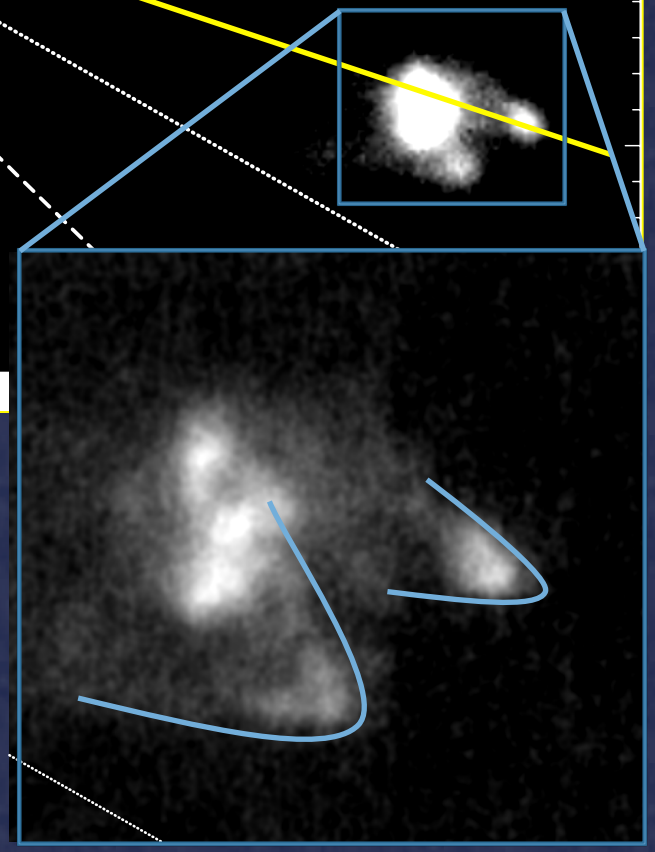
Source

G092.69+3.08

d =1.6 kpc, L= 5 10^3 L_{sun}







JET PRECESSION ?

