The ANTIHEROES-PRODIGE large program: Unveiling the chemical and kinematic connection from the large-scale environment down to protostellar systems

AG Splinter Meeting StarFormation
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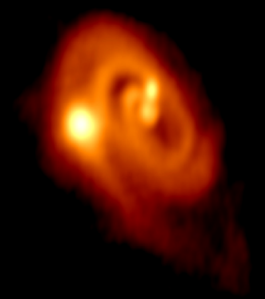
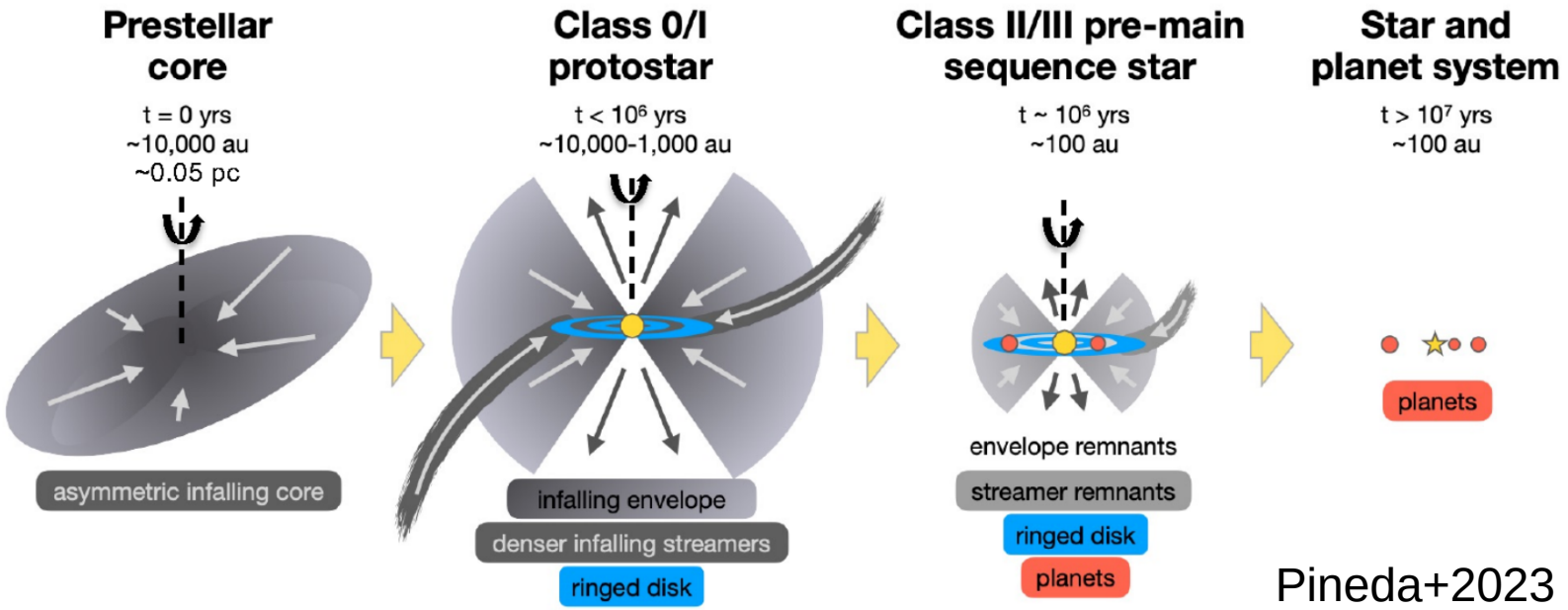
& the ANTIHEROES-PRODIGE team



The role of infall during the embedded stage

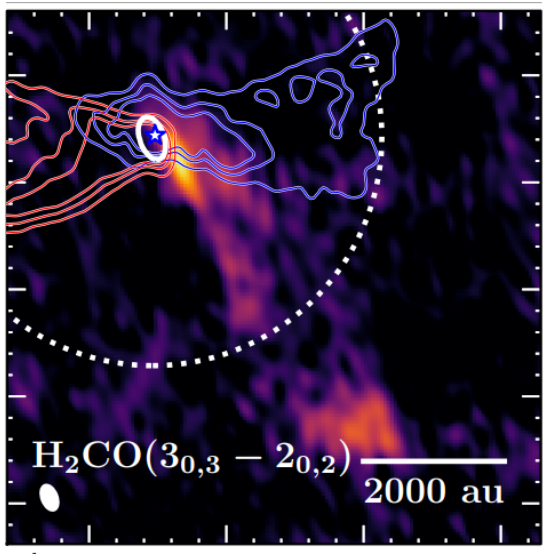


Pineda+2023

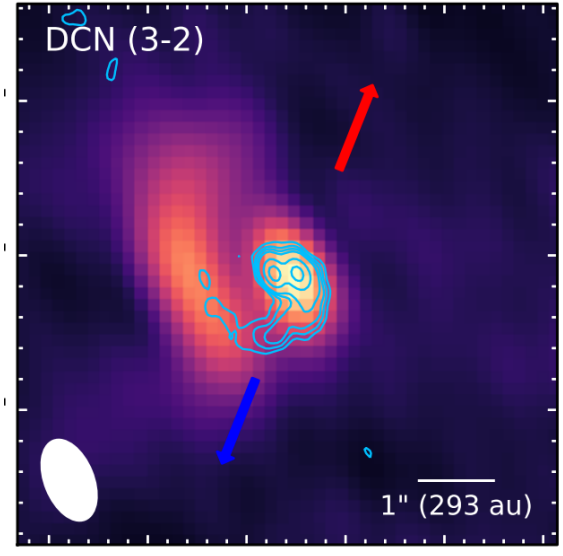
PRODIGE

PROtostars & DIsks: Global Evolution
NOEMA large program
PIs: Paola Caselli & Thomas Henning

30 Class 0/I protostellar systems in Perseus molecular cloud (d = 300 pc)
NOEMA 1.3 mm continuum and **high resolution spectral line data** at 300 au resolution



