

# Chemical differentiation within a binary Class II disk system

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*Towards new frontiers: the astrochemical journey from young stellar nurseries  
to exoplanets*

*Garching, 12<sup>th</sup> of March 2025*

in collaboration with: Karin Öberg, Feng Long, David Wilner, Sean Andrews,  
Josh Lovell, **Clara Ross**, Alice Booth

CENTER FOR

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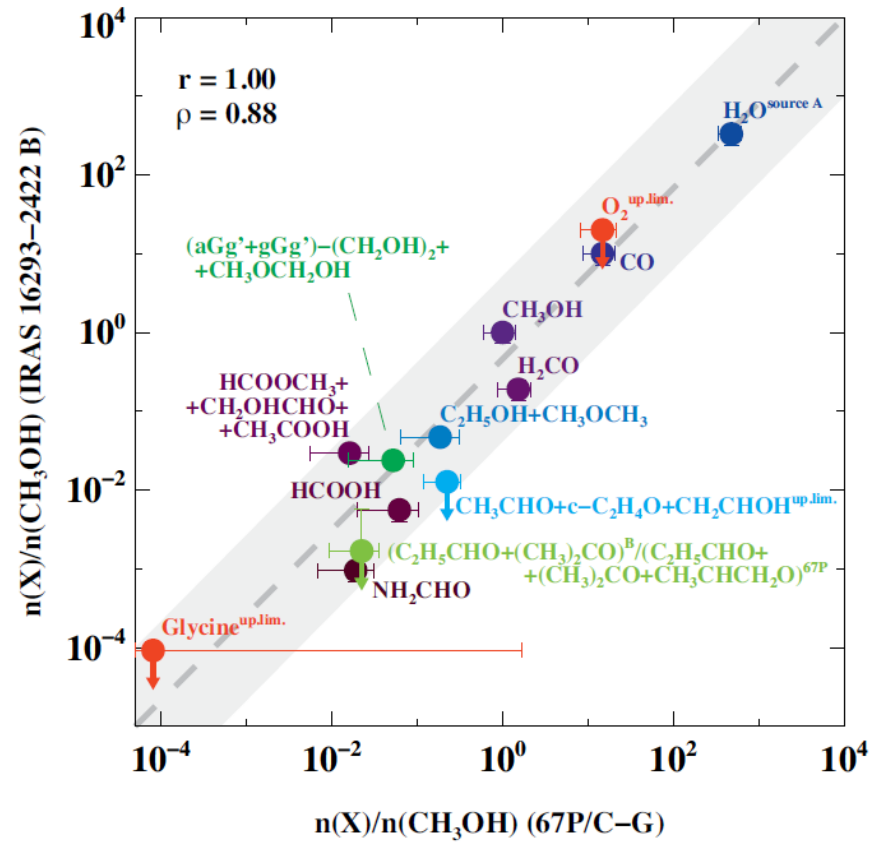
How does the chemistry change during the different stages of star formation?

How do the physical conditions influence the chemistry and vice versa?

How does the individual evolution of the protostar influence the chemistry?

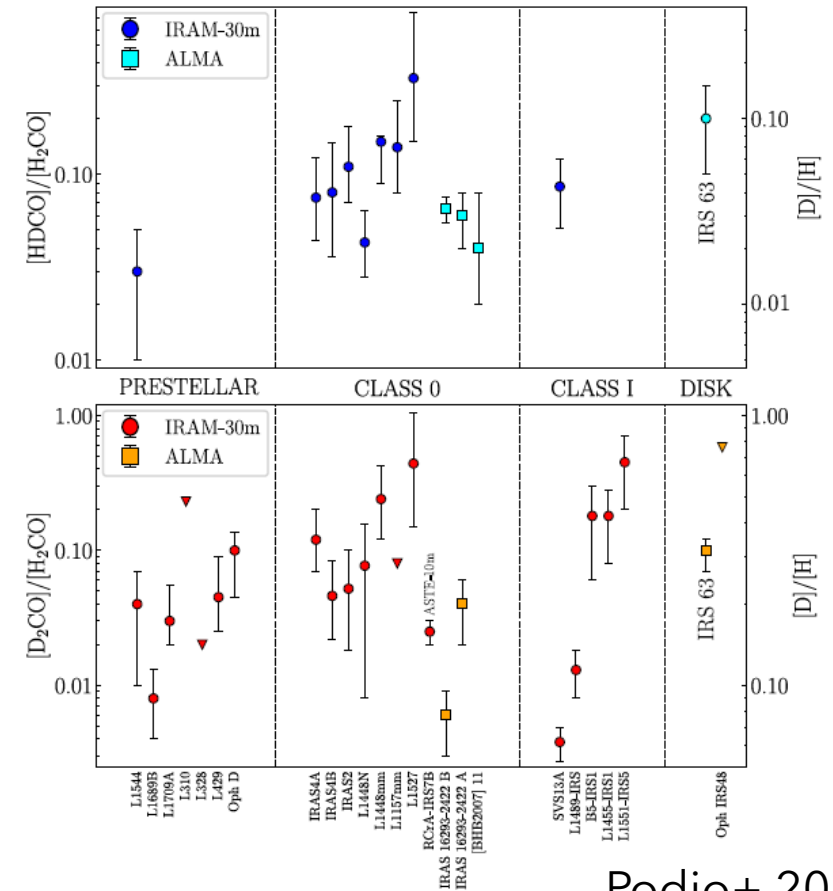
# Inheritance or reprocessing?