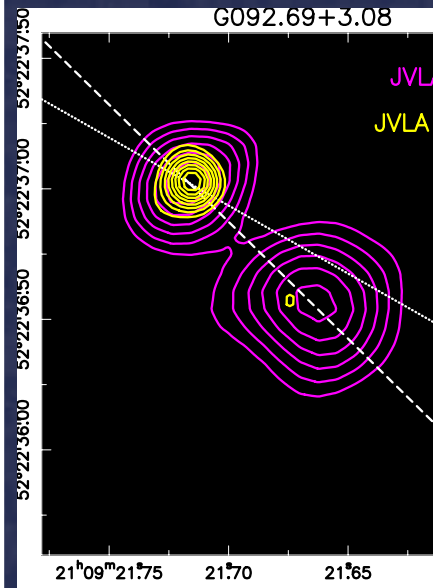
AO image in H_2

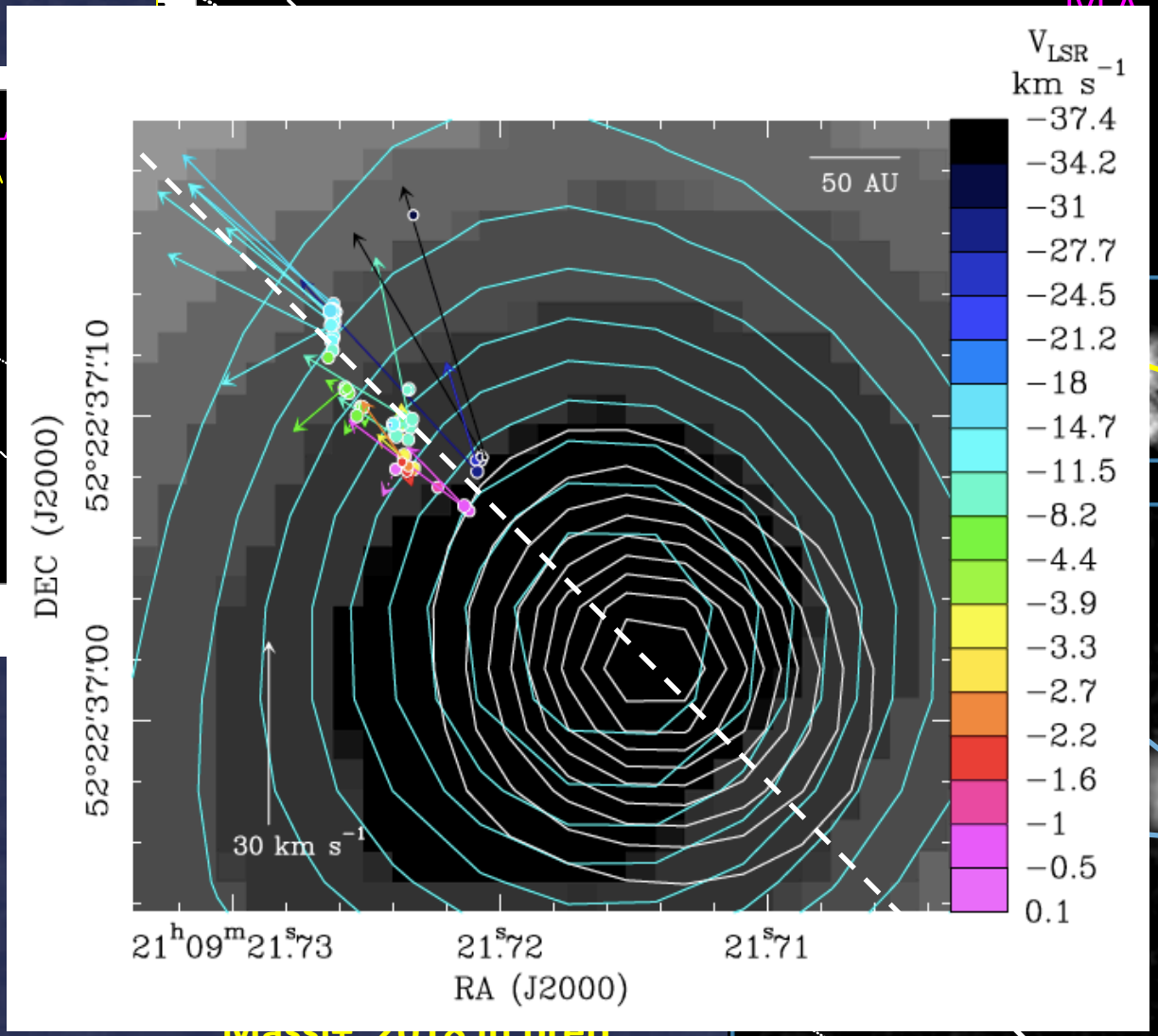
Massi+ 2018 in prep

Source

G092.69+3.08

d =1.6 kpc, L=5 10^3 L_{sun}





JVLA 6 GHz

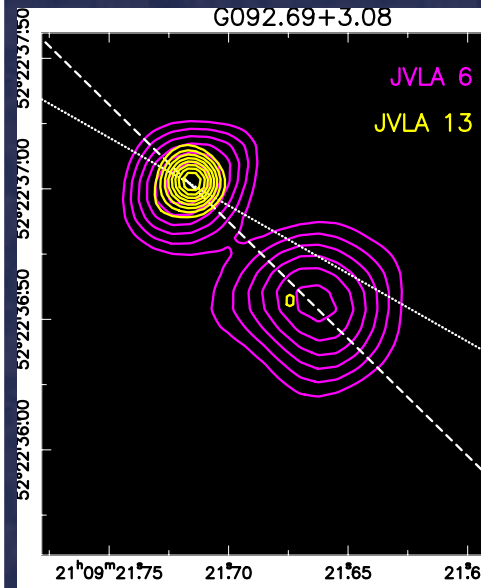
3 GHz

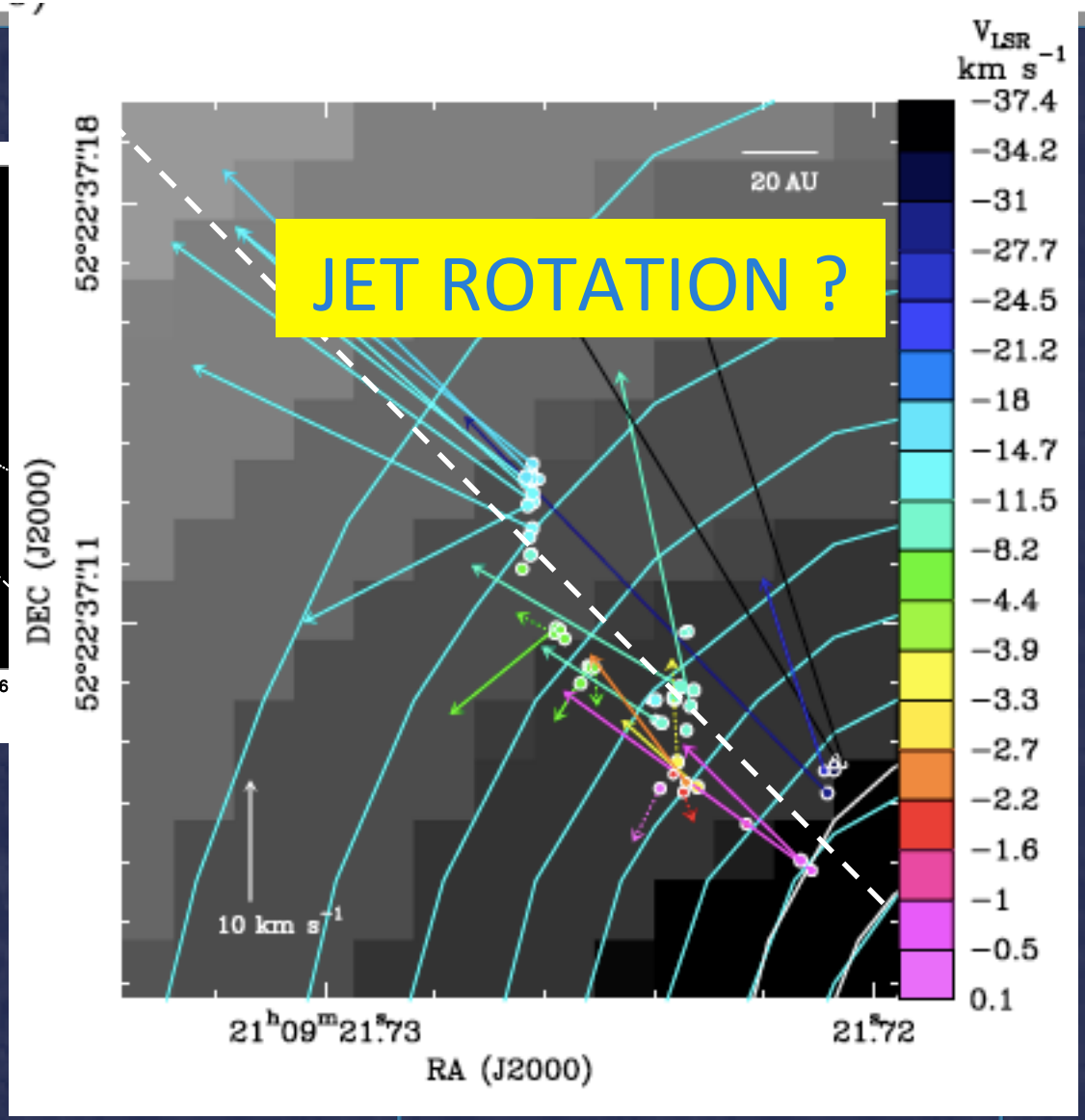
MassiF 2018 in prep