Per-emb-50: Valdivia-Mena+2022



SVS13A: Hsieh+2023

- **What is the origin of infalling streamers?**

- **How much mass do streamers deliver to the disk?**

- **How does the chemical composition change from cloud to disk scales?**

ANTIHEROES

Quantifying the connection from envelope to disk with MIOP-PRODIGE
PI: Caroline Gieser

Sarah Böttinger, Laure Bouscasse, Laura Ann Busch, Paola Caselli, Yu-Ru Chou, Anne Dutrey, Asuncion Fuente, Stephane Guilloteau, Thomas Henning, Tien-Hao Hsieh, Yuxin Lin, Ana Lopez-Sepulcre, Lauren Mason, Maria Jose Maureira, Suchitra Narayanan, Jaime Pineda, Dominique Segura-Cox, Mario Tafalla, Maria Teresa Valdivia Mena, Sierk van Terwisga

- What is the origin of infalling streamers?

- How much mass do streamers deliver to the disk?

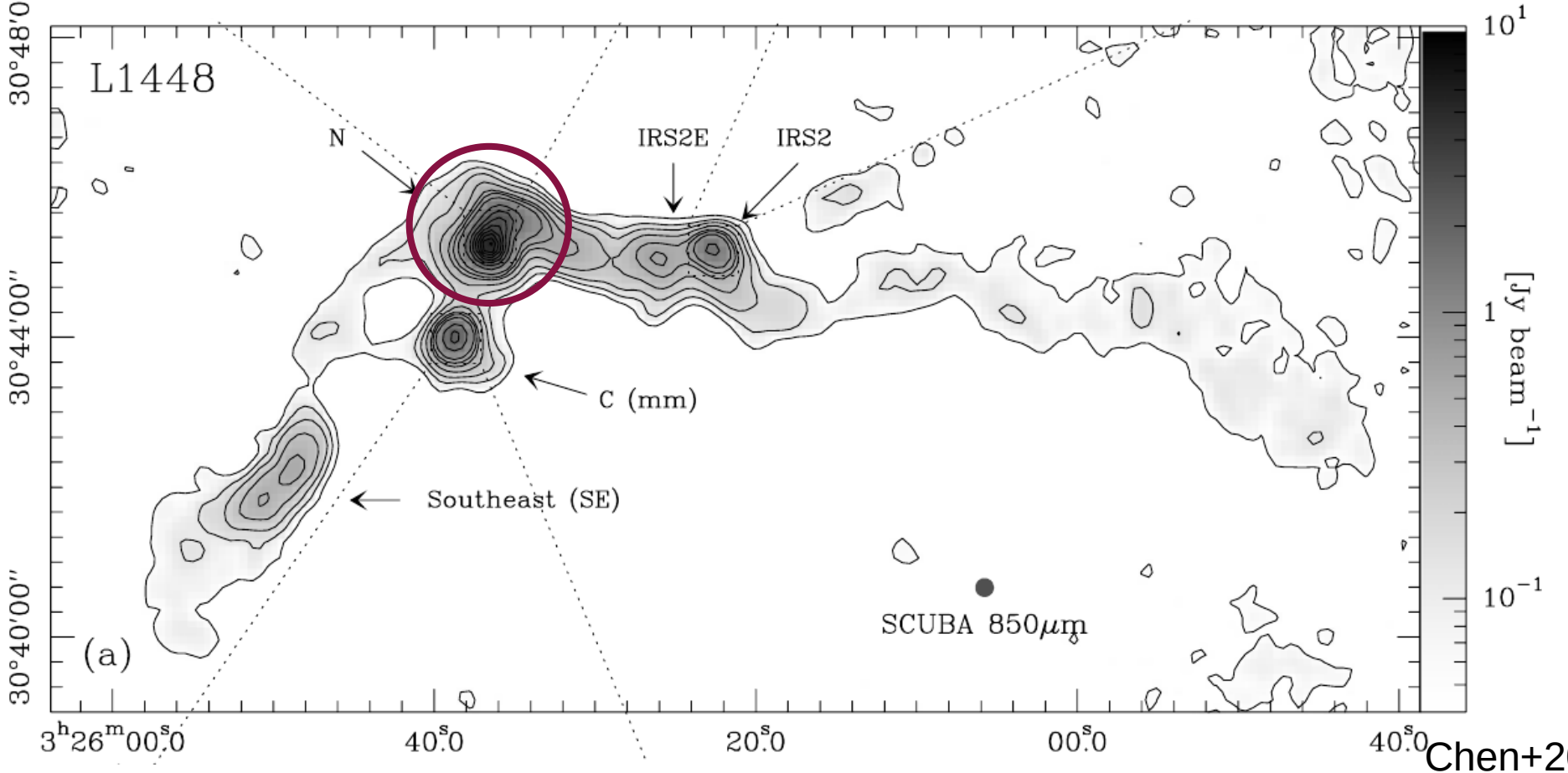
- How does the chemical composition change from cloud to disk scales?

- ongoing IRAM 30m large program (> 200h)
- 1mm follow-up of the entire PRODIGE sample
- observations completed at 94 %
- bridging spatial scales from 10 000s au down to 300 au