Abundance ratios



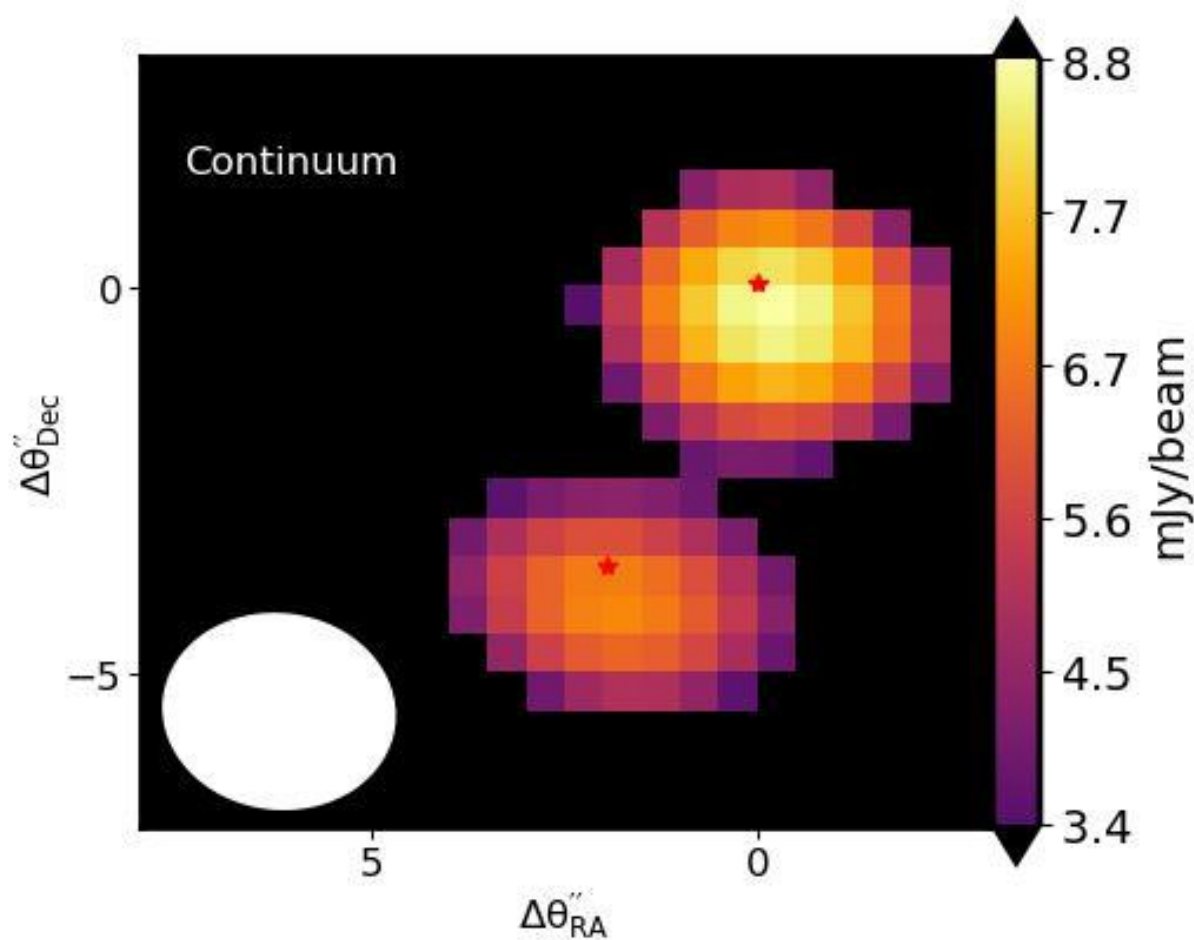
Drozdovskaya+ 2019

Isotopic ratios



Podio+ 2024

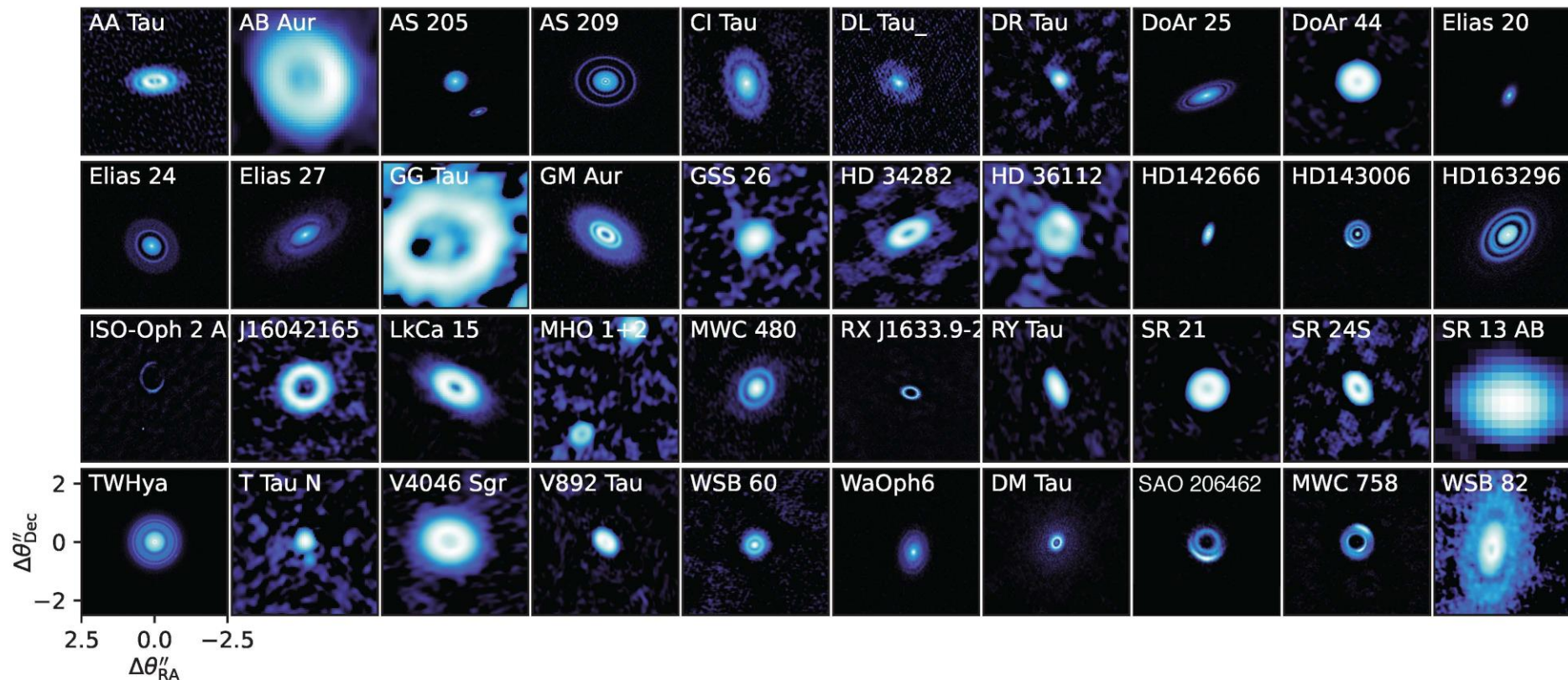
# MHO 1+2



- located in Taurus at  $d = 140$  pc
- separation:  $\sim 570$  au
- both: M2.5 spectral type at  $0.45 M_{\star}$  (Andrews+ 2013)
- $0.35 M_{\star}$  southern source,  $0.48 M_{\star}$  northern source (Akeson+ 2014)
- Same formation environment