Source

G092.69+3.08

d =1.6 kpc, L=5 10^3 L_{sun}

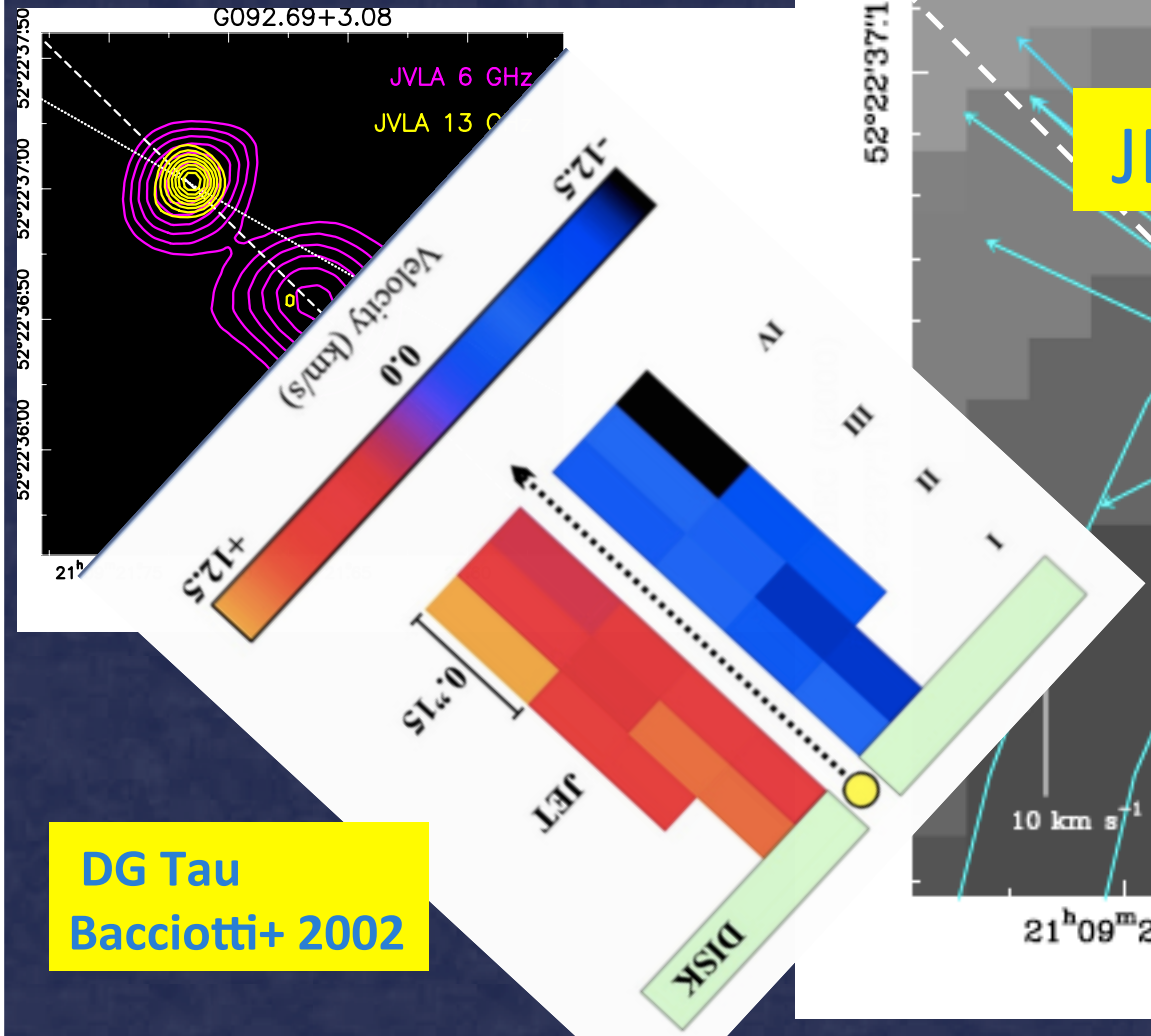


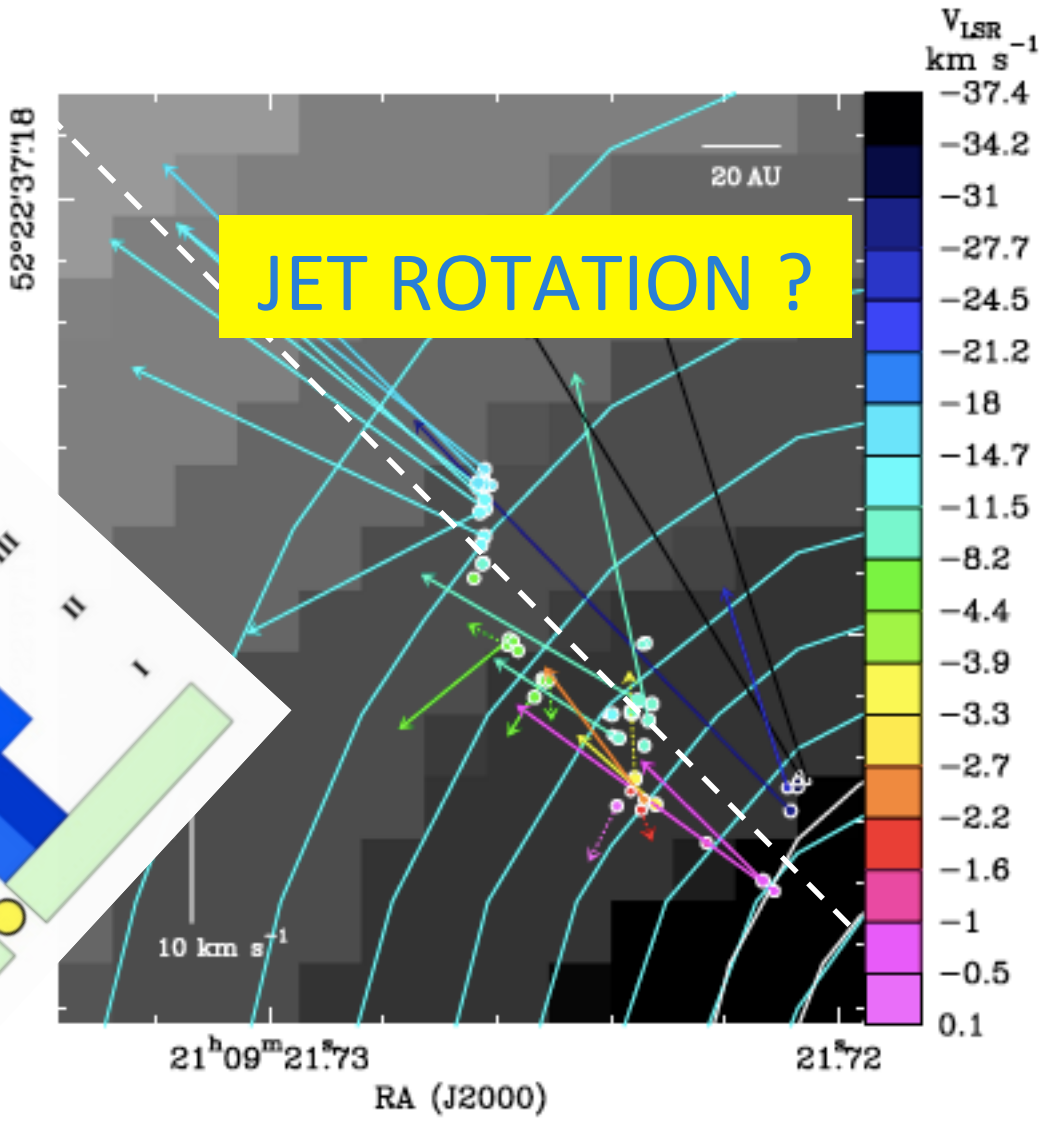


Source

G092.69+3.08

d =1.6 kpc, L=5 10^3 L_{sun}



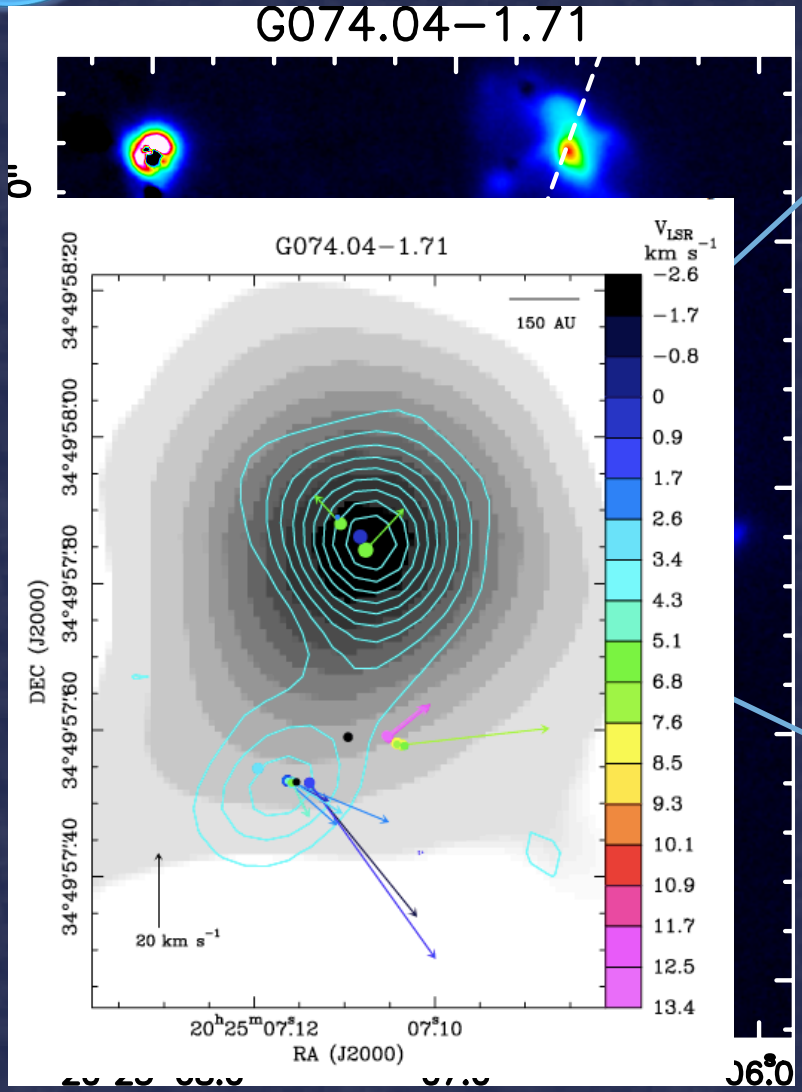


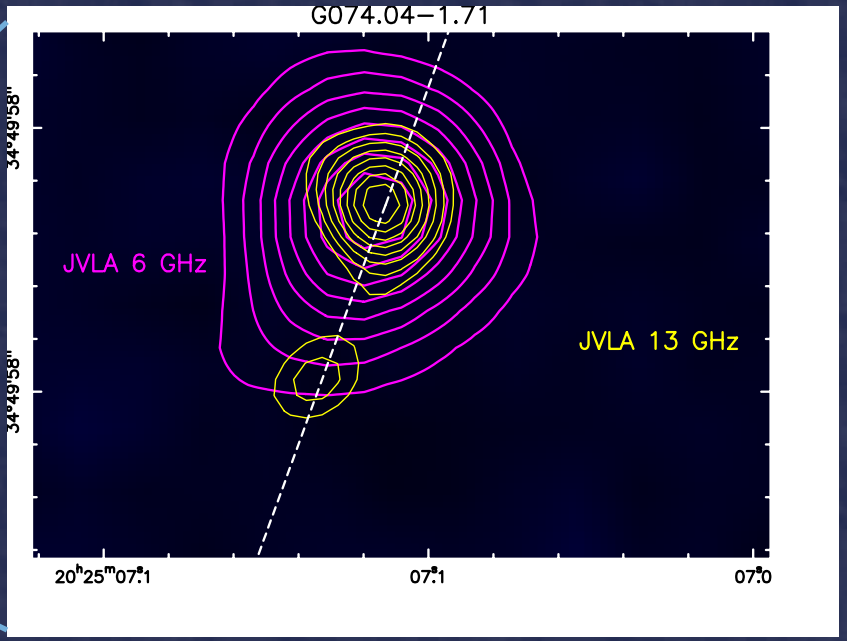
DG Tau