=> more on ANTIHEROES-PRODIGE: talks by Yu-Ru Chou & Lauren Mason

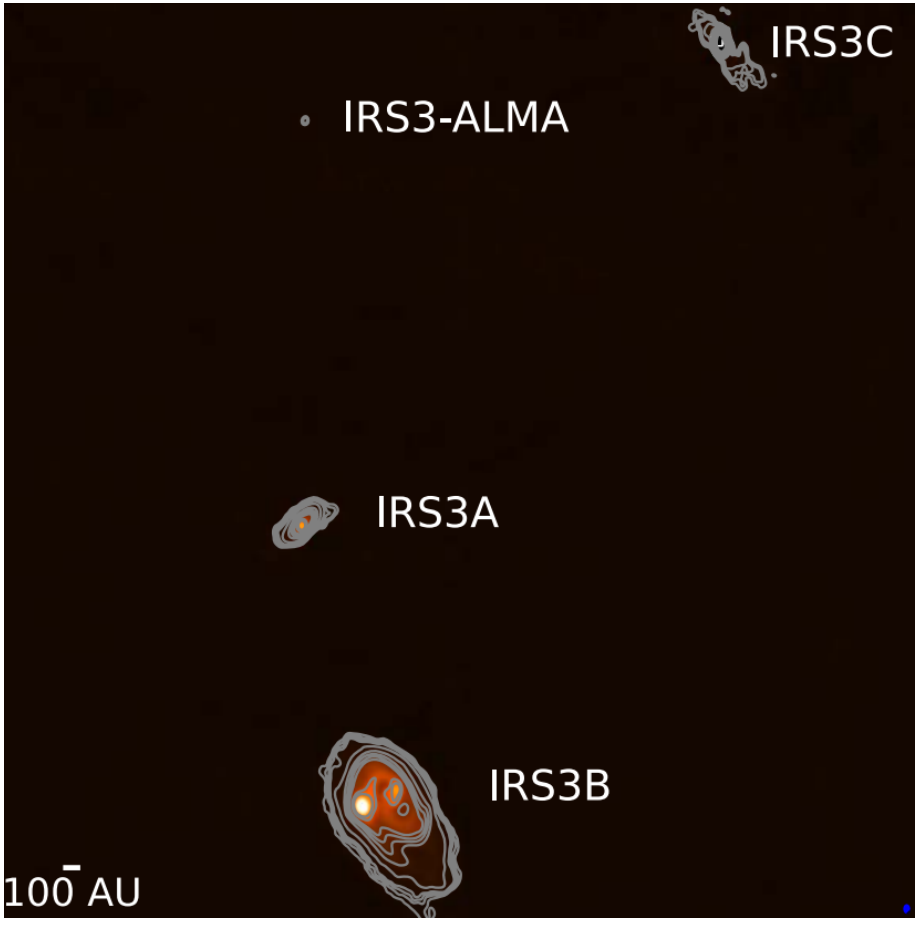
L1448N: cloud scales

L1448 star-forming region in the Perseus molecular cloud (d = 300 pc)