# Introducing SMA-SPEC

= the SMA Survey of Protoplanetary disks to Explore their Chemistry (PI: Karin Öberg)





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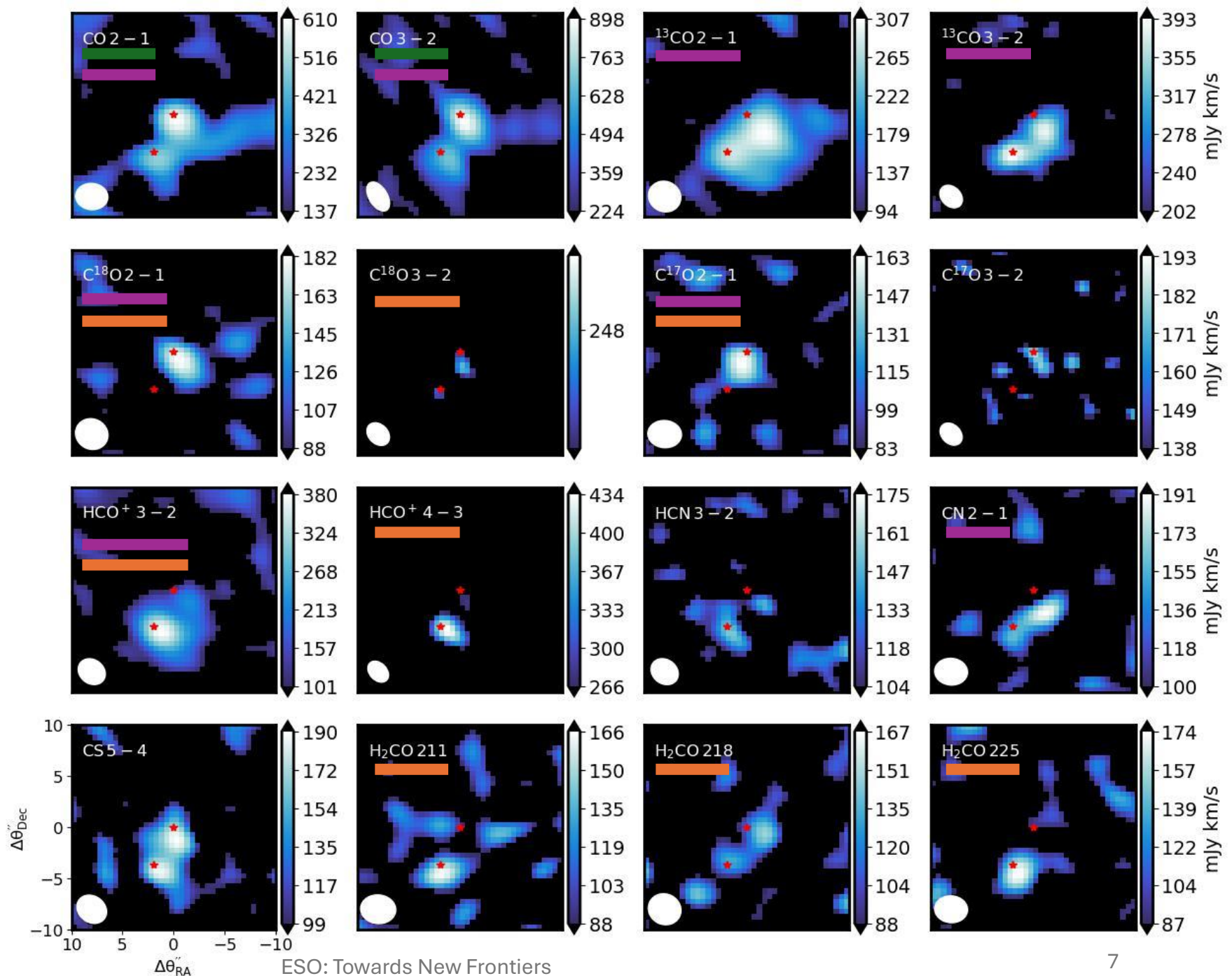
**For more info check out  
the poster of Clara Ross**

# SMA data

Accretion from the  
envelope: CO,  $^{13}\text{CO}$ ,  
 $\text{C}^{18}\text{O}$ ,  $\text{HCO}^+$ ,  $\text{C}^{17}\text{O}$  (?),  
 $\text{CN}$  (?)

