JWST: L1527
Figure credit: NASA, ESA, CSA, STScl

OBSERVATIONAL EVIDENCE OF EPISODIC ACCRETION BURSTS TOWARD YOUNG EMBEDDED DISKS

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FONDECYT Postdoctoral fellow - PUC

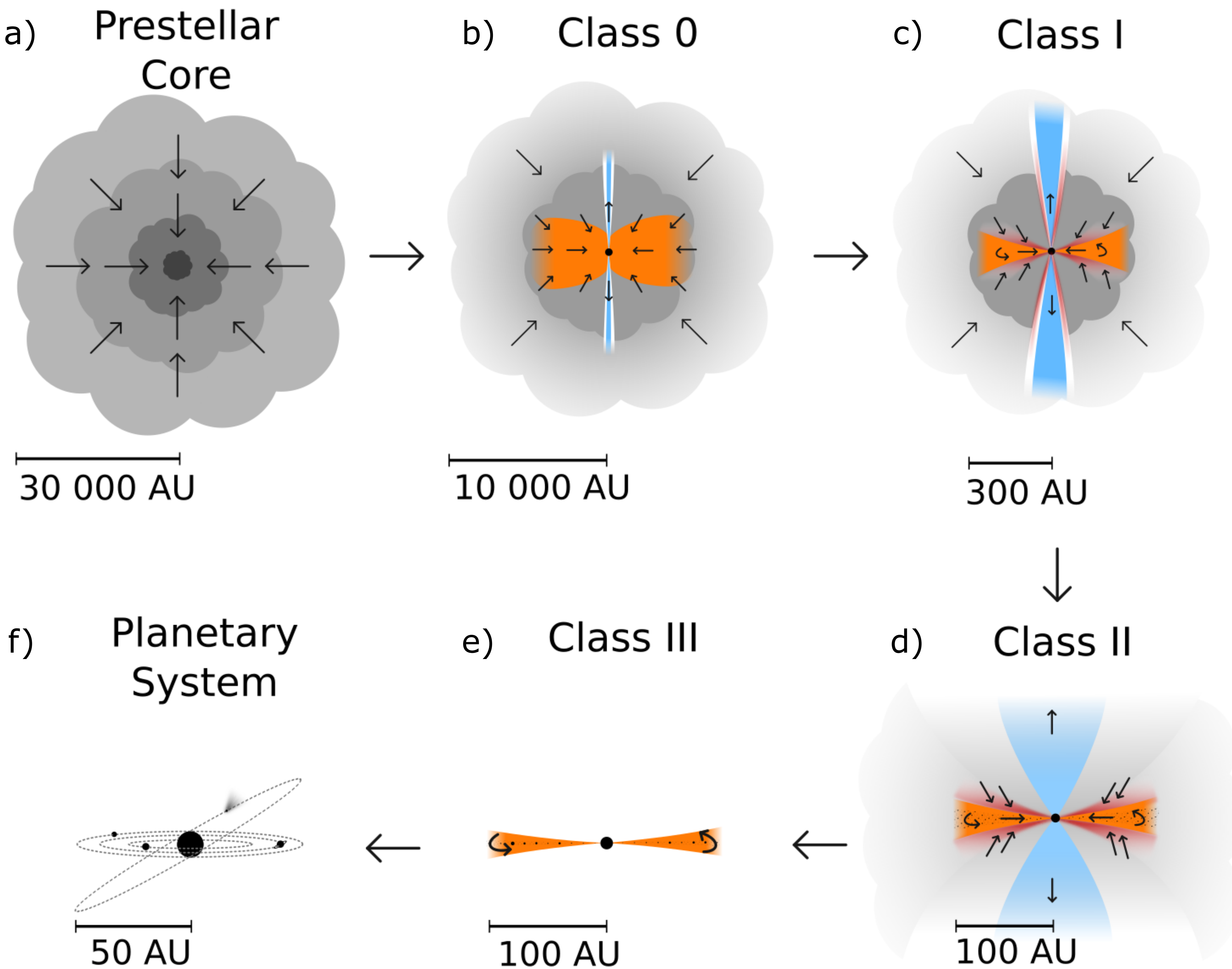
Accretion/ejection processes in star formation

November 30, 2022

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
INSTITUTO DE ASTROFÍSICA
FACULTAD DE FÍSICA

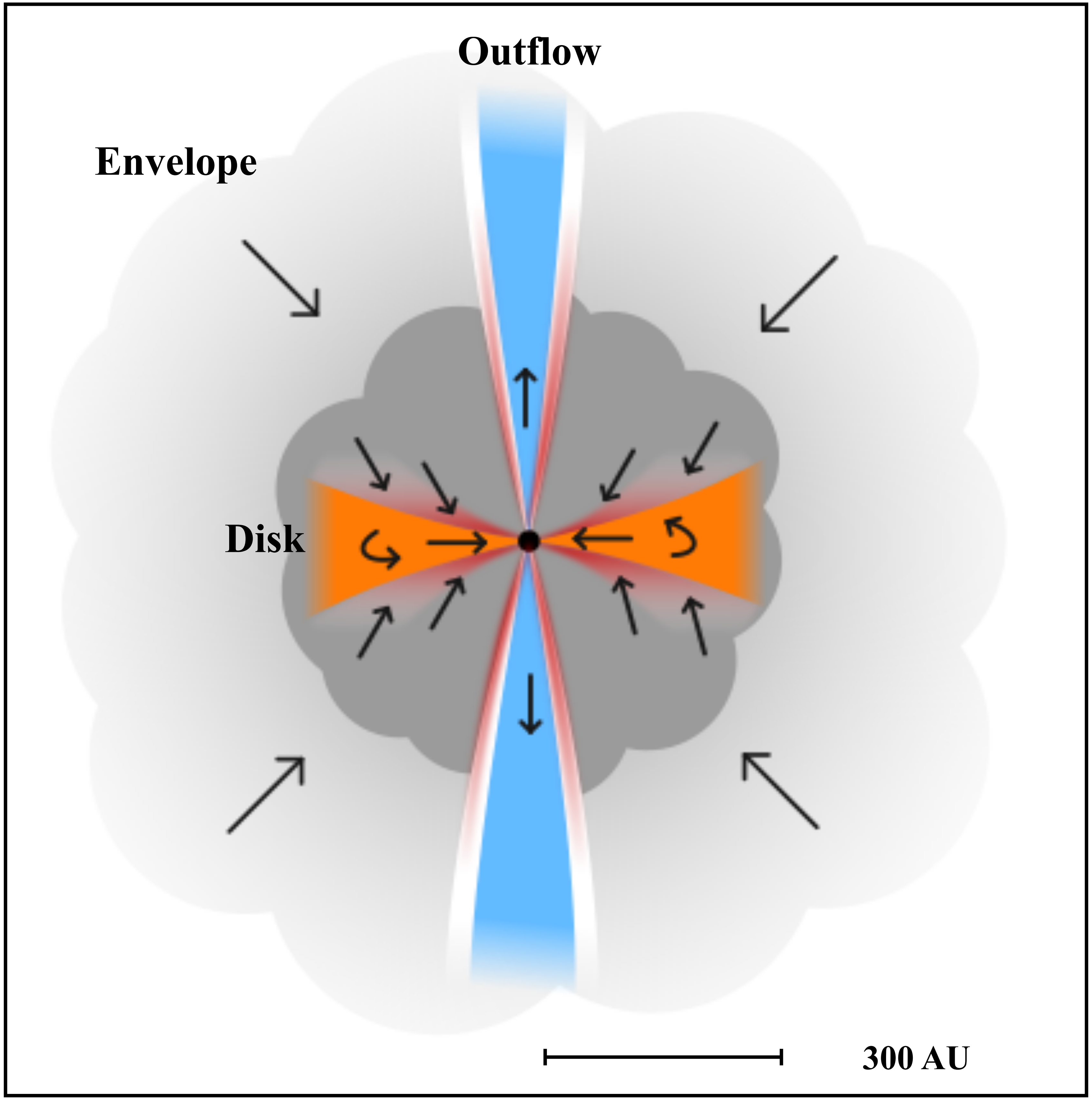
NPF
NÚCLEO MILENIO DE FORMACIÓN PLANETARIA