Bacciotti+ 2002

Source

G074.04-1.71

d =1.6 kpc, L=4 10^2 L_{sun}



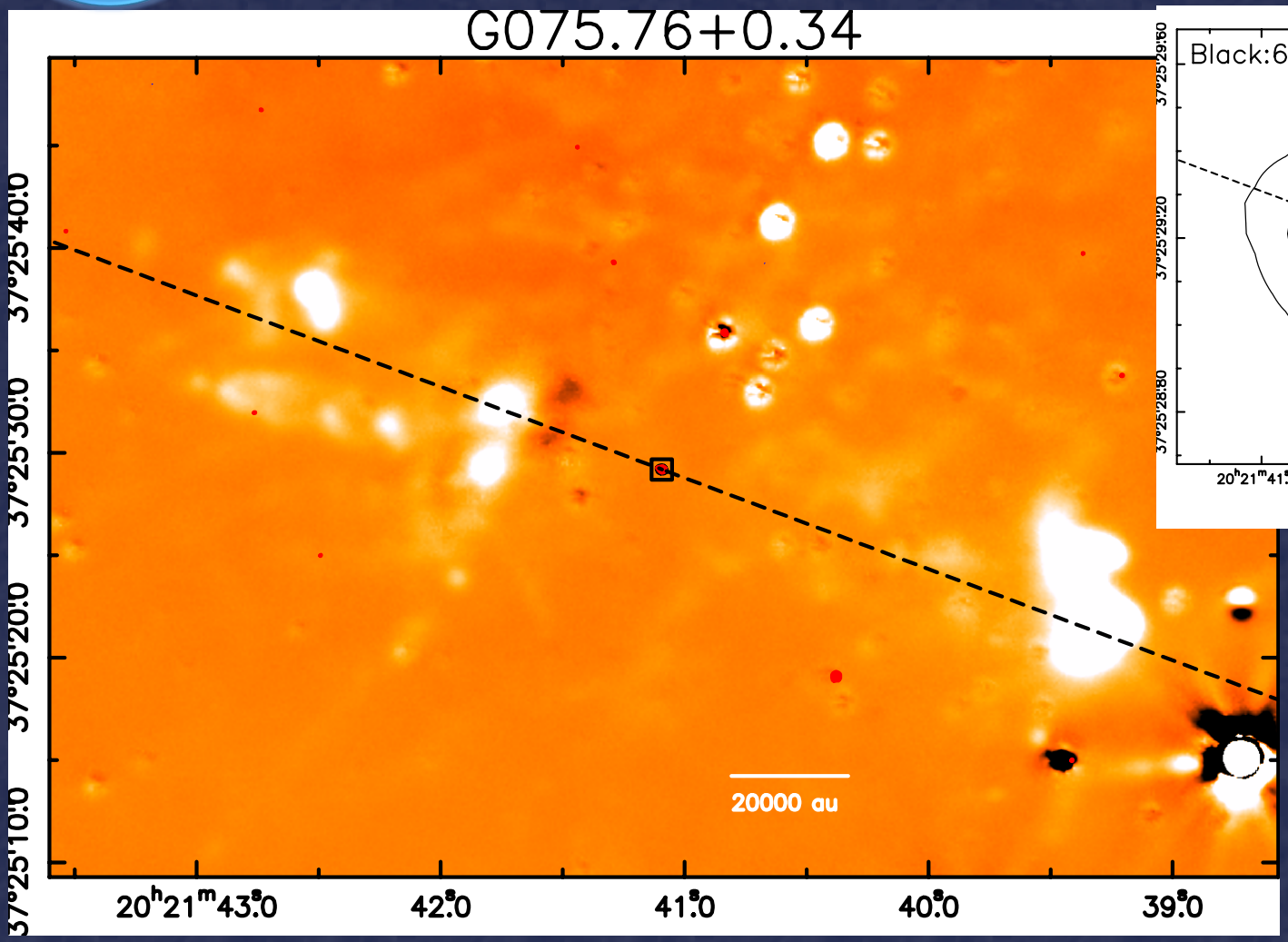


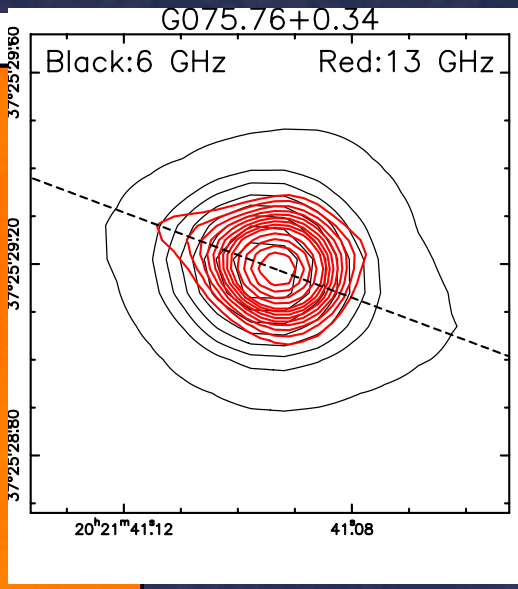
Massi+ 2018 in prep

Source

G075.76+0.34

d =3.5 kpc, L= 10^4 L_{sun}





Massi+ 2018 in prep