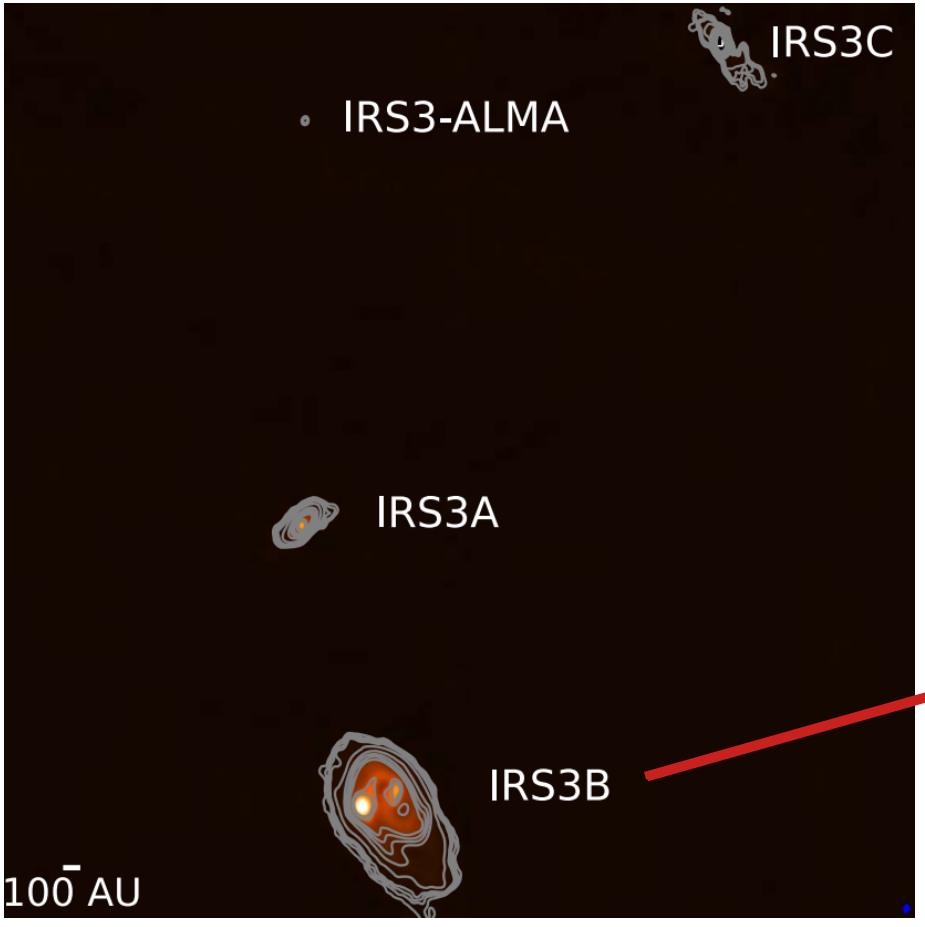
Chen+2013

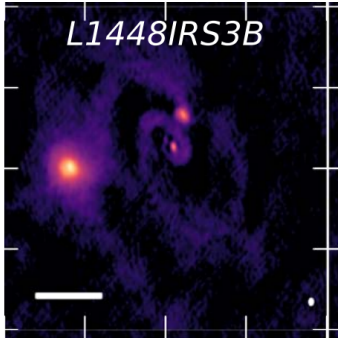
L1448N: disk scales



Looney+2025

L1448N: disk scales

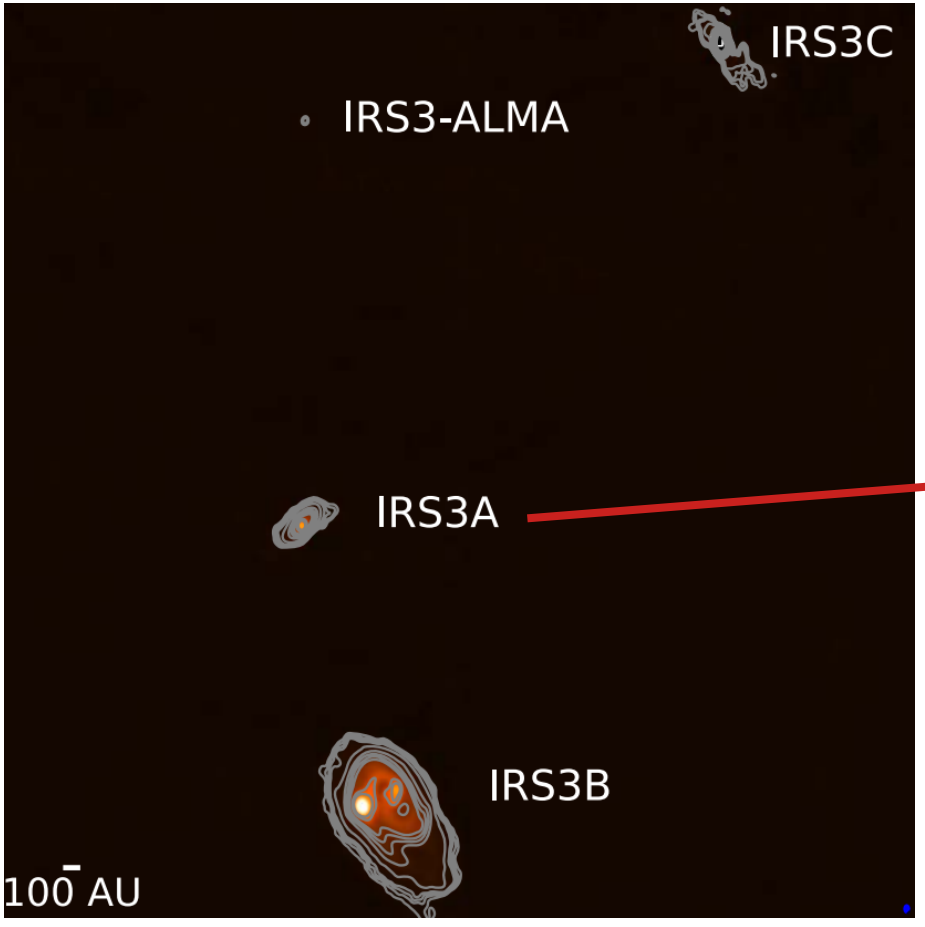


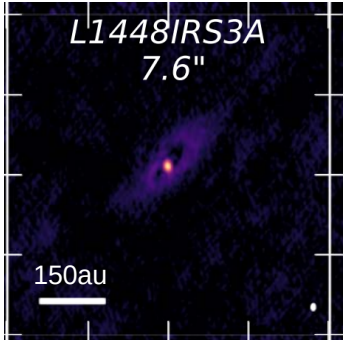


Looney+2025

Tobin+2016,2018
Reynolds+2021,2024

L1448N: disk scales