LOW-MASS STAR FORMATION



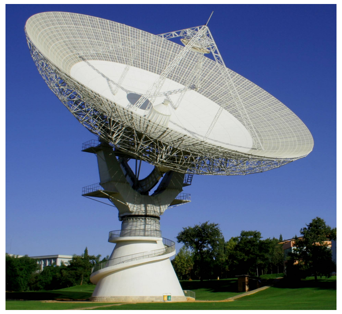
Magnus Persson

THE COMPLEX ENVIRONMENT OF CLASS I SOURCES



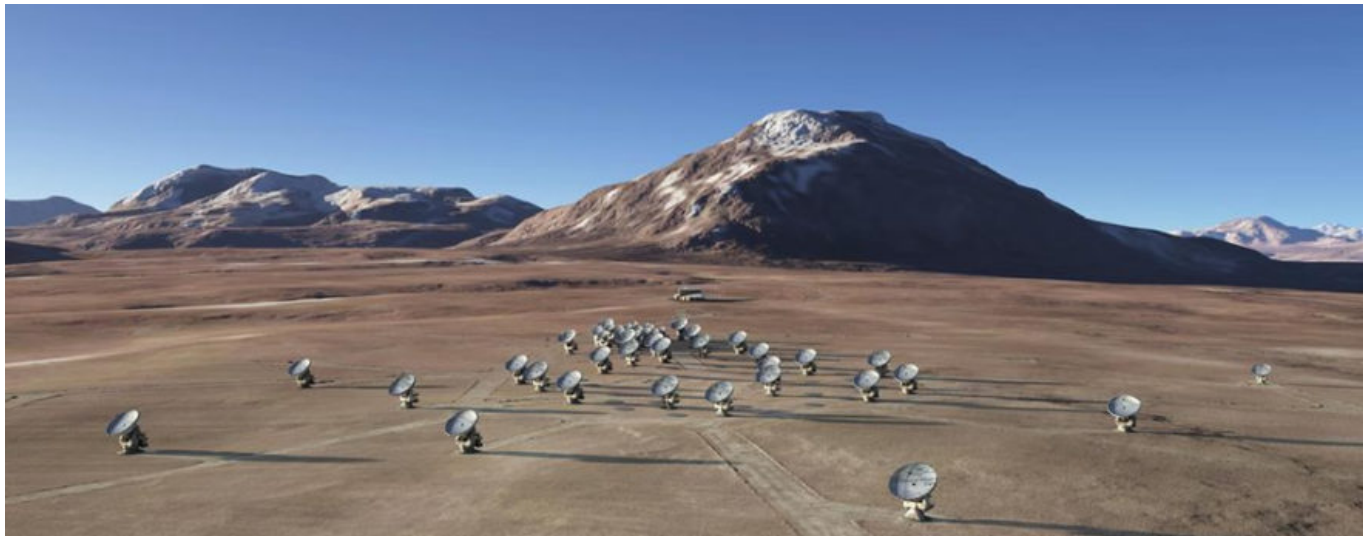
RADIO TELESCOPES

Single dish



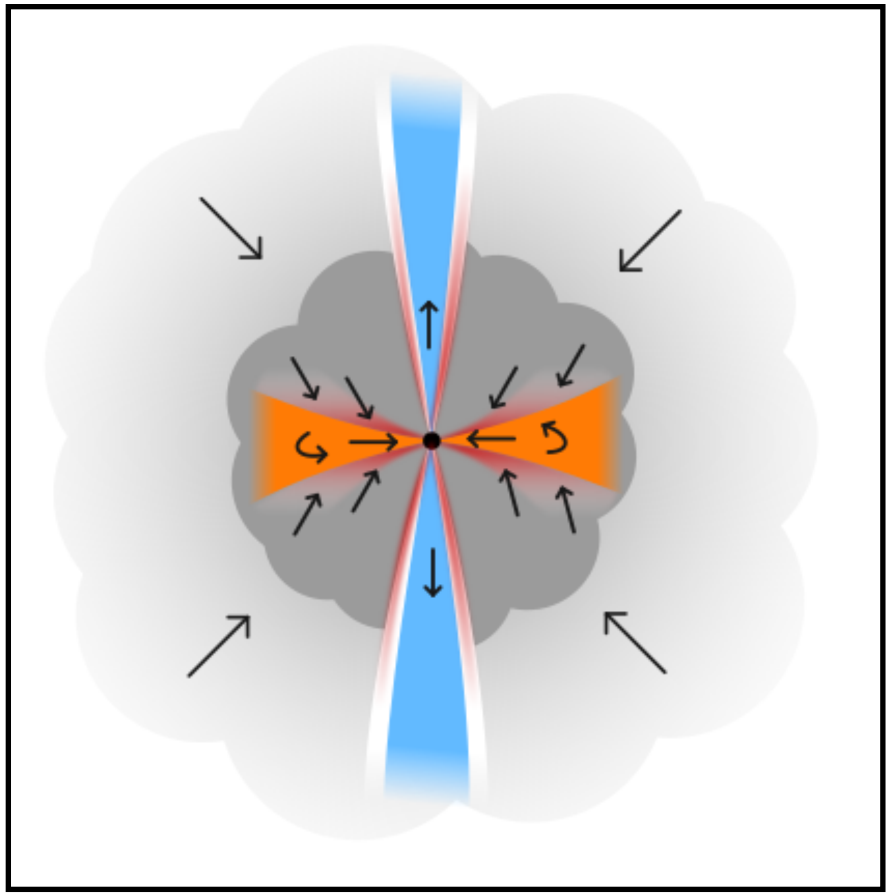
D = 15 m

Array



B_{max} = 16 km

Class I source