Extended emission in  
the envelope: CO

Chemical  
differentiation:  $\text{C}^{18}\text{O}$ ,  
 $\text{C}^{17}\text{O}$ ,  $\text{HCO}^+$ ,  $\text{H}_2\text{CO}$



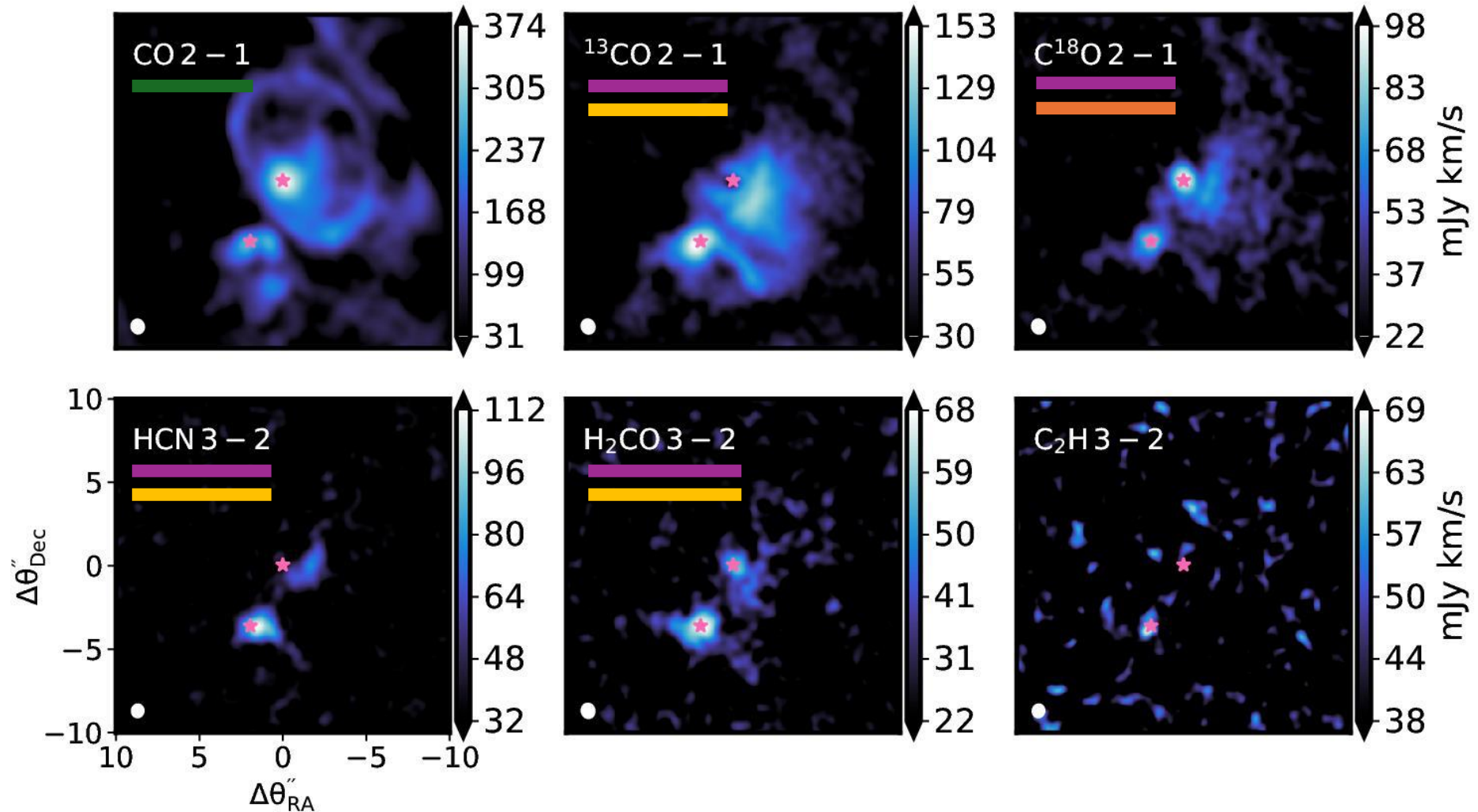
# ALMA data

Streamer: CO

Accretion from the  
envelope:  $^{13}\text{CO}$ ,  
 $\text{C}^{18}\text{O}$ , HCN,  $\text{H}_2\text{CO}$