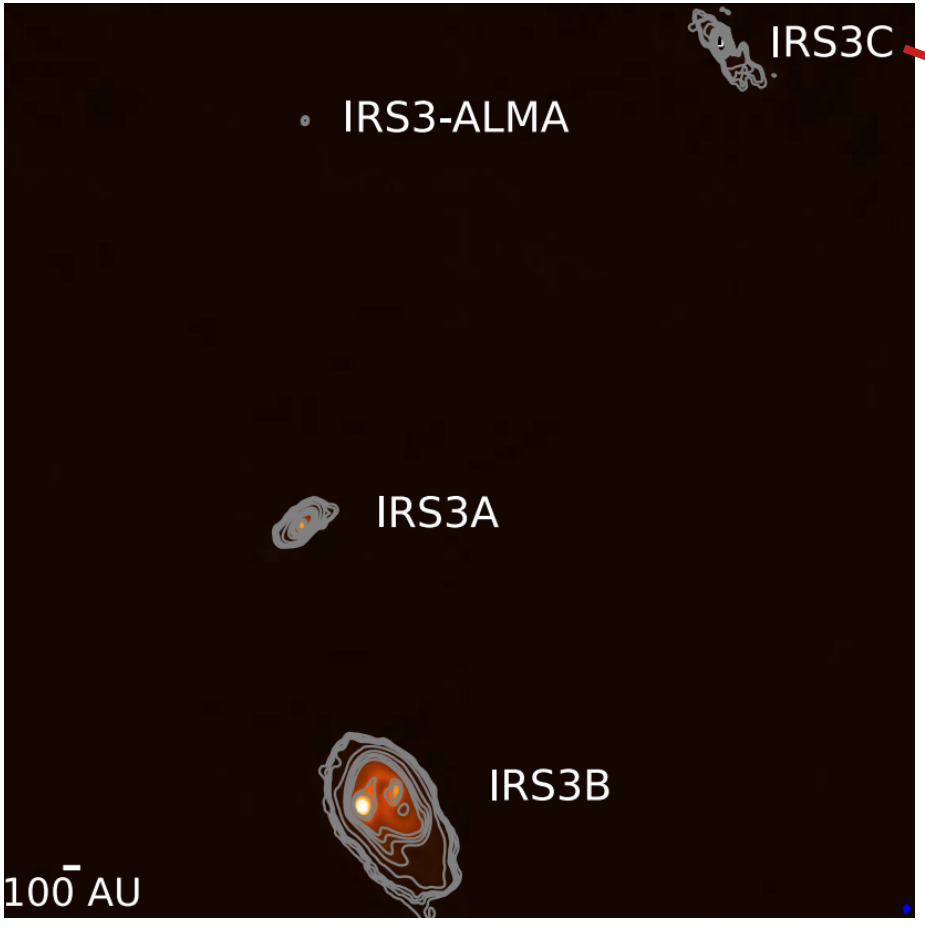


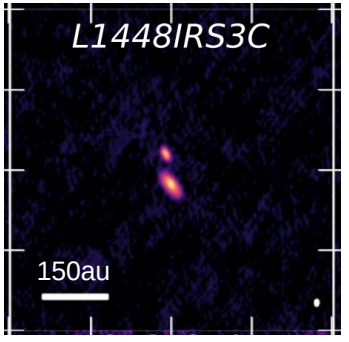


Looney+2025

Tobin+2016,2018
Reynolds+2021,2024

L1448N: disk scales

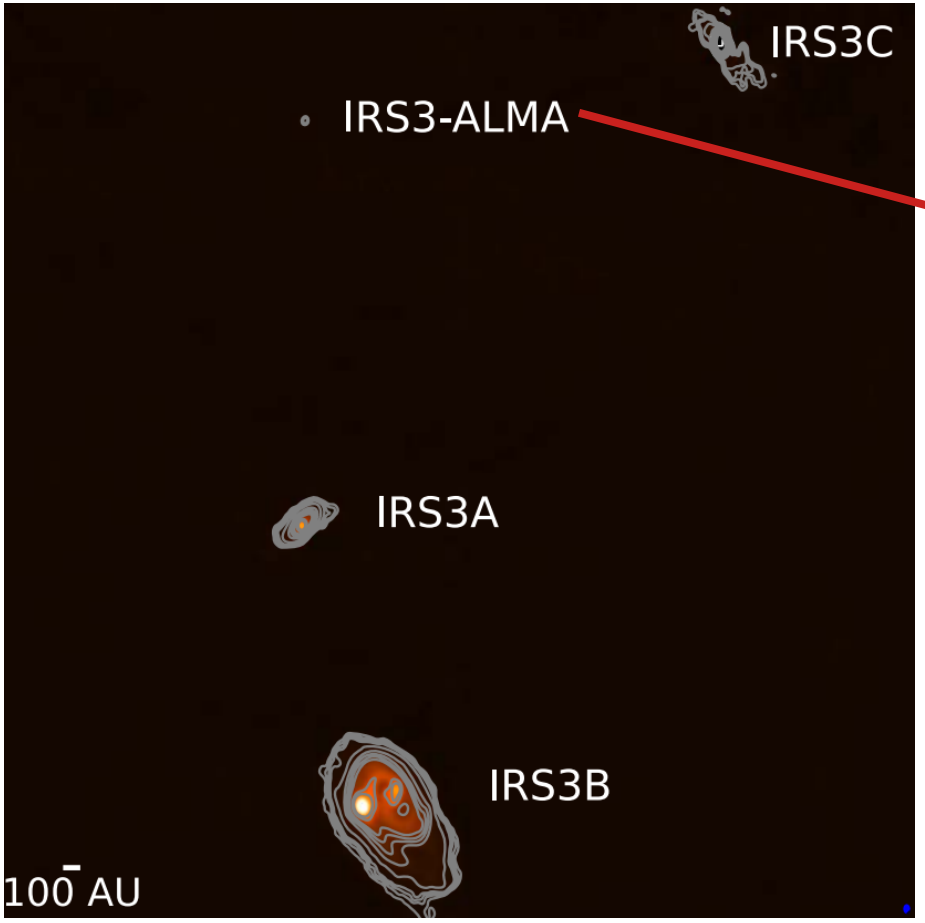




Looney+2025

Tobin+2016,2018
Reynolds+2021,2024

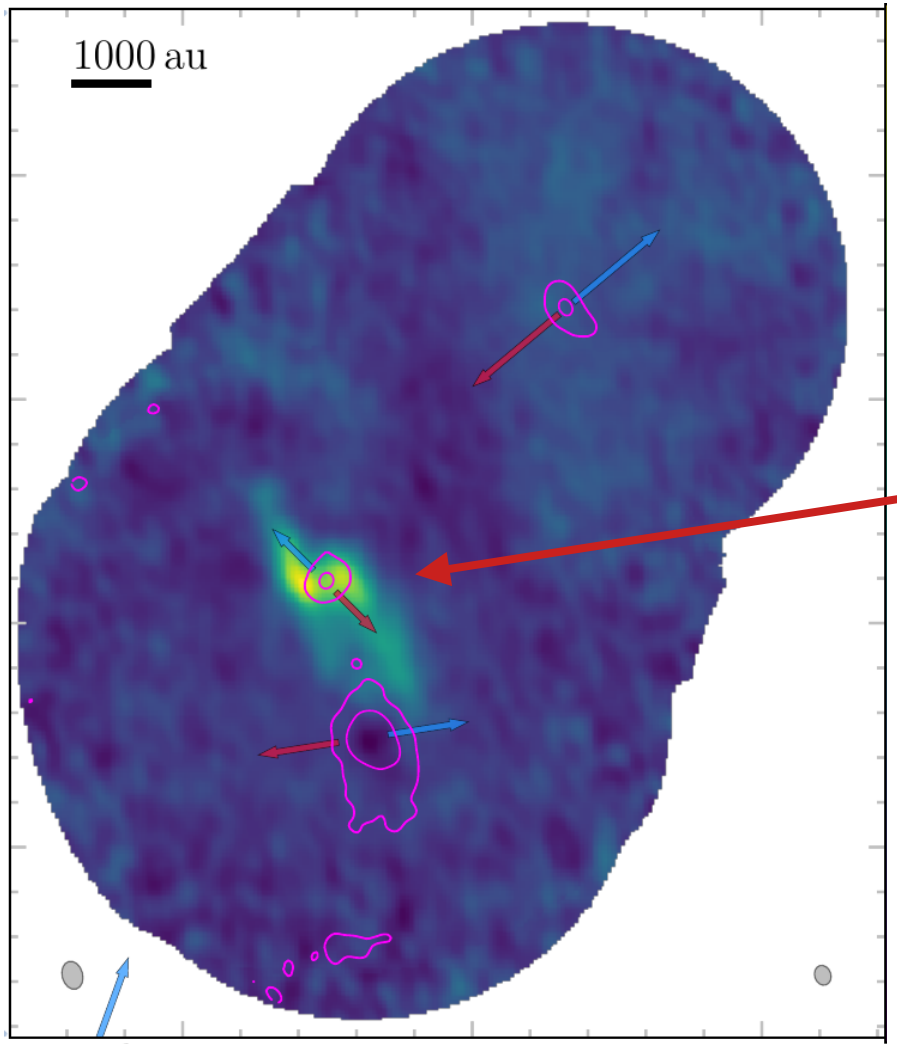
L1448N: disk scales



background galaxy?
(Looney+2025)