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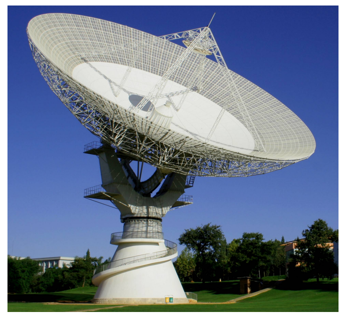

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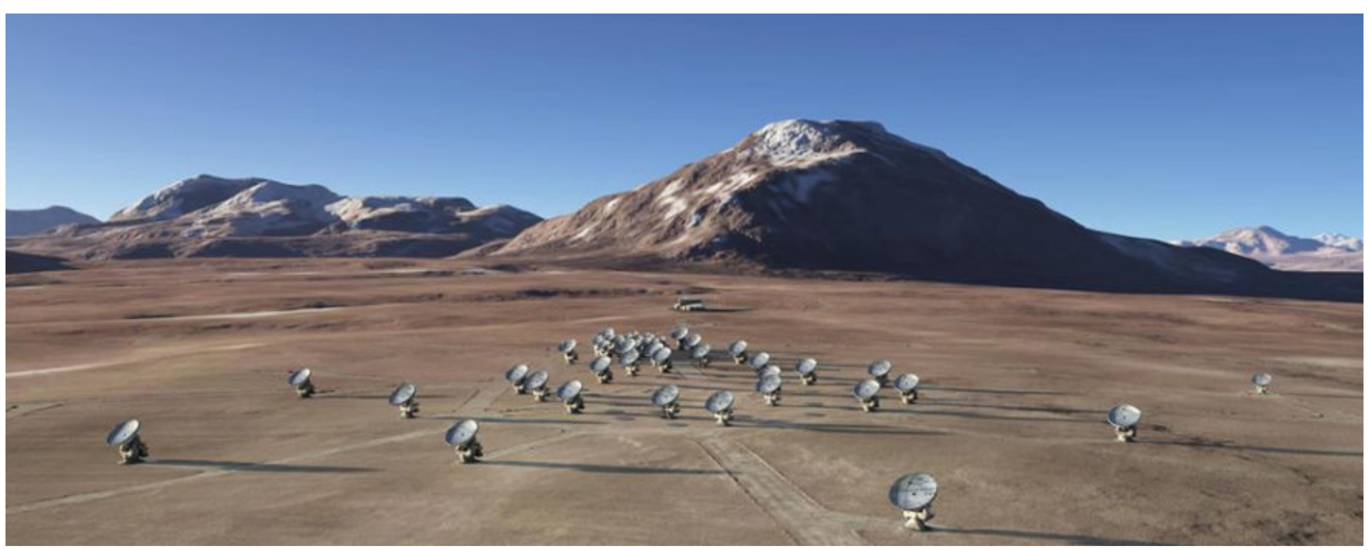

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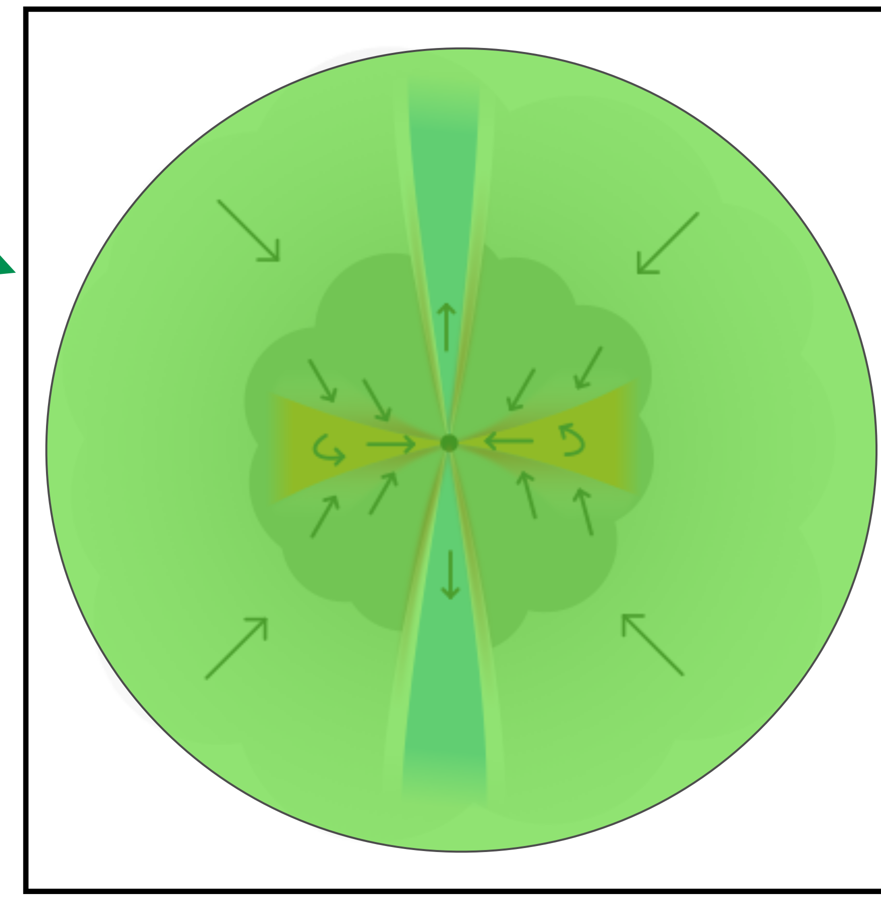