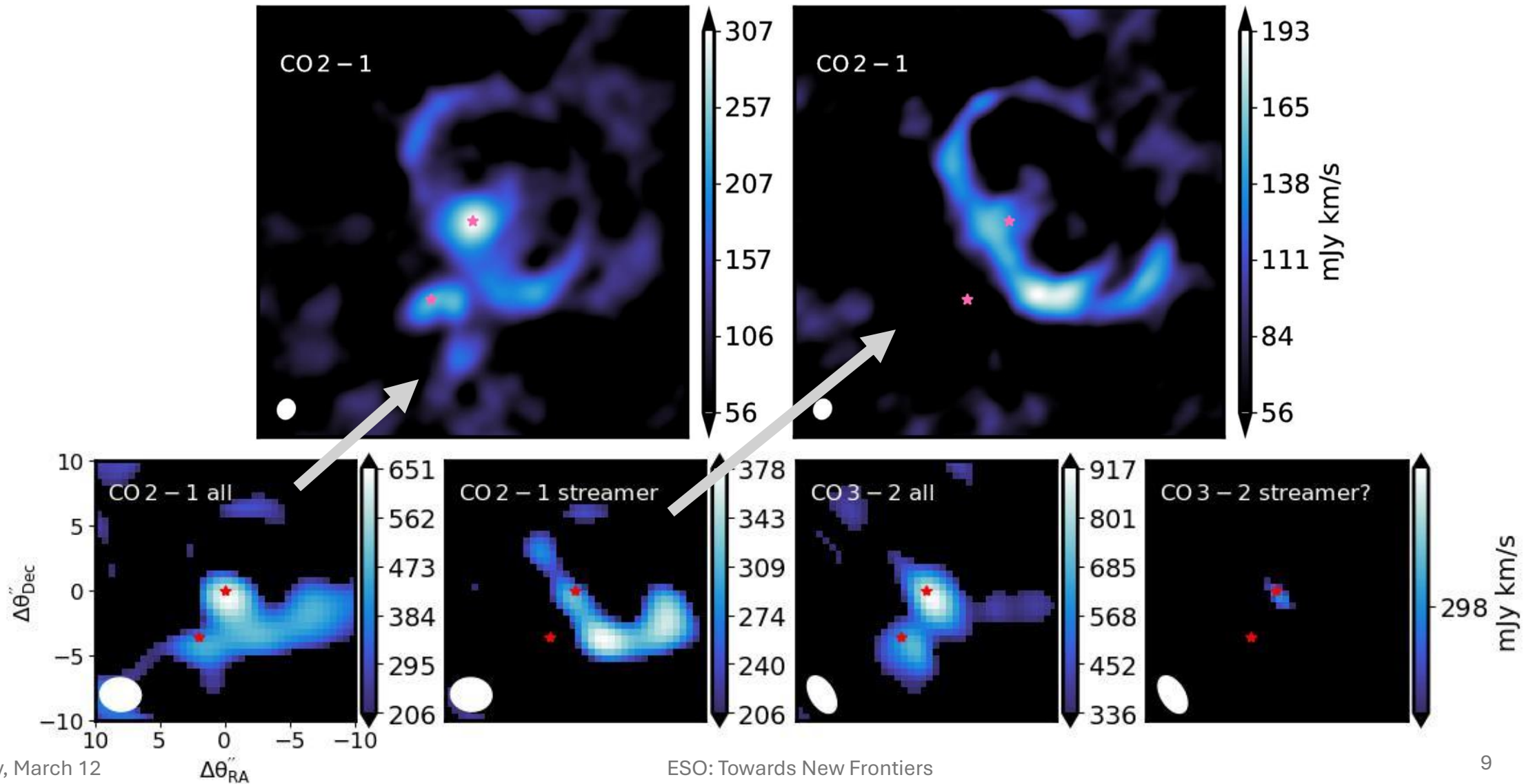
Bright towards  
northern source:  
 $\text{C}^{18}\text{O}$

Bright towards  
southern source:  
 $^{13}\text{CO}$ , HCN,  $\text{H}_2\text{CO}$