Looney+2025

ANTIHEROES-PRODIGE
DCN (3-2)

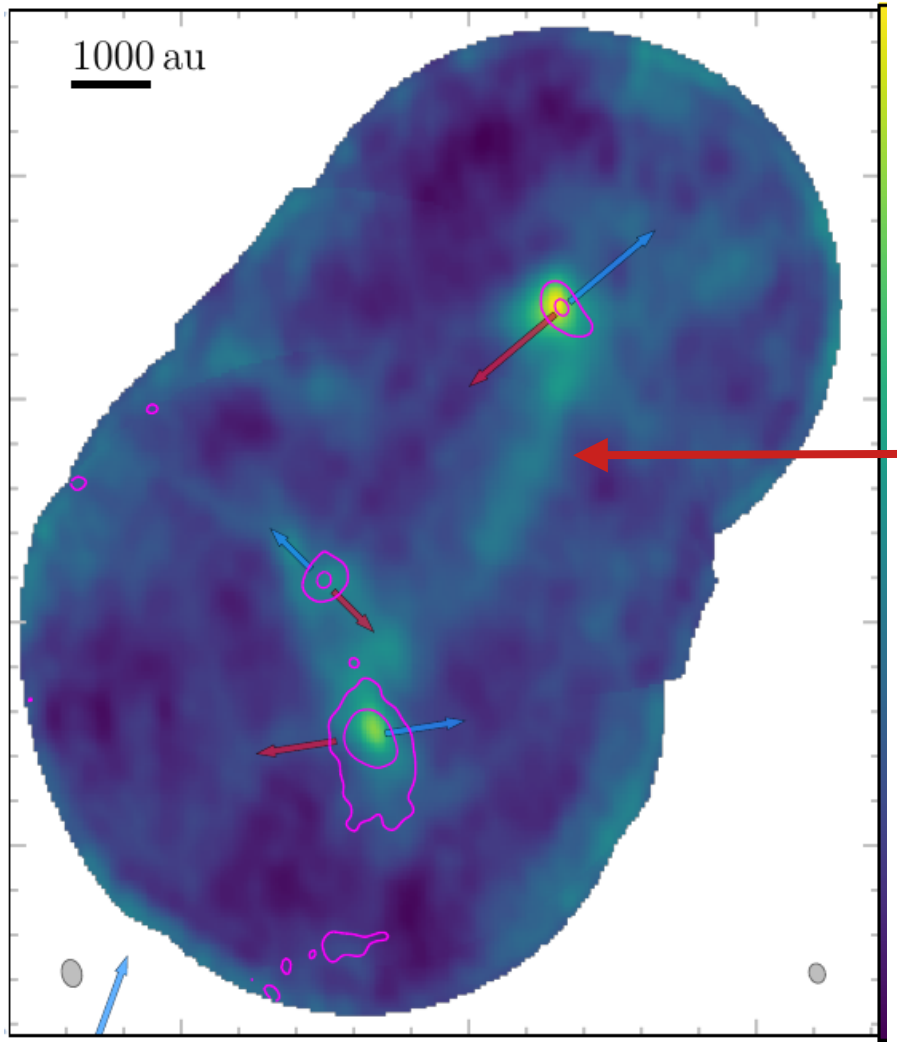


L1448N: bridging the scales

gas bridge surrounding IRS3A and IRS3B
infalling towards IRS3A from both sides

Gieser+2024

ANTIHEROES-PRODIGE
$C^{18}O$ (2-1)