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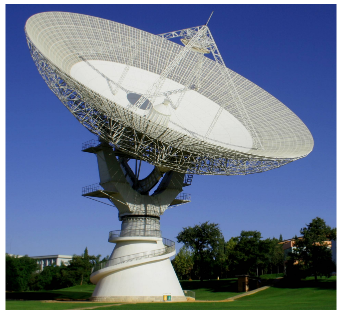

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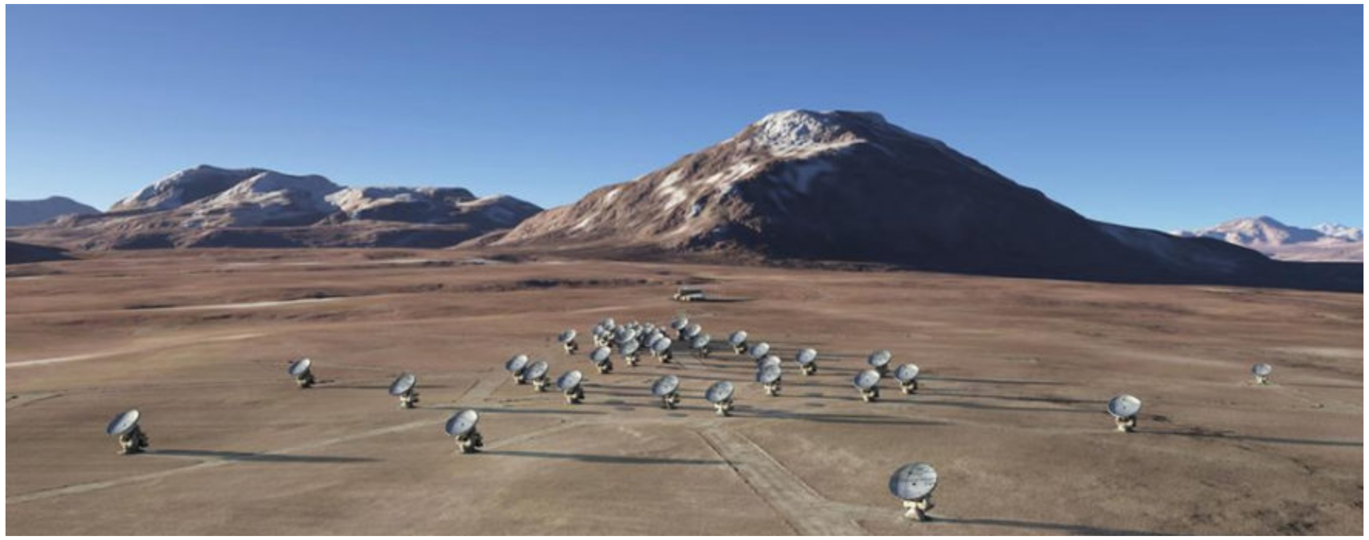

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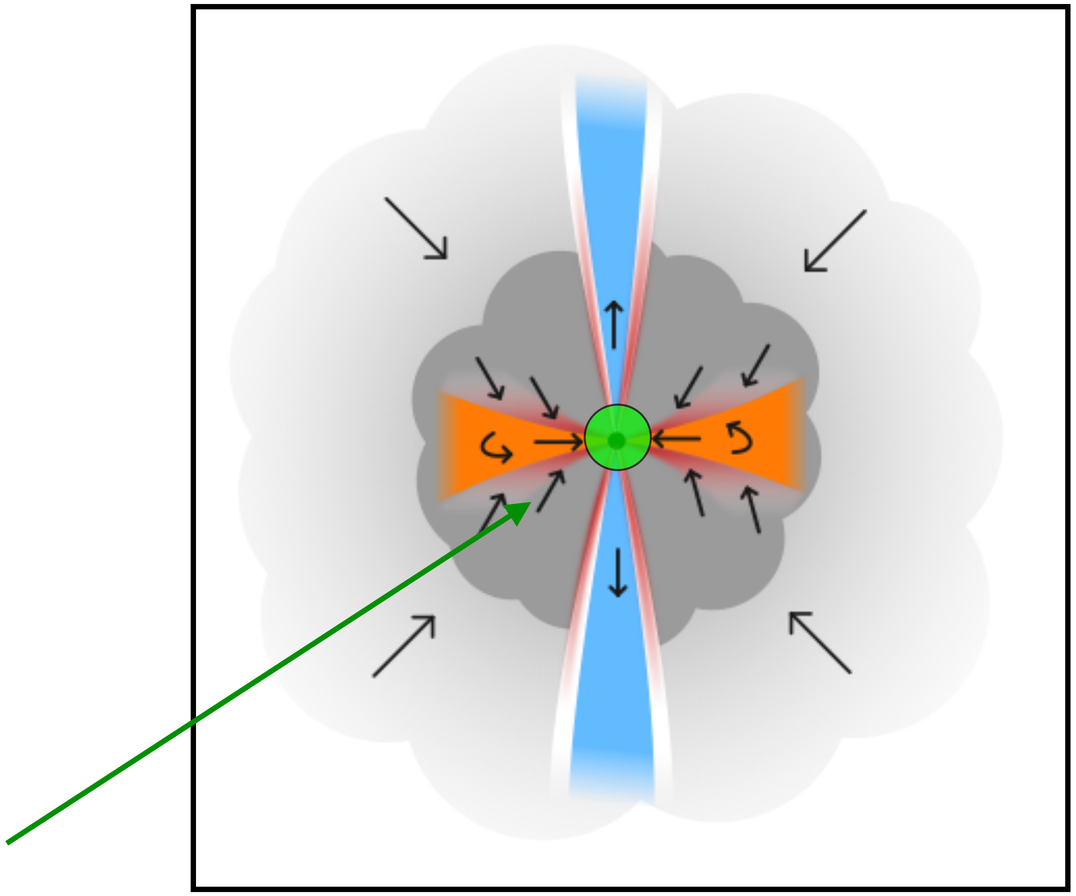