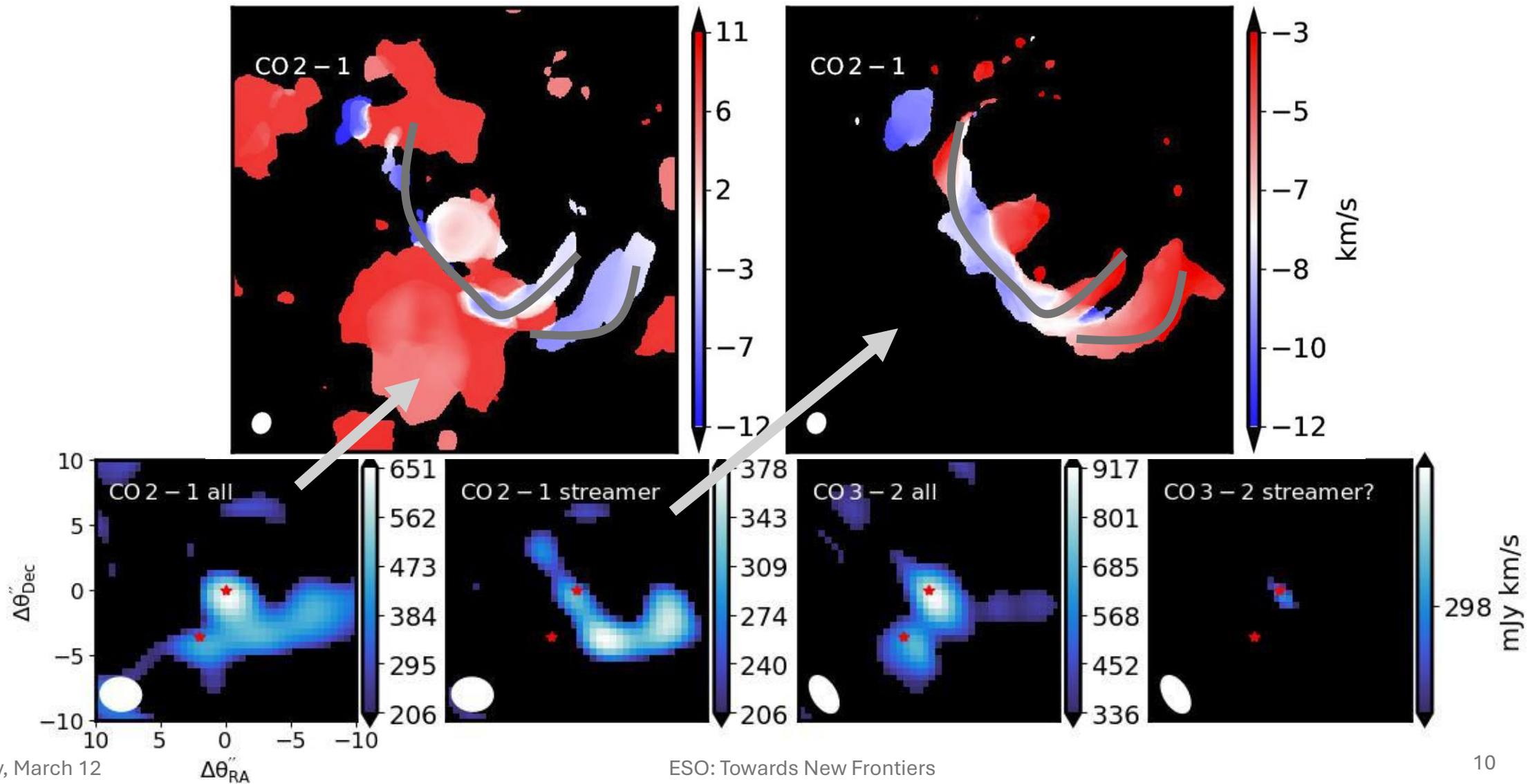




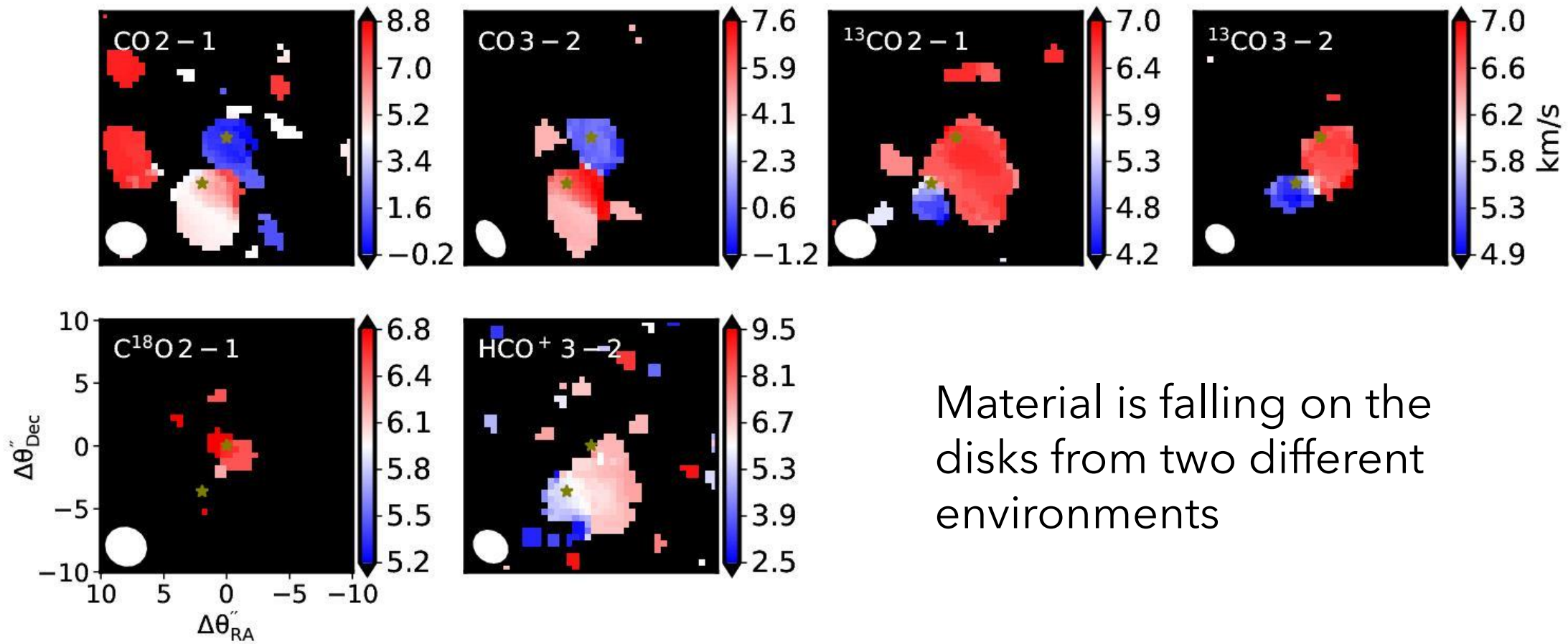
# Streamer detected in CO



# Streamer detected in CO



# Two different accretion environments

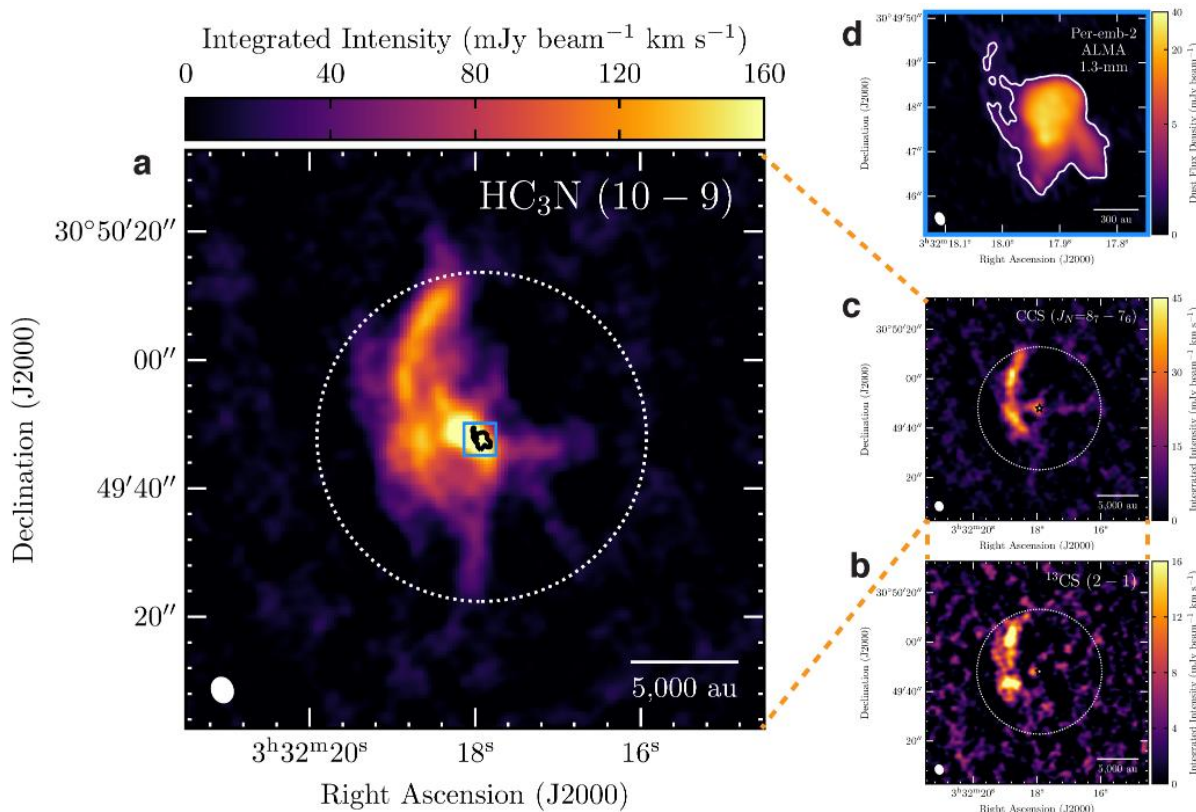


Material is falling on the disks from two different environments



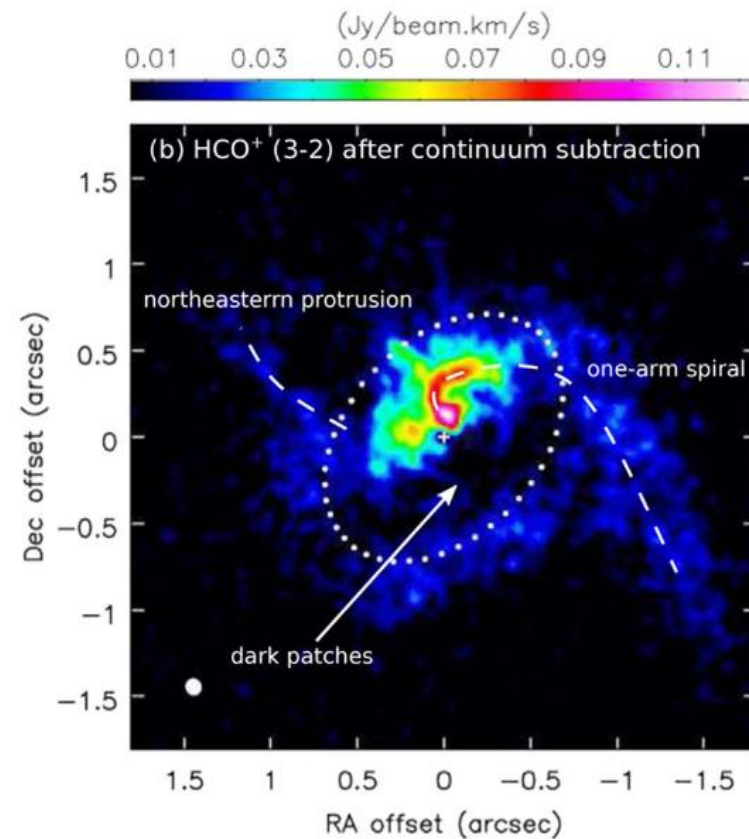
# Streamers

## Per-emb 2: Class 0



Piñeda+ 2020

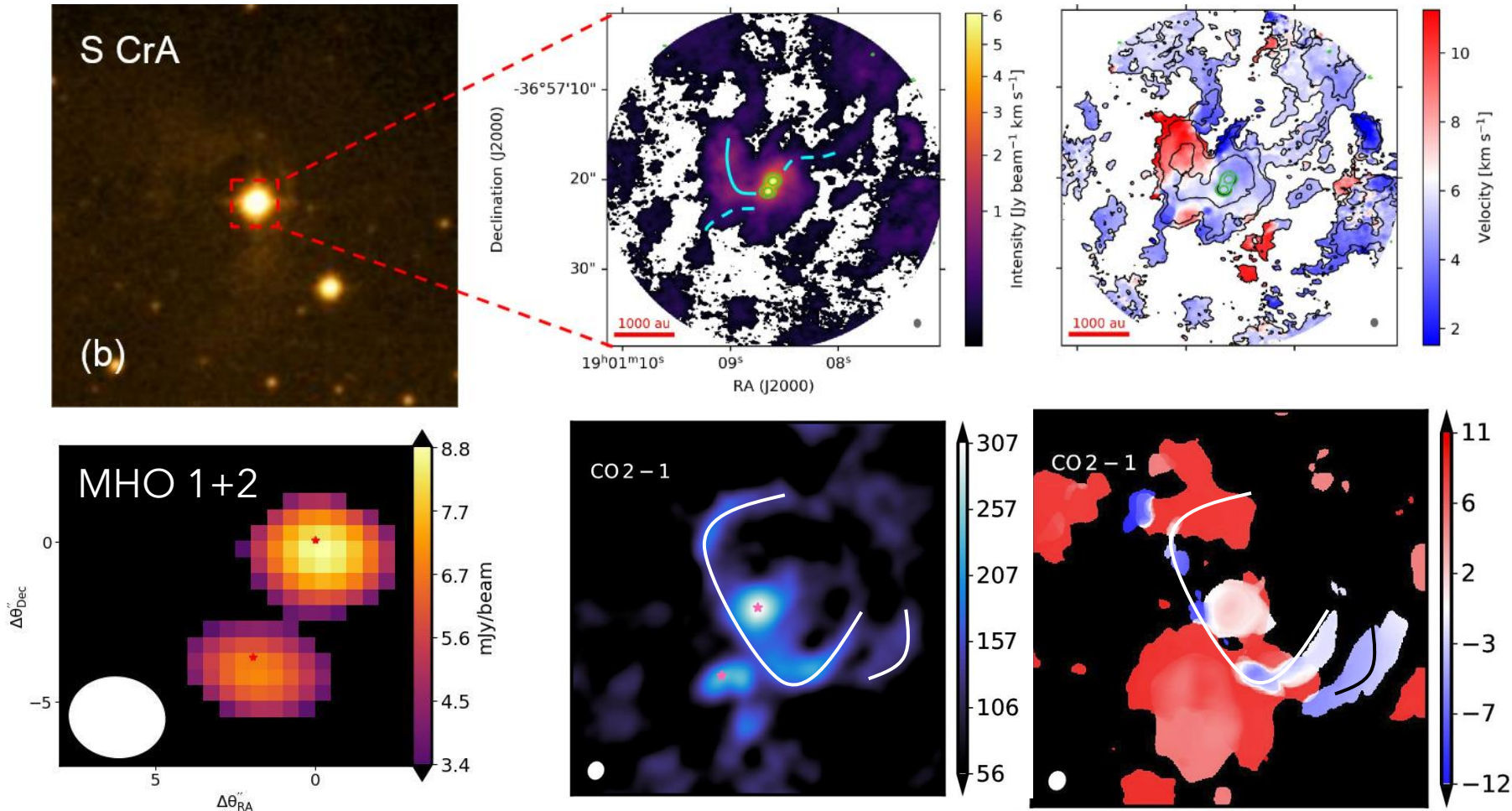
## HL Tau: Class II



Yen+ 2019