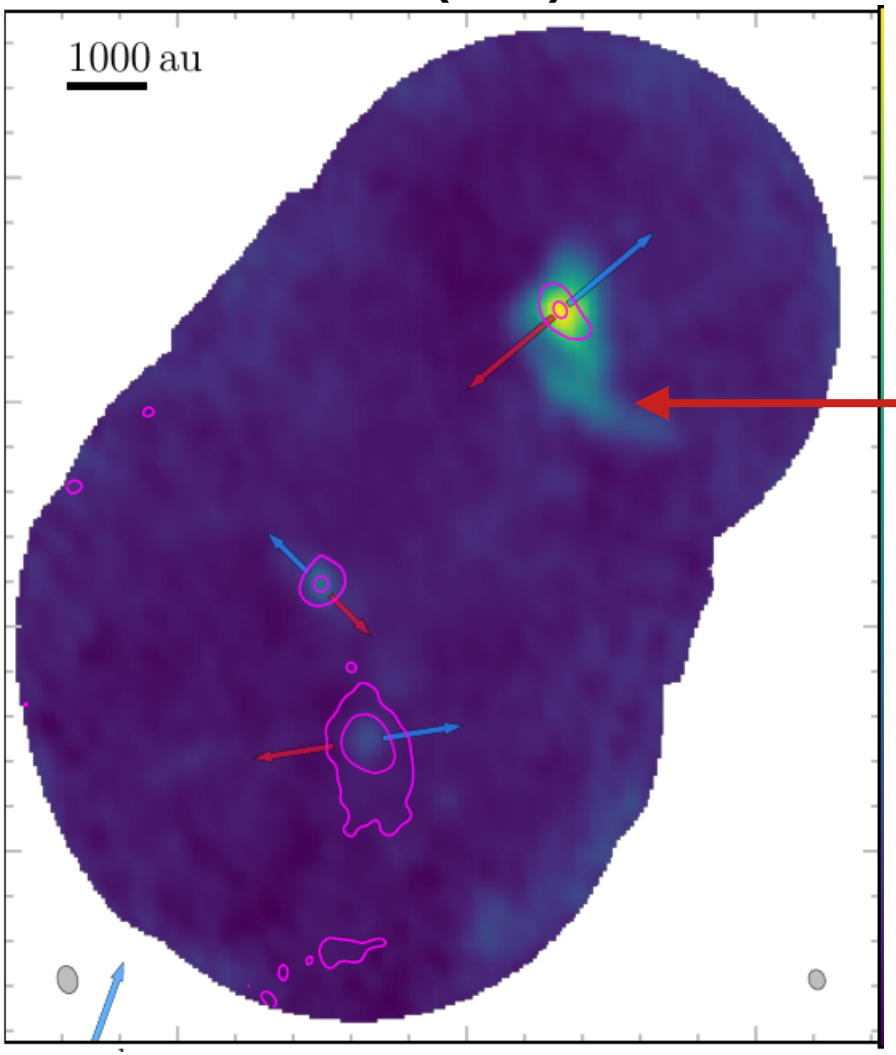


L1448N: bridging the scales

infalling streamer towards IRS3C

Gieser+2025

ANTIHEROES-PRODIGE
SO (6_5-5_4)



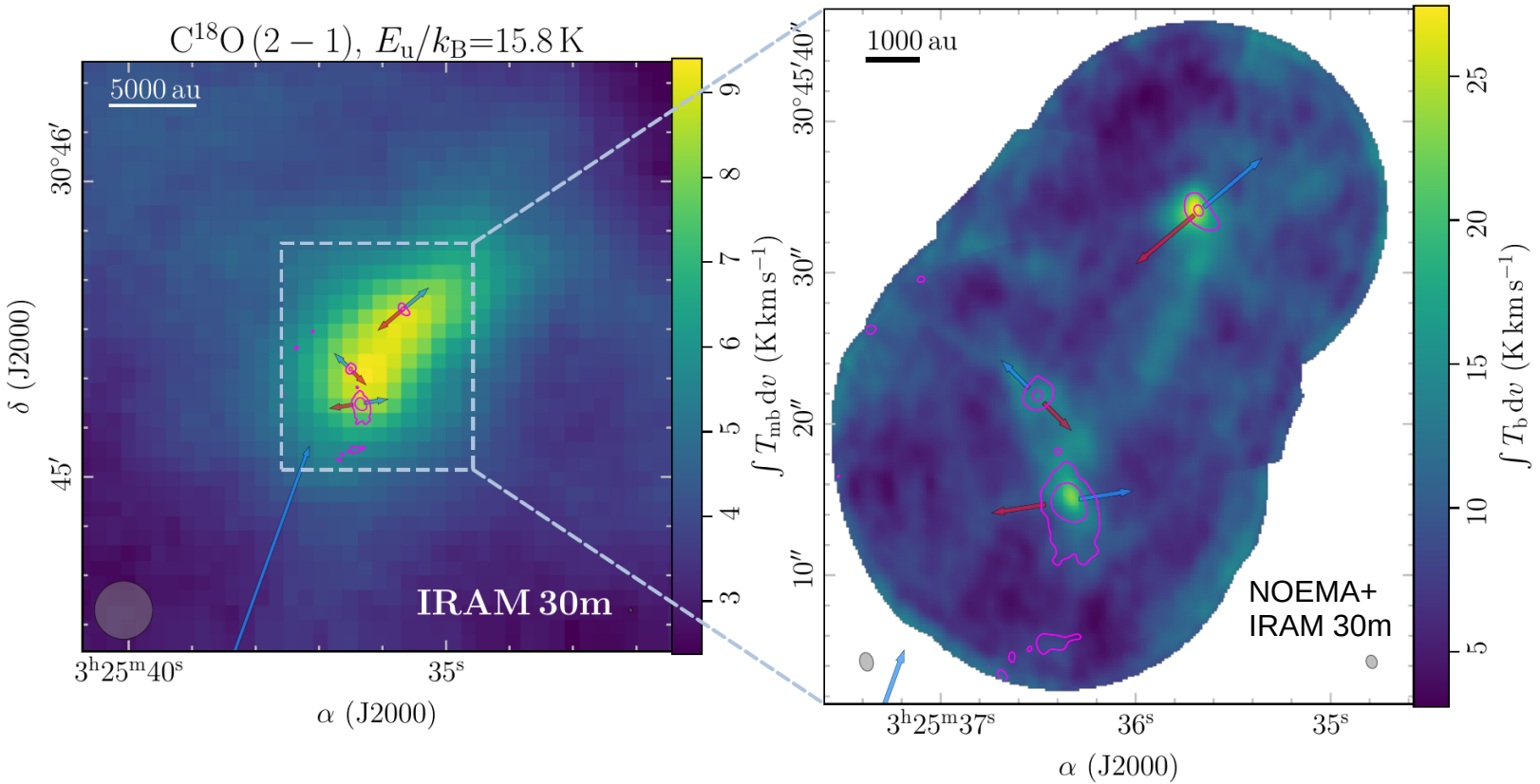
L1448N: bridging the scales

a second infalling streamer
detected in SO and SO2 towards IRS3C

the in total four detected streamers
may deliver an additional 1-17%
of mass onto the disks
(compared to the mass of
the protostellar systems)