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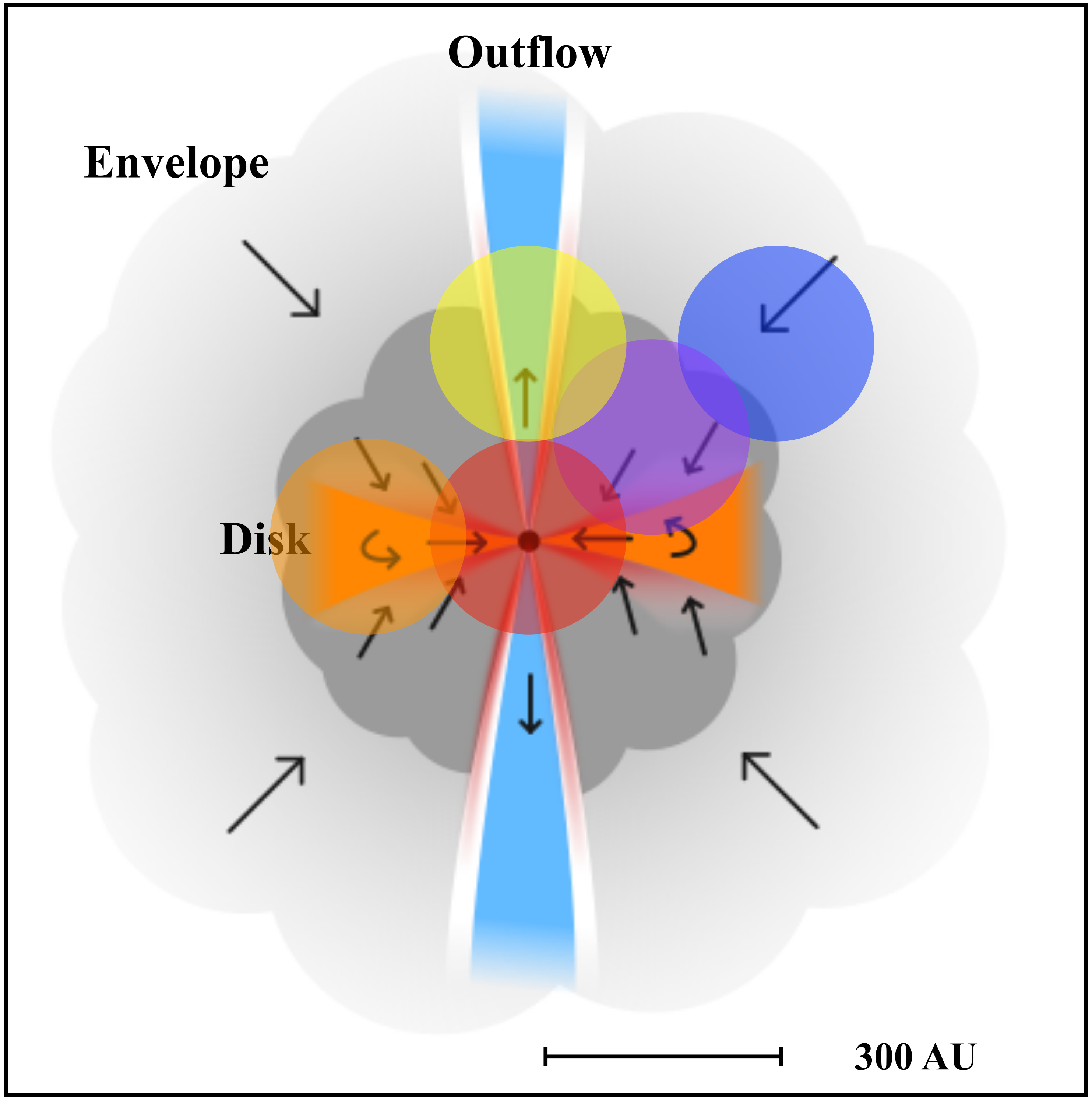


Outer envelope

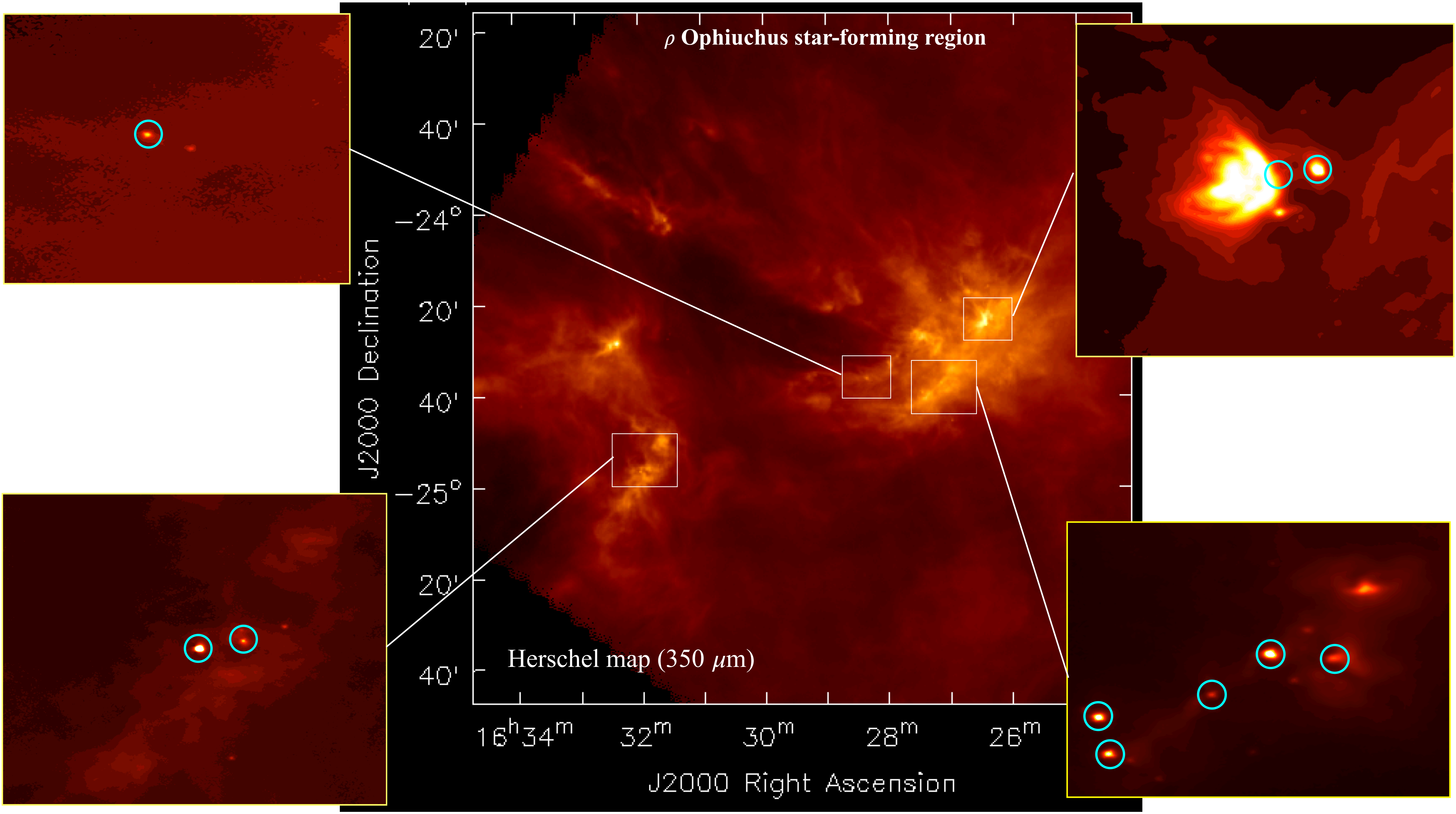
Inner envelope

Warm gas (hot-corino)