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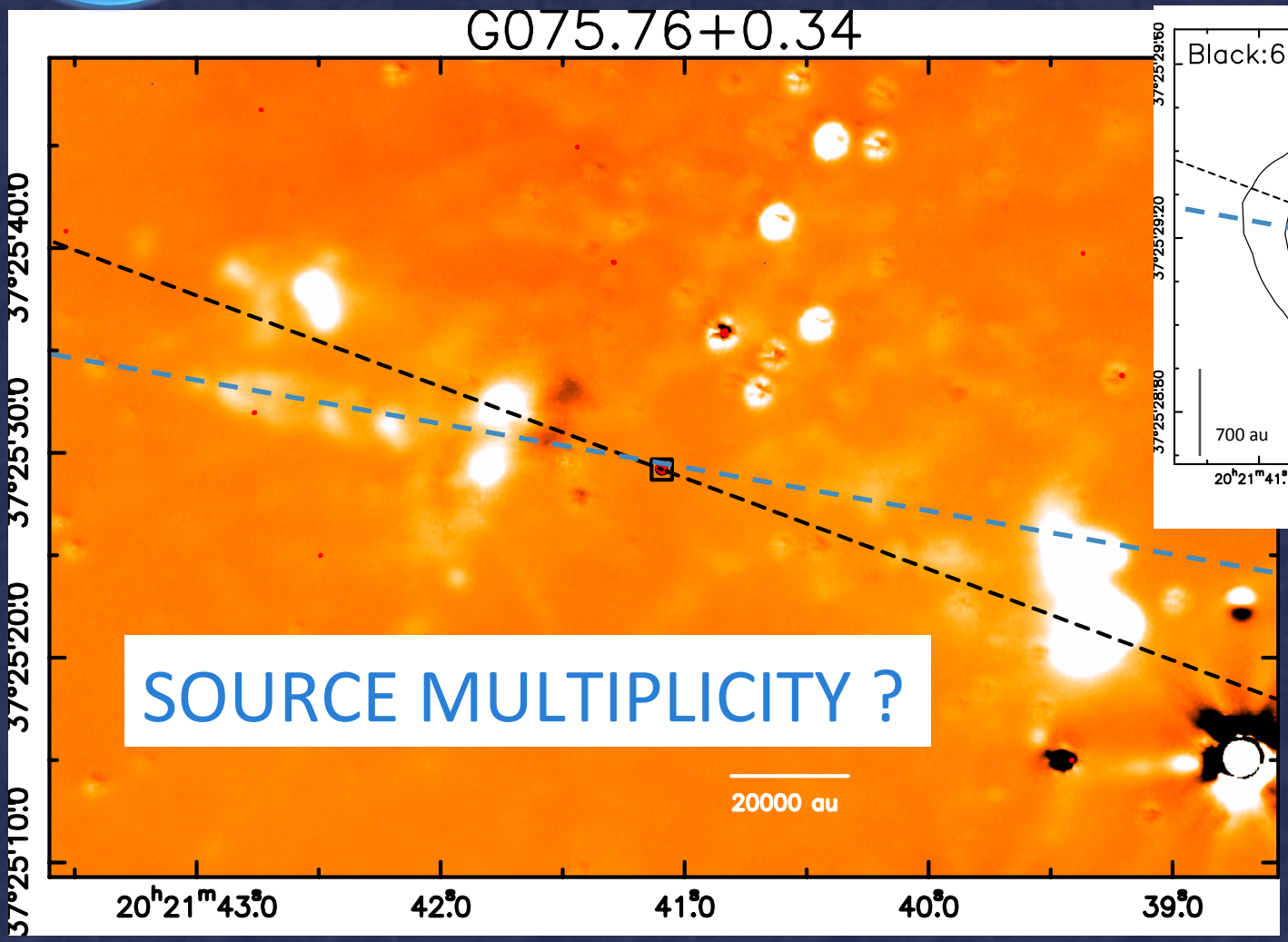
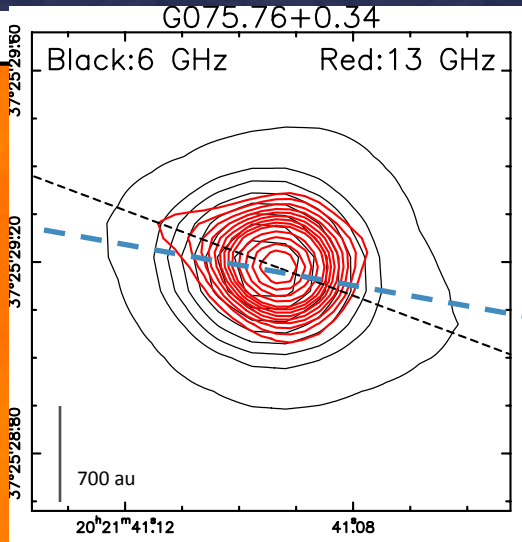
d =3.5 kpc, L= 10^4 L_{sun}





Massi+ 2018 in prep

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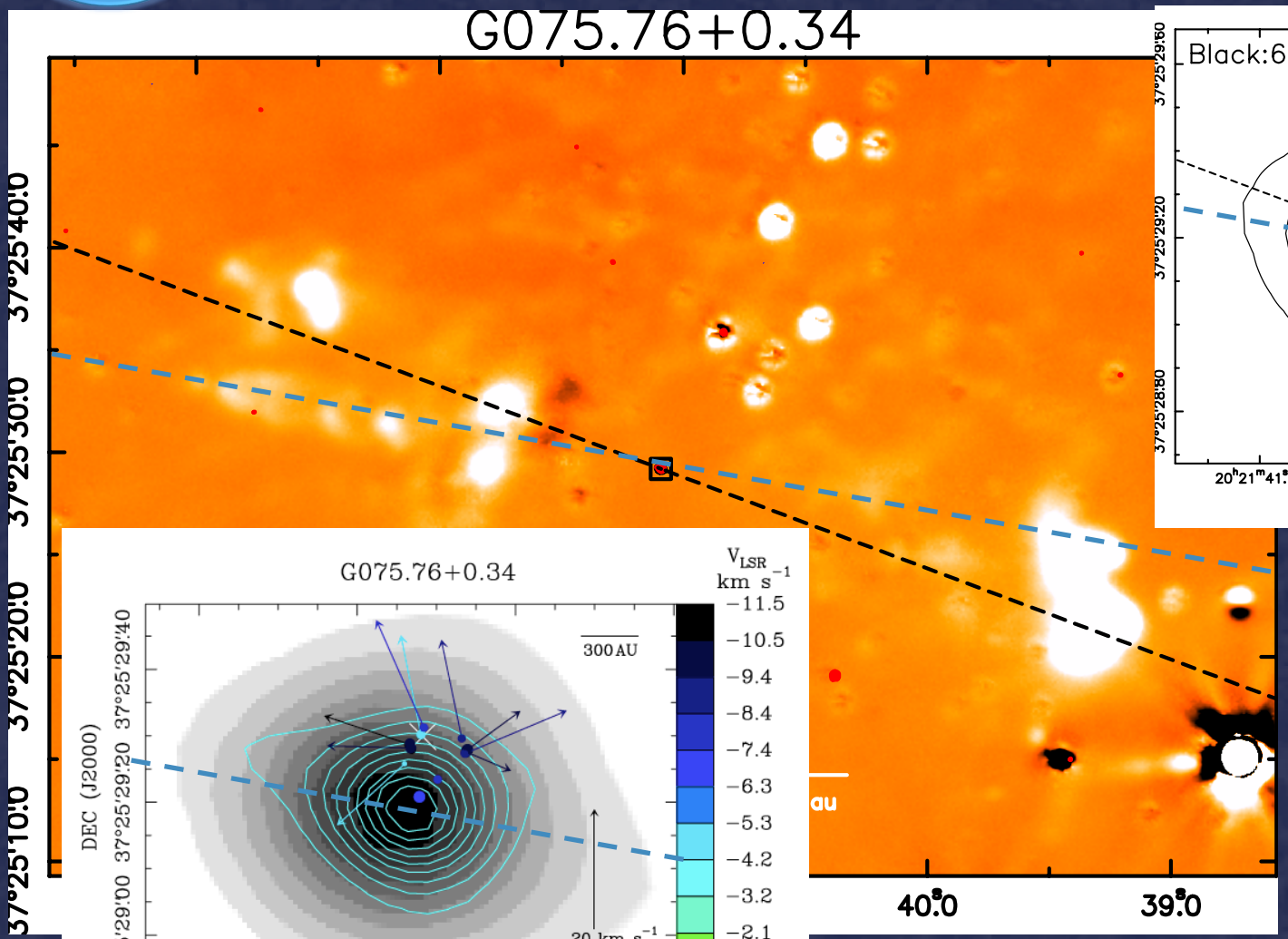
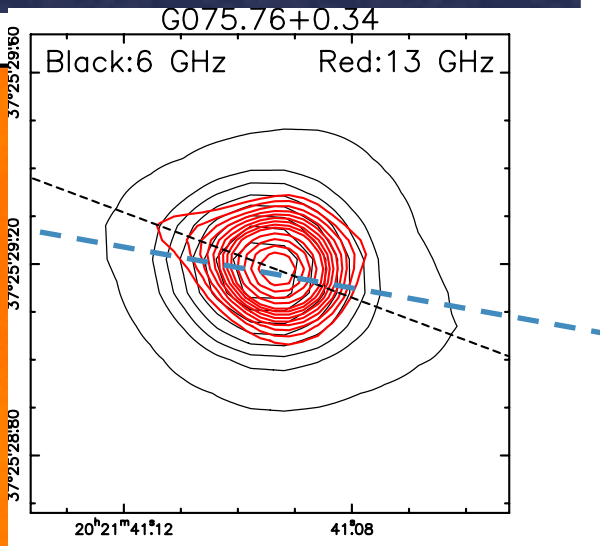