Gieser+2025

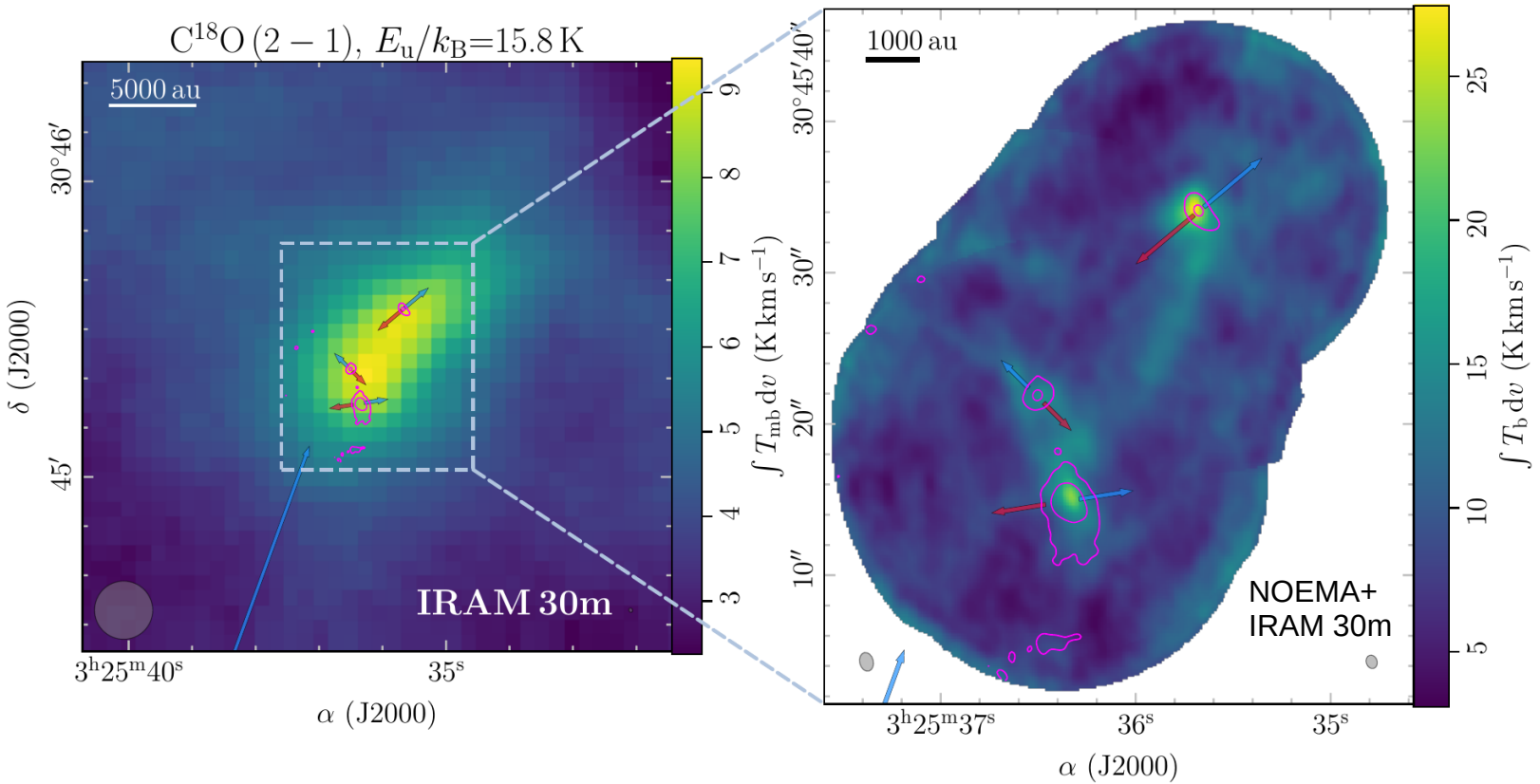
L1448N: bridging the scales



infalling streamers in L1448N are velocity coherent with the large-scale environment

Gieser+2025

L1448N: bridging the scales

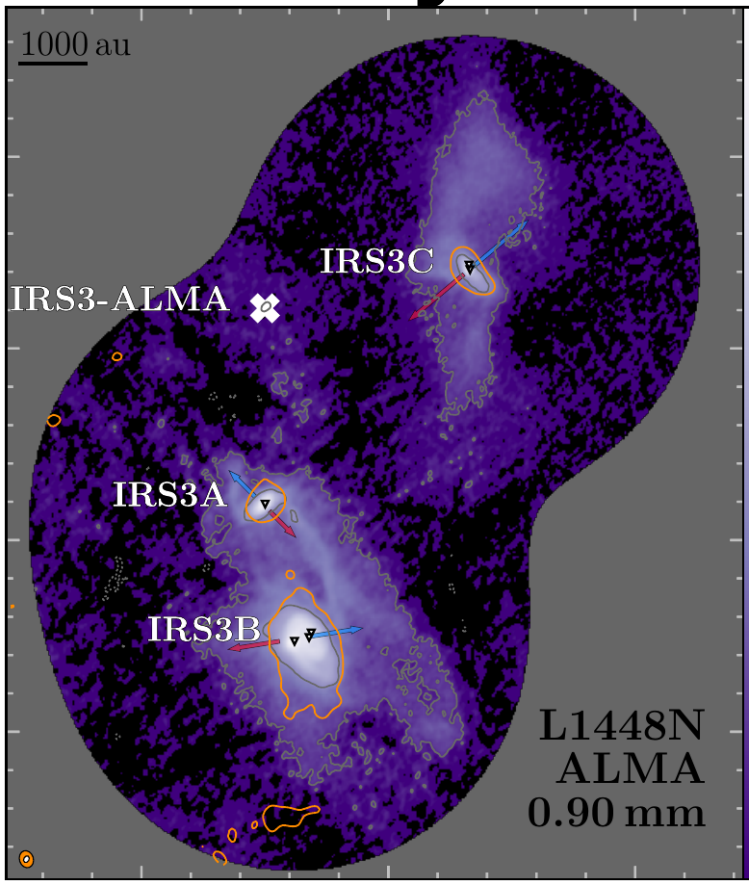


=> 93 % of the line $C^{18}O$ flux is filtered out in the NOEMA-only data

Gieser+2025

L1448N: dusty streamers

ALMA Perseus Polarization Survey (ALPPS): Cortes+2025



Gieser+ in preparation

(Some) open questions

- What is the origin of infalling streamers?

- Do high streamer infall rates imply high accretion rates?

- Can streamers affect the properties of the protoplanetary disk?

- Is infall in the early stage different compared to later stages?

- Is streamer infall similar from low- to high-mass protostars?