Shocks

Disk

Survey of 10 young embedded sources



T_{bol}: 36 - 420 K L_{bol}: 0.12 - 18 $L_{\odot}$

OBSERVATIONS

Angular resolution 0.4" (~50 AU)

Continuum (0.87 mm)

Disk tracers: optically thin isotopologues	**$C^{17}O$ J = 3-2** **$H^{13}CO^{+}$ J = 4-3** **$C^{34}S$ J = 7-6**
Warm chemistry	**CH_3OH $J_k = 7_k - 6_k$ branch** **SO_2 $J_{k_a k_c} = 18_{4,14} - 18_{3,15}$**
Envelope	**C_2H N = 4-3, J = 9/2-7/2**

Artur de la Villarmois et al. (2018)
Artur de la Villarmois et al. (2019)

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Warm ch

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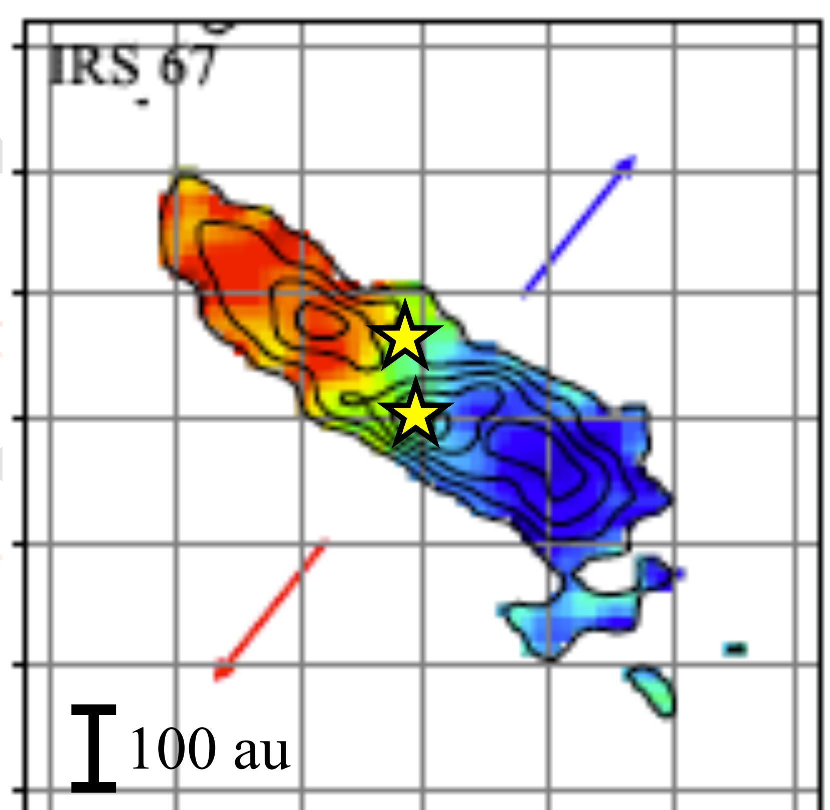

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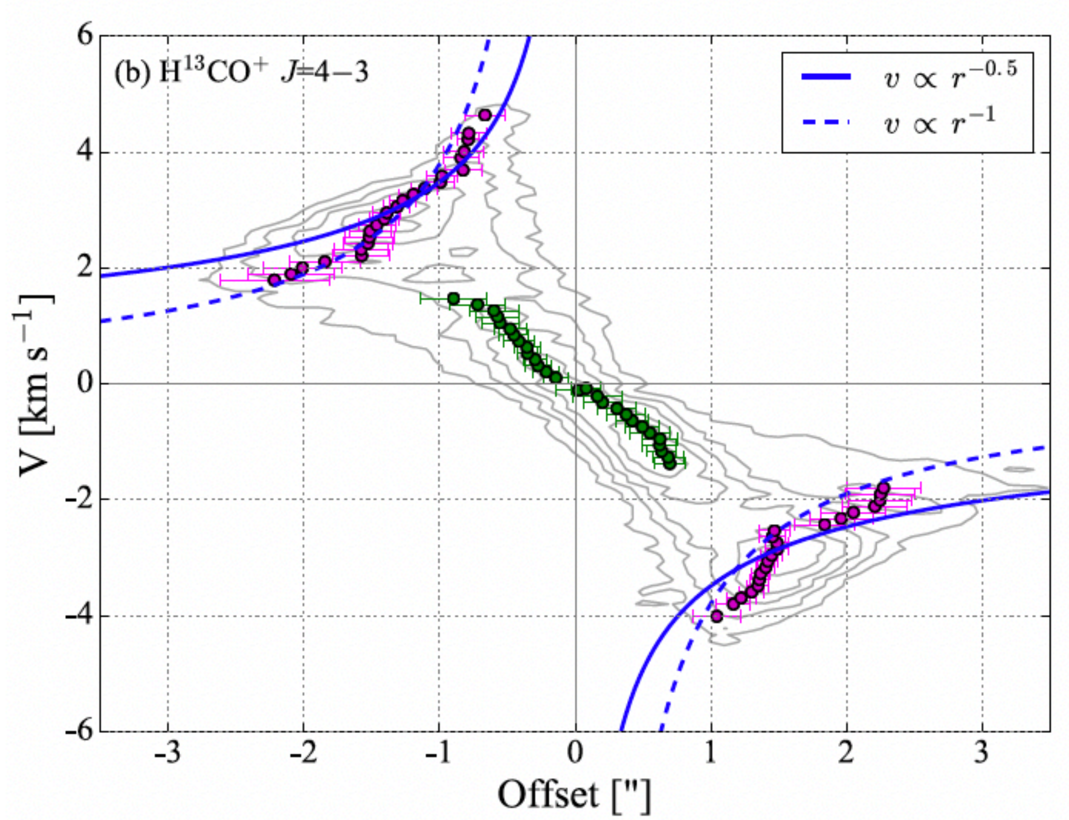
PV diagrams →  → $M_{\star}$