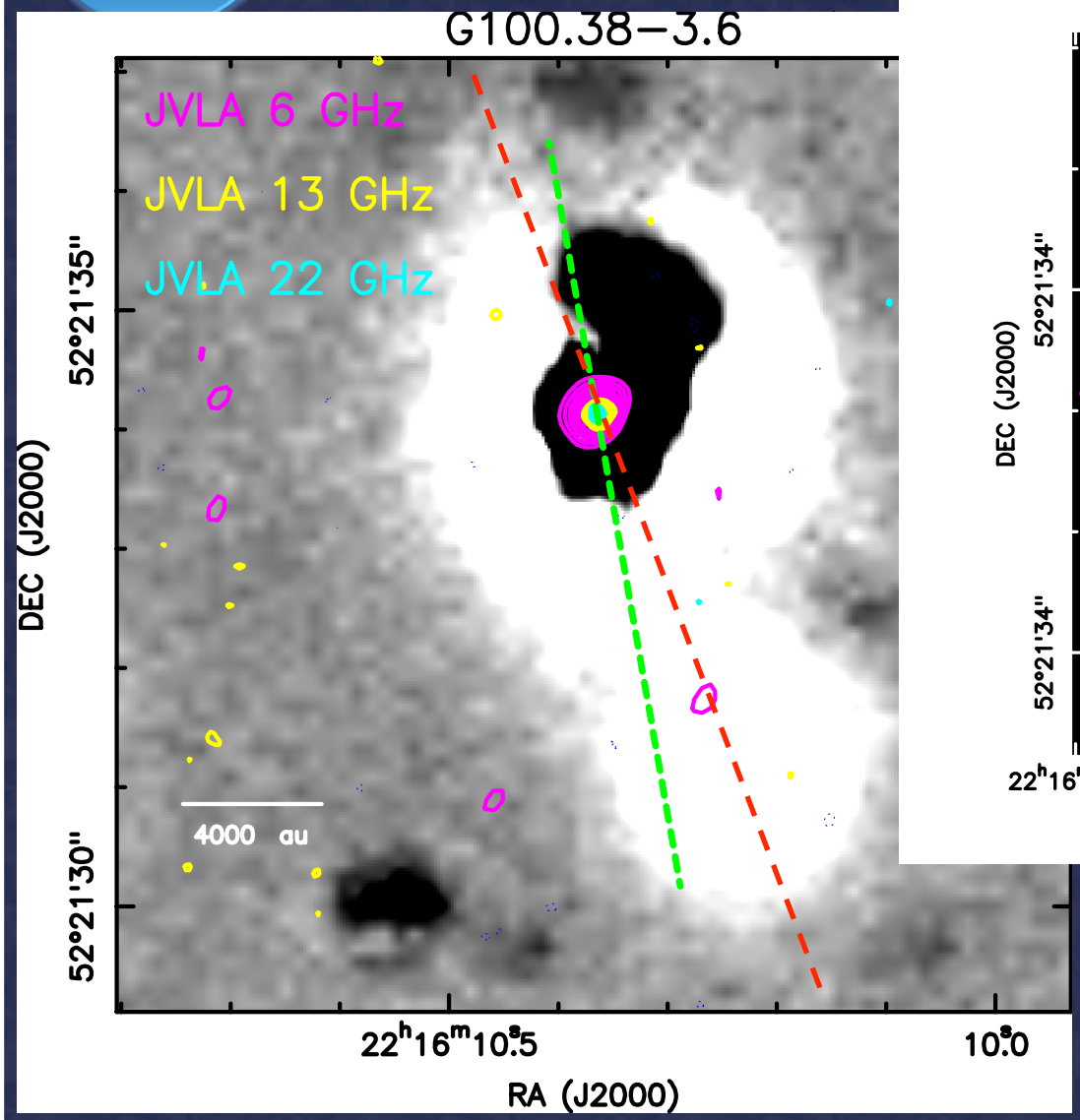


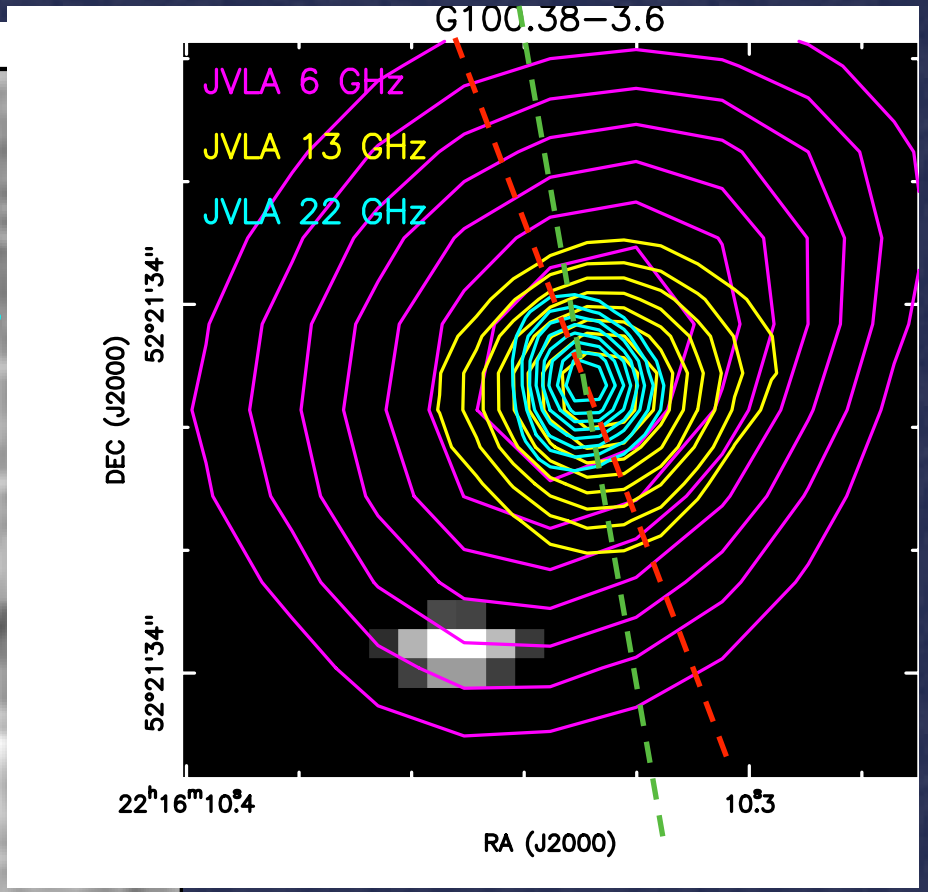
Massi+ 2018 in prep

Source

G100.38-3.6

d =3.4 kpc, L= 10^4 L_{sun}





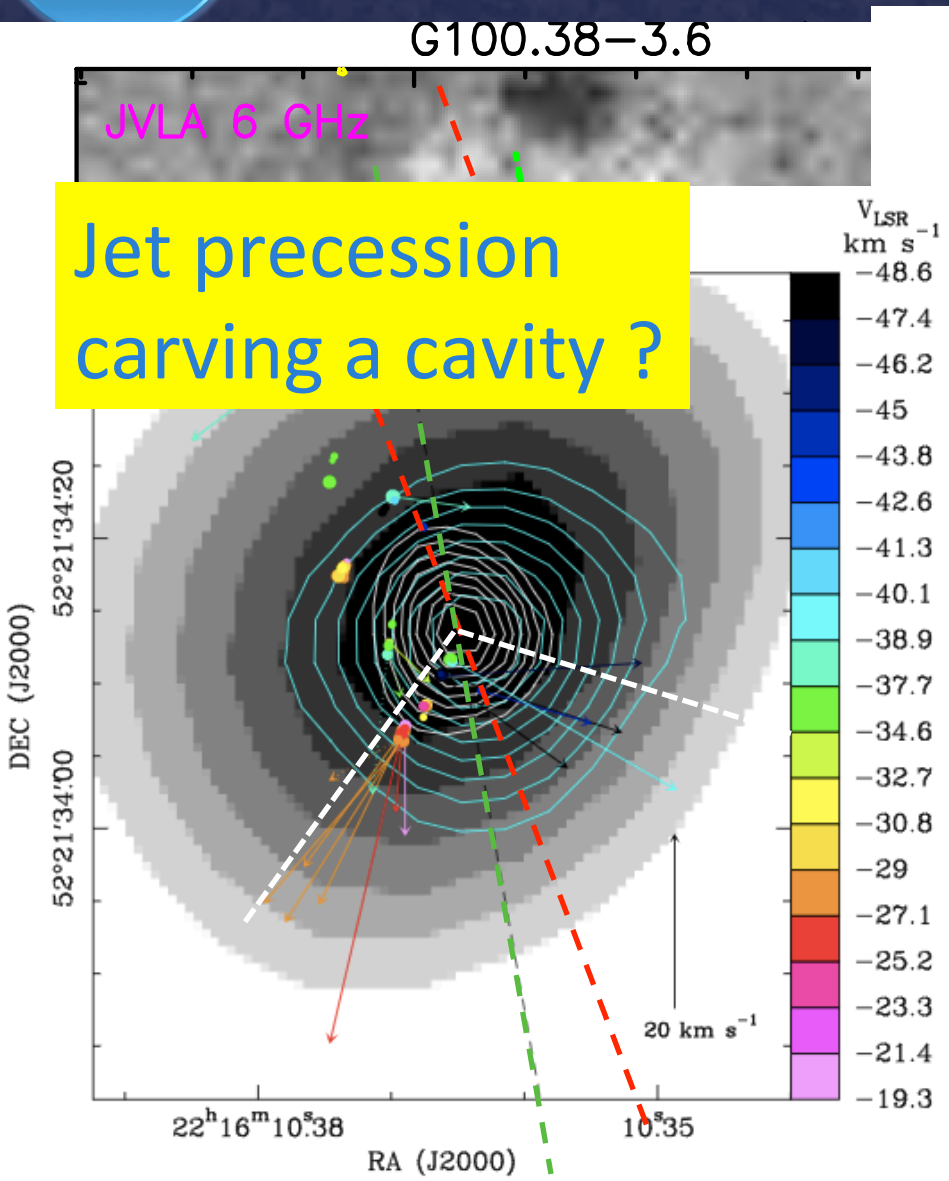
PA of HH objects at large scale

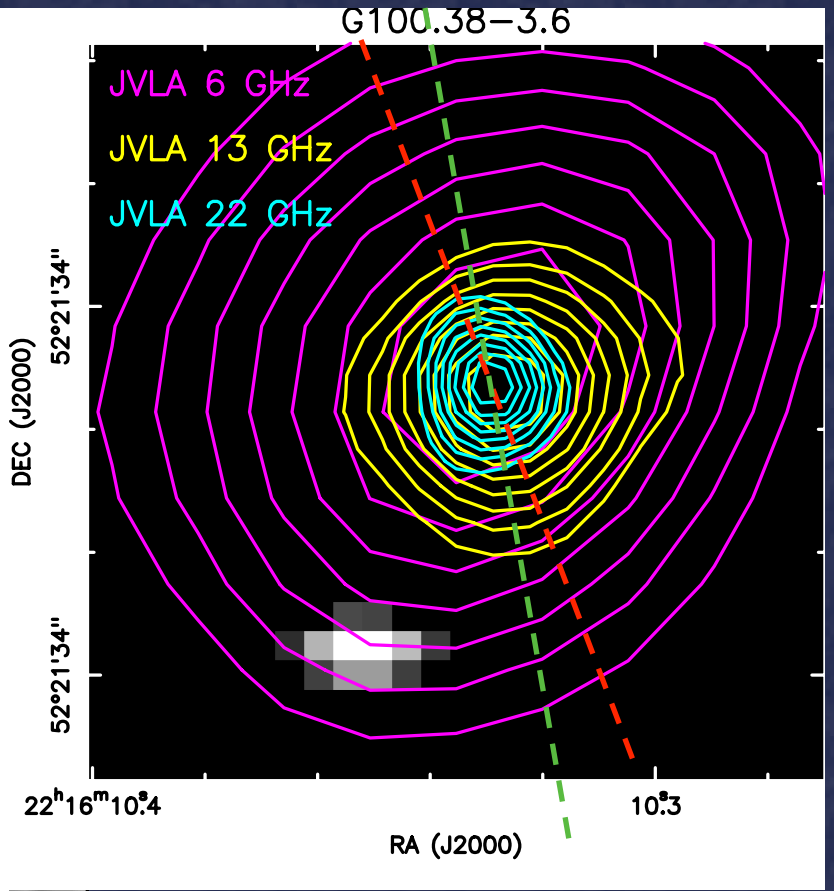
Massi+ 2018 in prep

Source

G100.38-3.6

d =3.4 kpc, L= 10^4 L_{sun}