also see talks by L. Podio, M. T. Valdivia Mena and A. Martinez-Henares

# Streamers in binary systems



Gupta+2023  
Gupta+2024

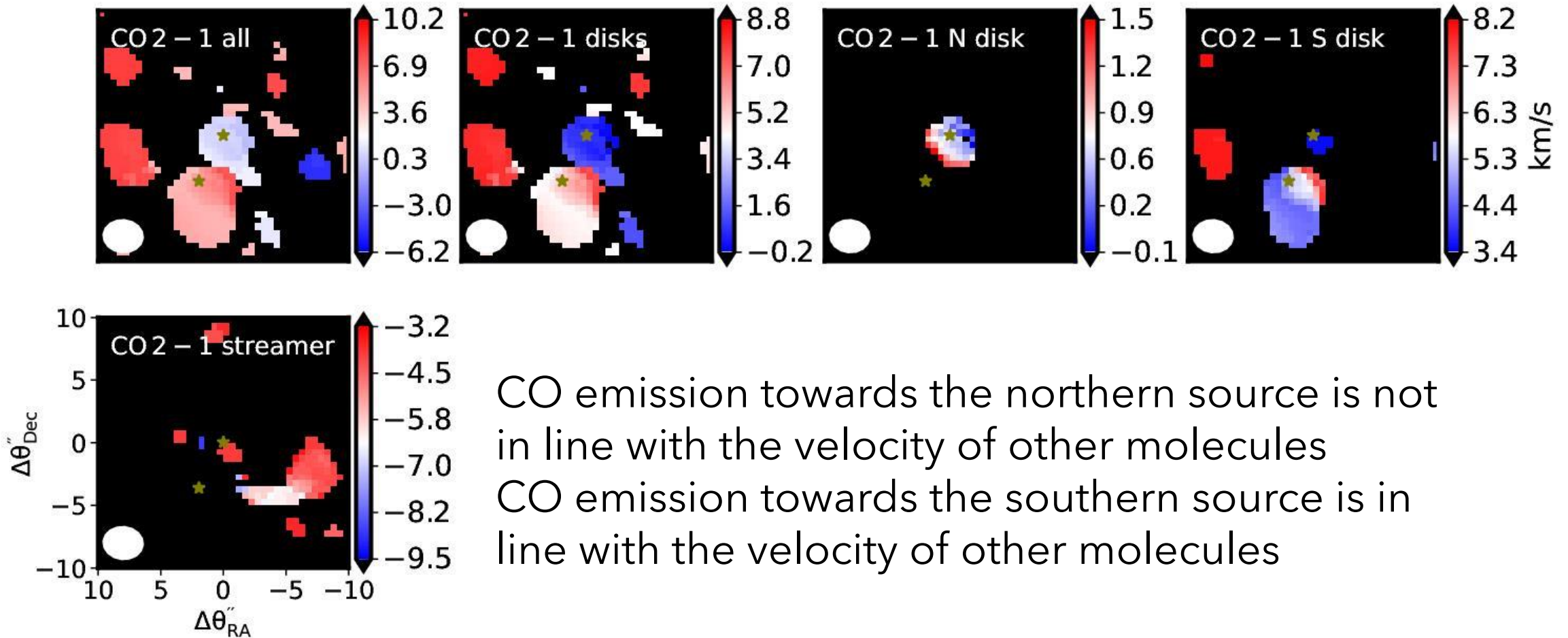
# Conclusions

- 1)** First unbiased survey of the chemistry in the outer disk is on its way at the SMA. First papers will be out this year!
- 2)** Same birth cloud  $\neq$  same chemistry. Interactions with the envelope of the binaries could selectively feed material onto one of the disks, and lead to different chemical compositions of disks in binary systems.
- 3)** MHO 1+2 accretes material from two different reservoirs from its natal cloud, CO reveals a streamer-like structure.
- 4)** Help me figure out what is happening here please 😊





# Two different accretion environments



CO emission towards the northern source is not in line with the velocity of other molecules  
CO emission towards the southern source is in line with the velocity of other molecules