Artur de la Villarmois et al. (2018)
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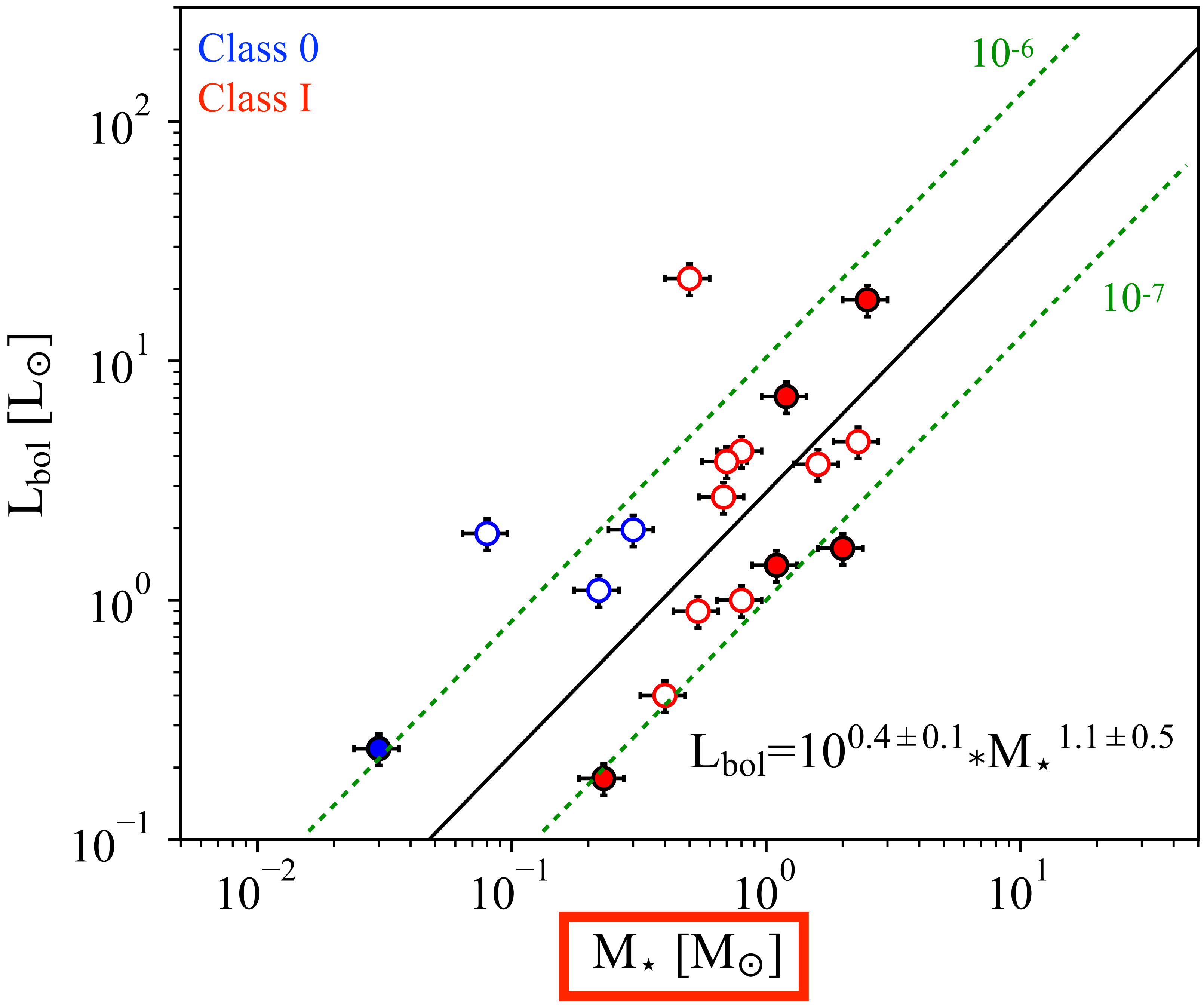
HOW DOES THE MATERIAL ACCRETE FROM THE DISK ONTO THE PROTOSTAR?



$$\dot{M}_{acc} = \frac{L_{bol} R_\star}{G M_\star}$$

$\dot{M}_{acc} = 2.4 \times 10^{-7}\ M_\odot/yr$

Solid circles: *Artur de la Villarmois et al. (2019)*
Open circles: *Aso et al. (2015)*