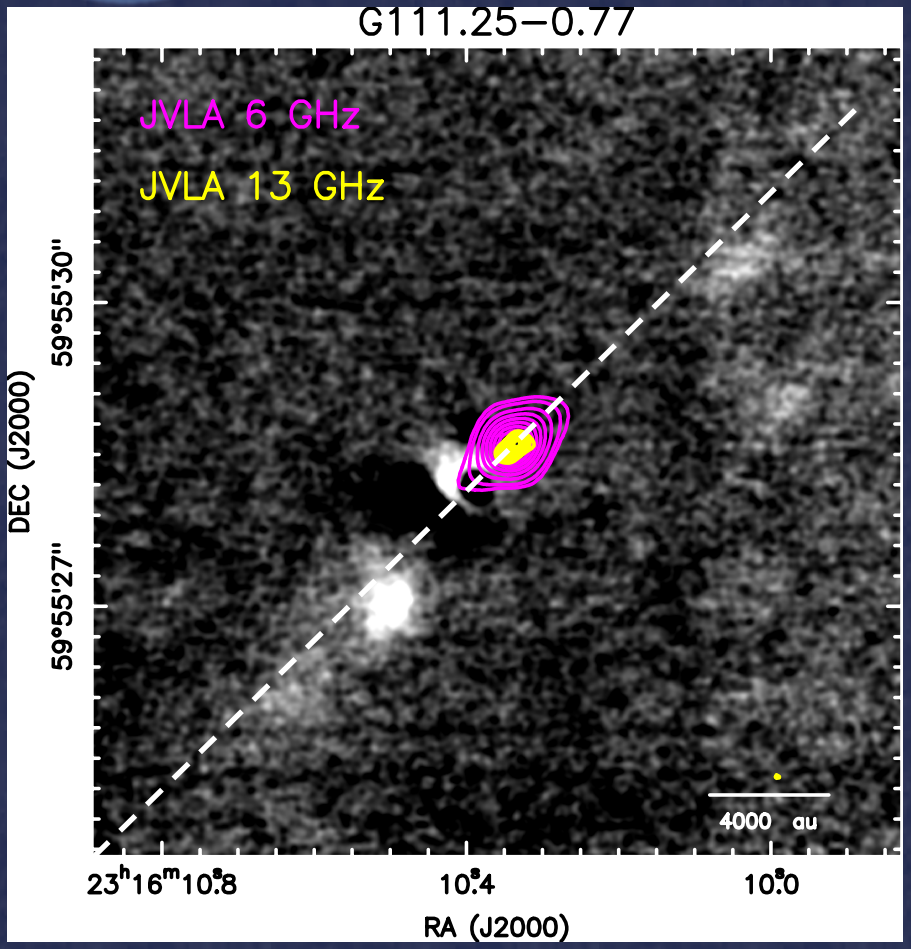
PA of HH objects at large scale

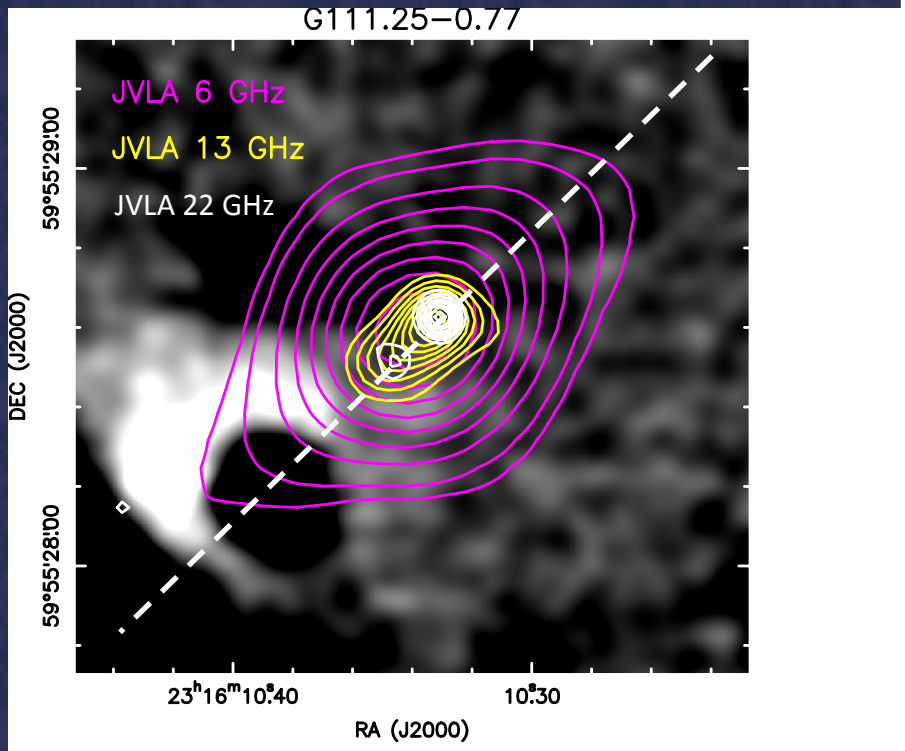
Massi+ 2018 in prep

Source

G111.25-0.77

d =3.4 kpc, L= 5 10^3 L_{sun}





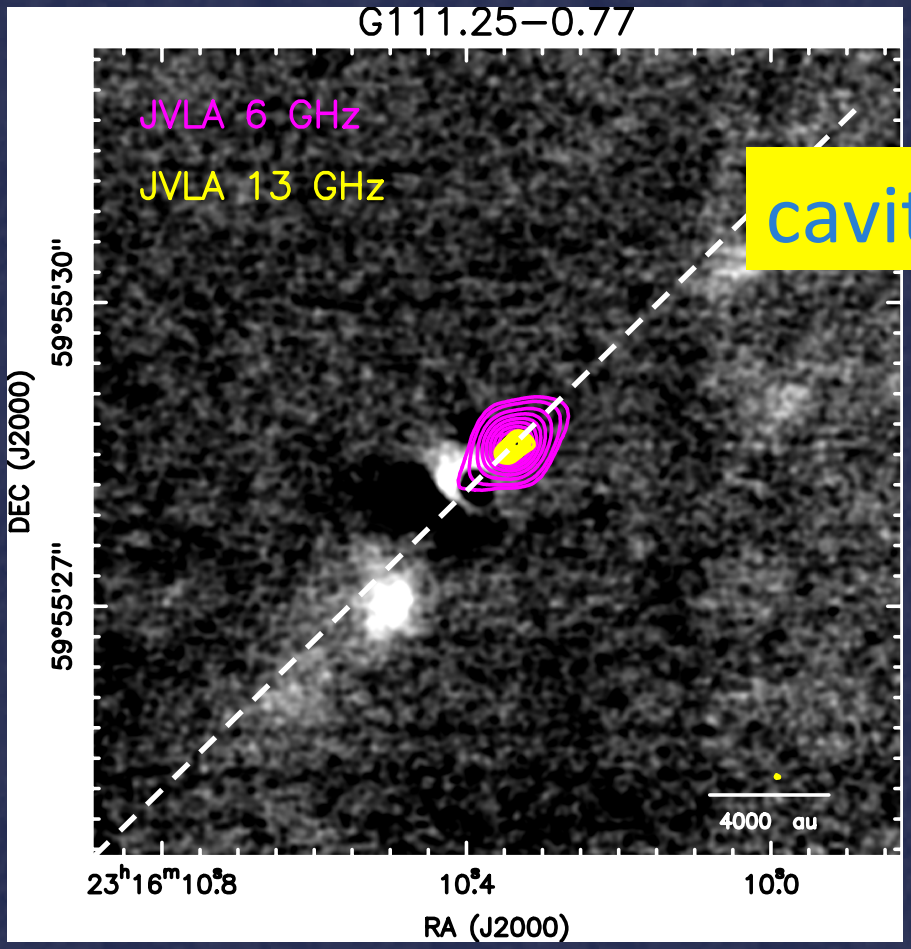
AO image in H_2

Massi+ 2018 in prep

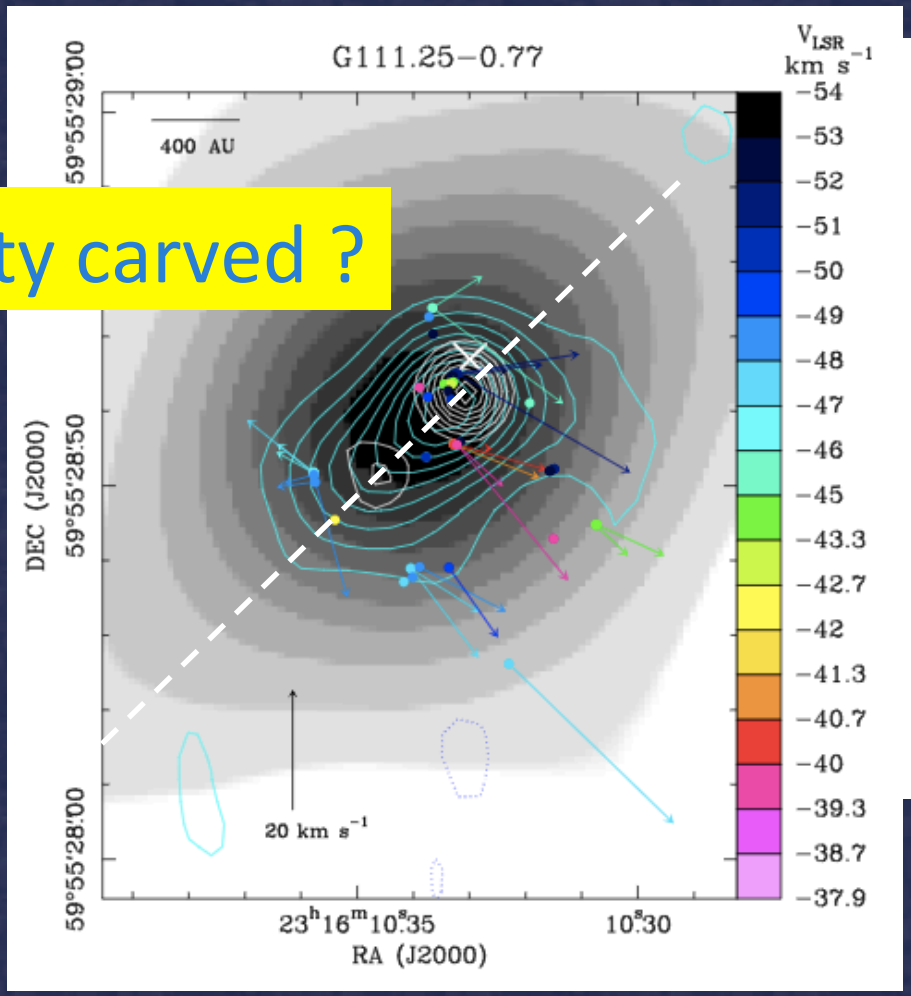
Source

G111.25-0.77

d =3.4 kpc, L= 5 10^3 L_{sun}



cavity carved ?



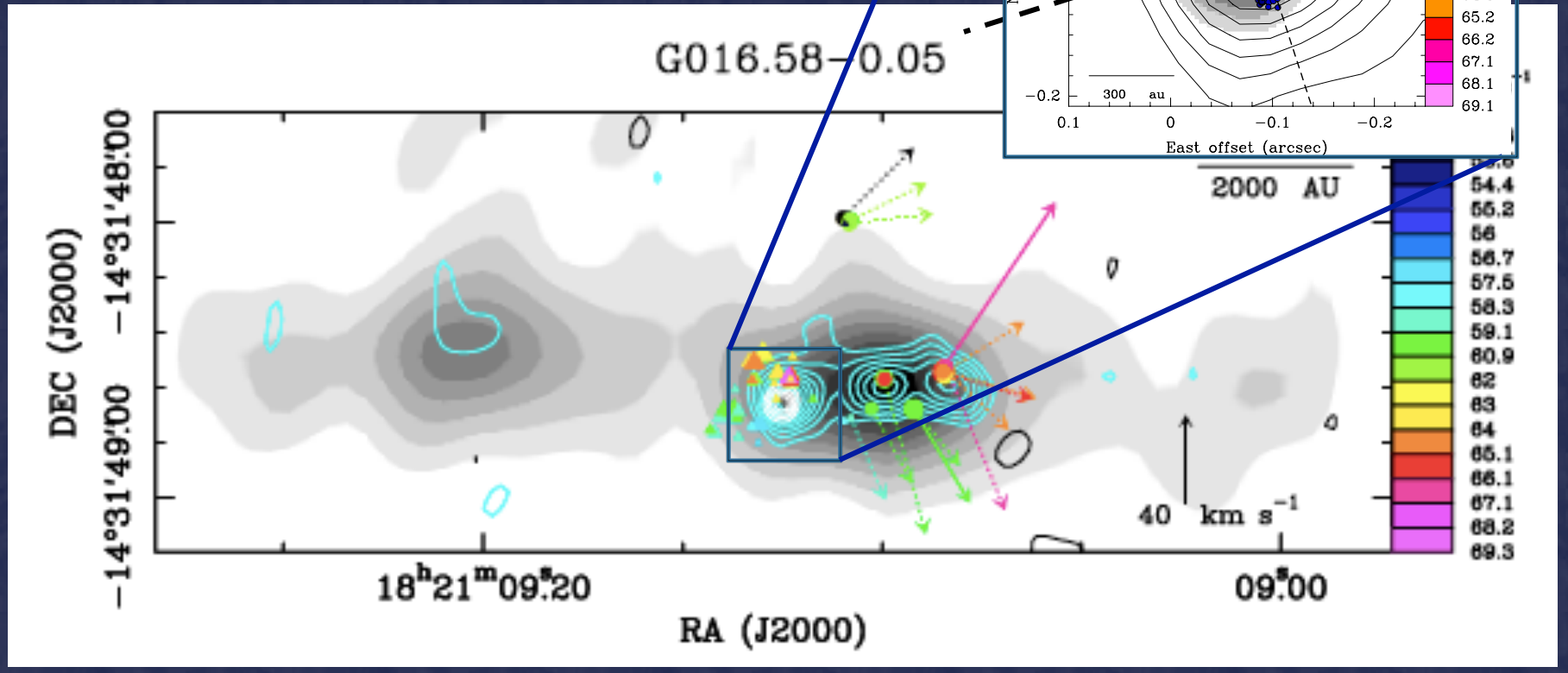
Massi+ 2018 in prep

Source

G016.58-0.05

d =3.6 kpc, L= 10^4 L_{sun}

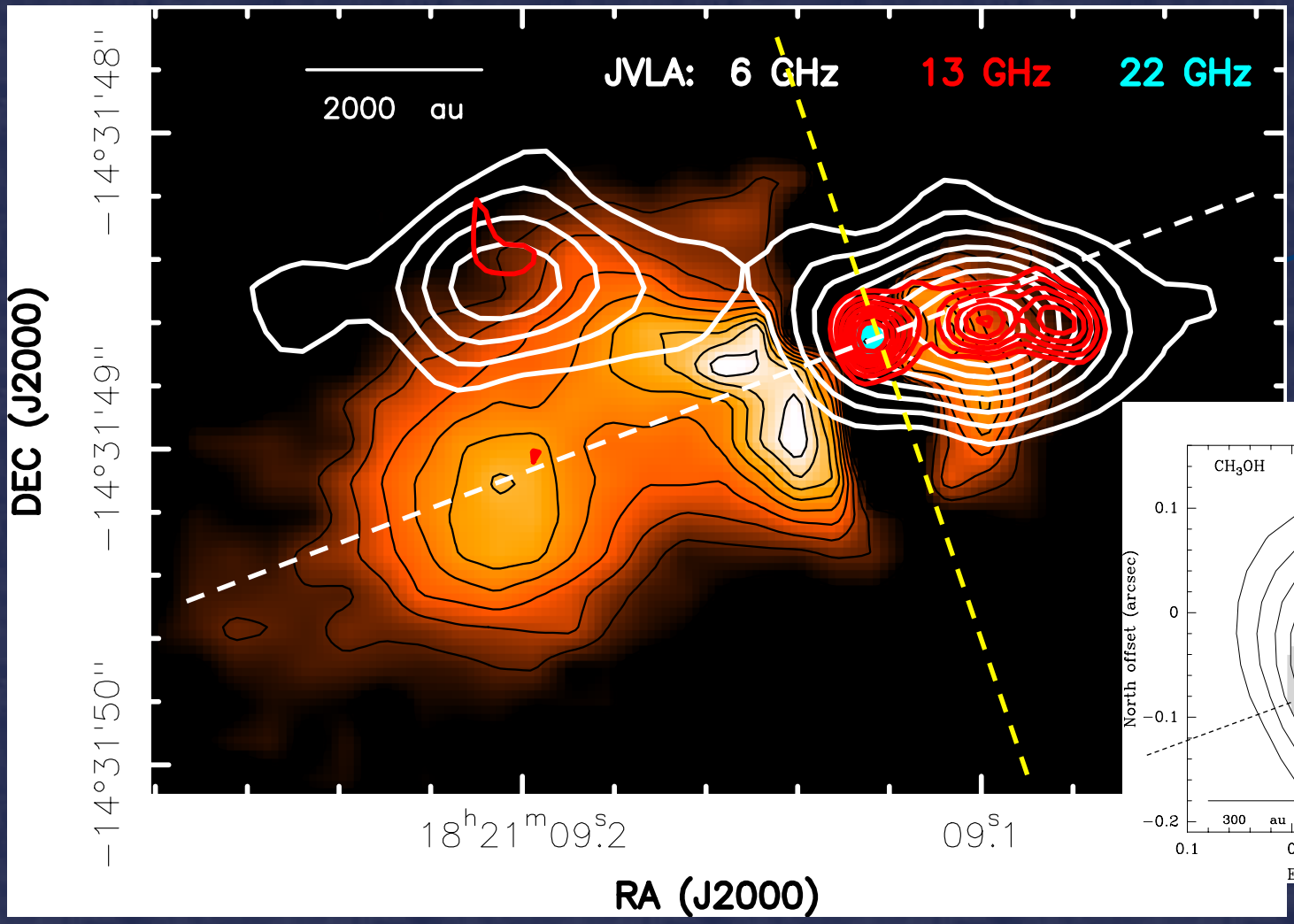
Talk by L. Moscadelli



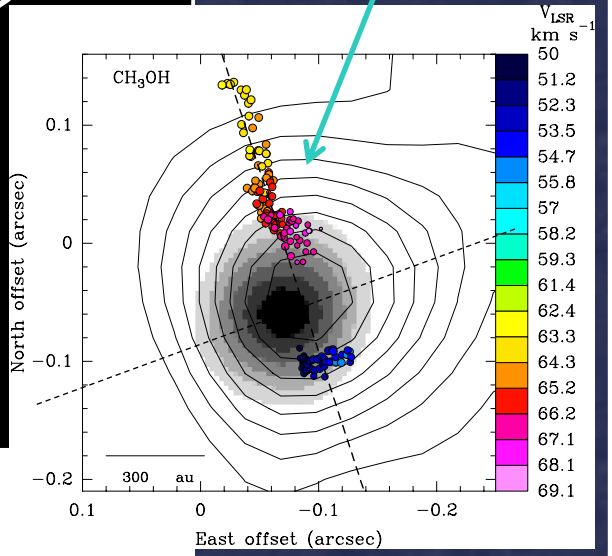
Source

G016.58-0.05

d =3.6 kpc, L= 10^4 L_{sun}



Peaks of Thermal CH_3OH



Massi+ 2018 in prep

Source

G016.58-0.05

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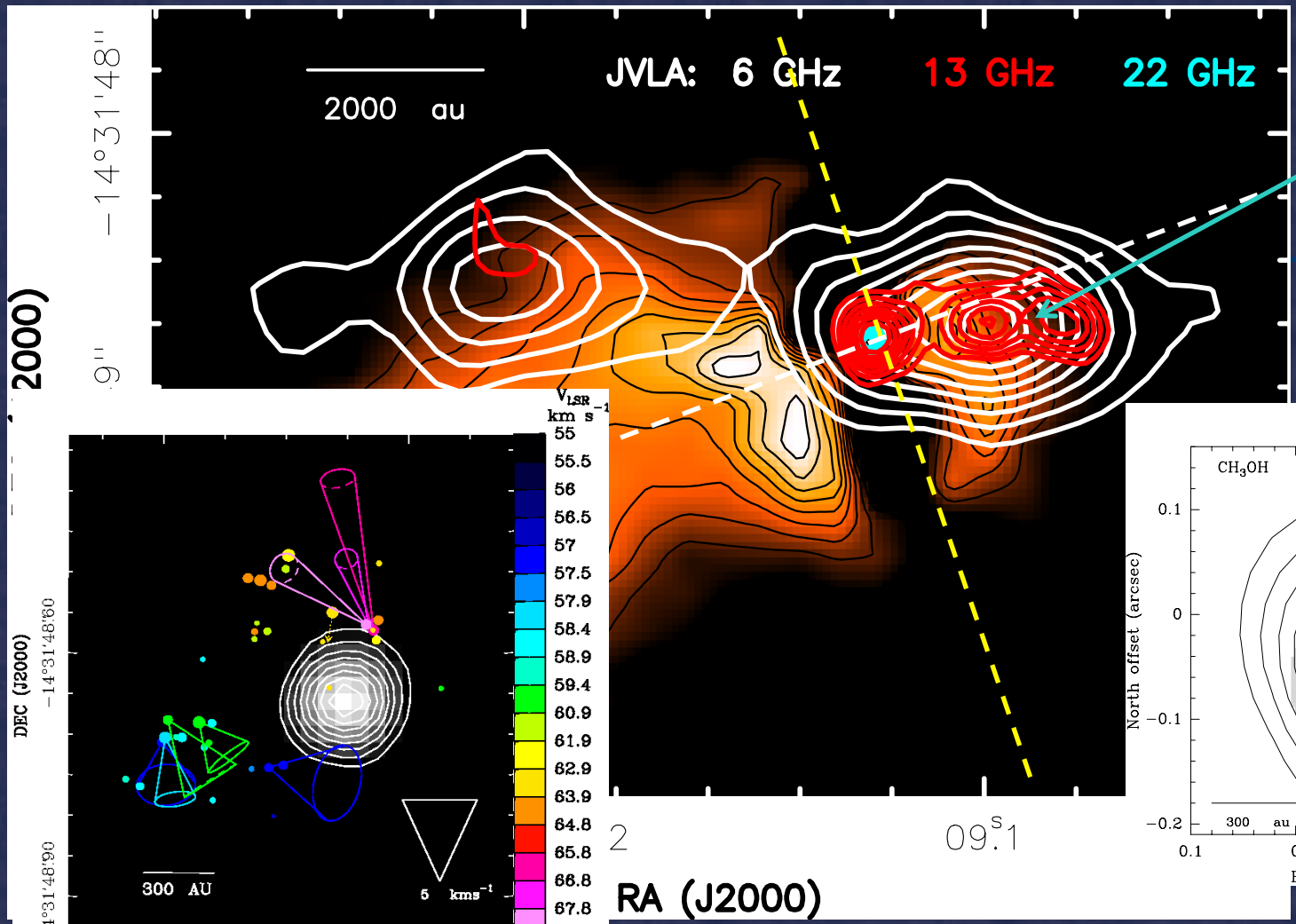

Massi+ 2018 in prep

Summary

- **H2 EMISSION FOUND IN ALL 6 CASES EXAMINED**
- **CONTINUUM EMISSION AND H2 FLOWS WELL ALIGNED**
- **COLLIMATED JETS, BOW SHOCKS, CAVITIES, ROTATION AS IN LOW MASS**
- **EVIDENCE OF FREQUENT PRECESSION → GRAVITATIONAL EFFECTS IN CLUSTER**
- **MASER DISTRIBUTION MORE DIFFICULT TO INTERPRET :**
  JET BASE ? SHOCKED CAVITY WALLS ?
  ANALYSIS TO BE COMPLETED BY THE END OF 2018

TAKE HOME :
RESULTS SUPPORT FORMATION SCHEME SIMILAR AT HIGH AND LOW STAR MASSES

THANKS !