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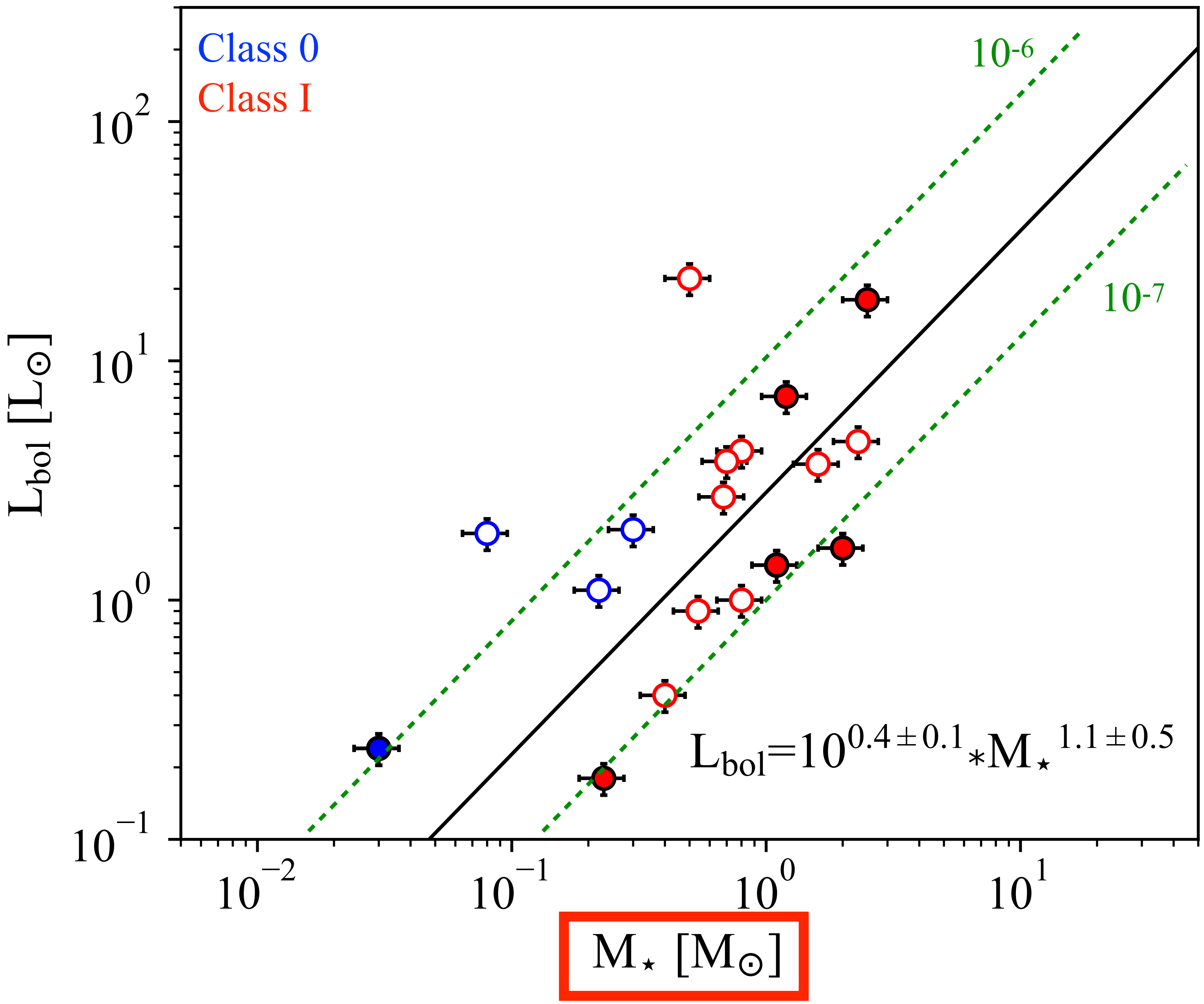

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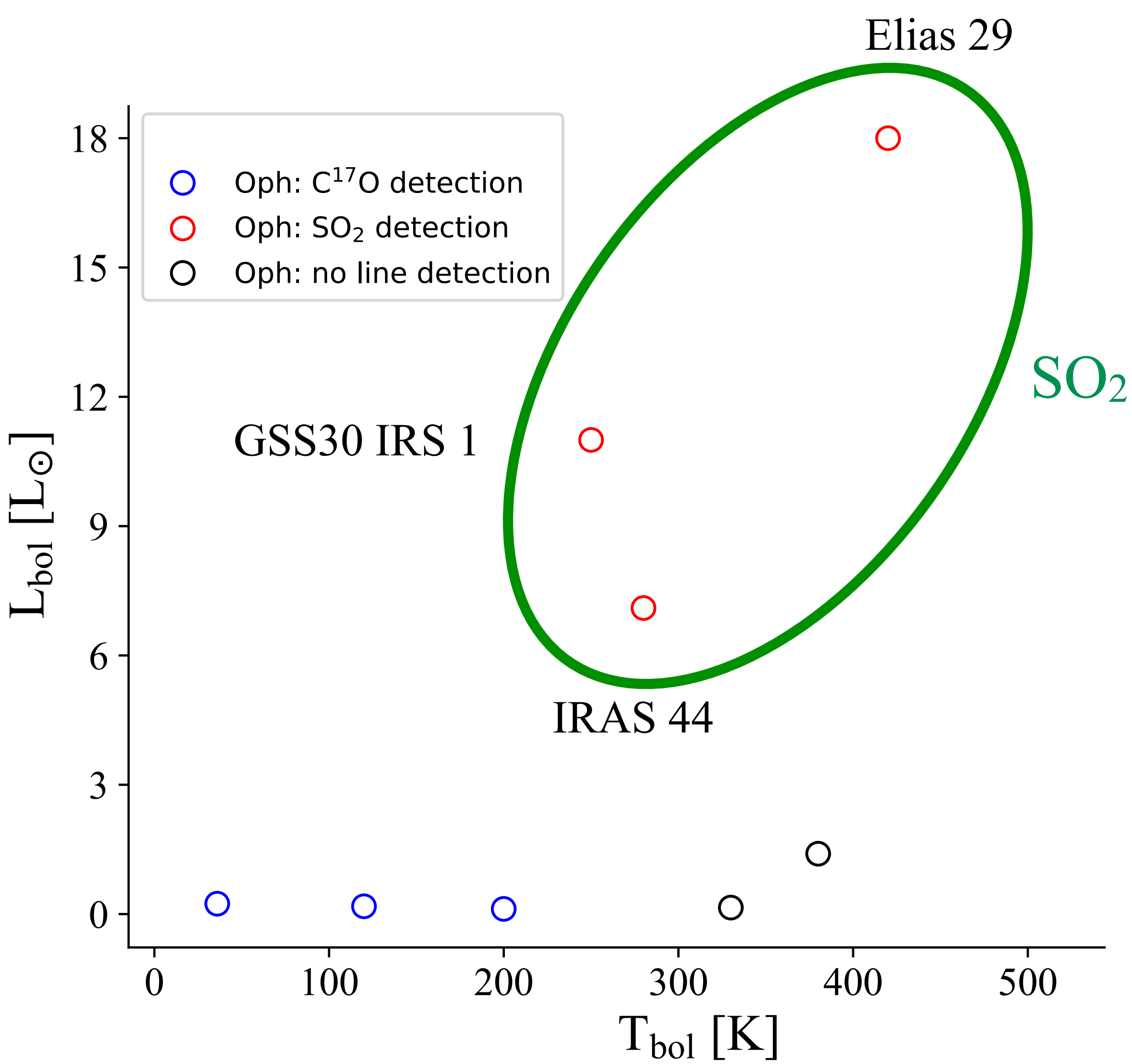
Variable accretion rate
(episodic accretion bursts)

Most of the sources
are in a quiescent
state of accretion

Solid circles: *Artur de la Villarmois et al. (2019)*
Open circles: *Aso et al. (2015)*

SO_2 DETECTED IN SOURCES WITH HIGH L_{bol}



$$L_{bol} > 6\ L_{\odot}$$

$$L_{bol} \leftrightarrow \dot{M}_{acc}$$

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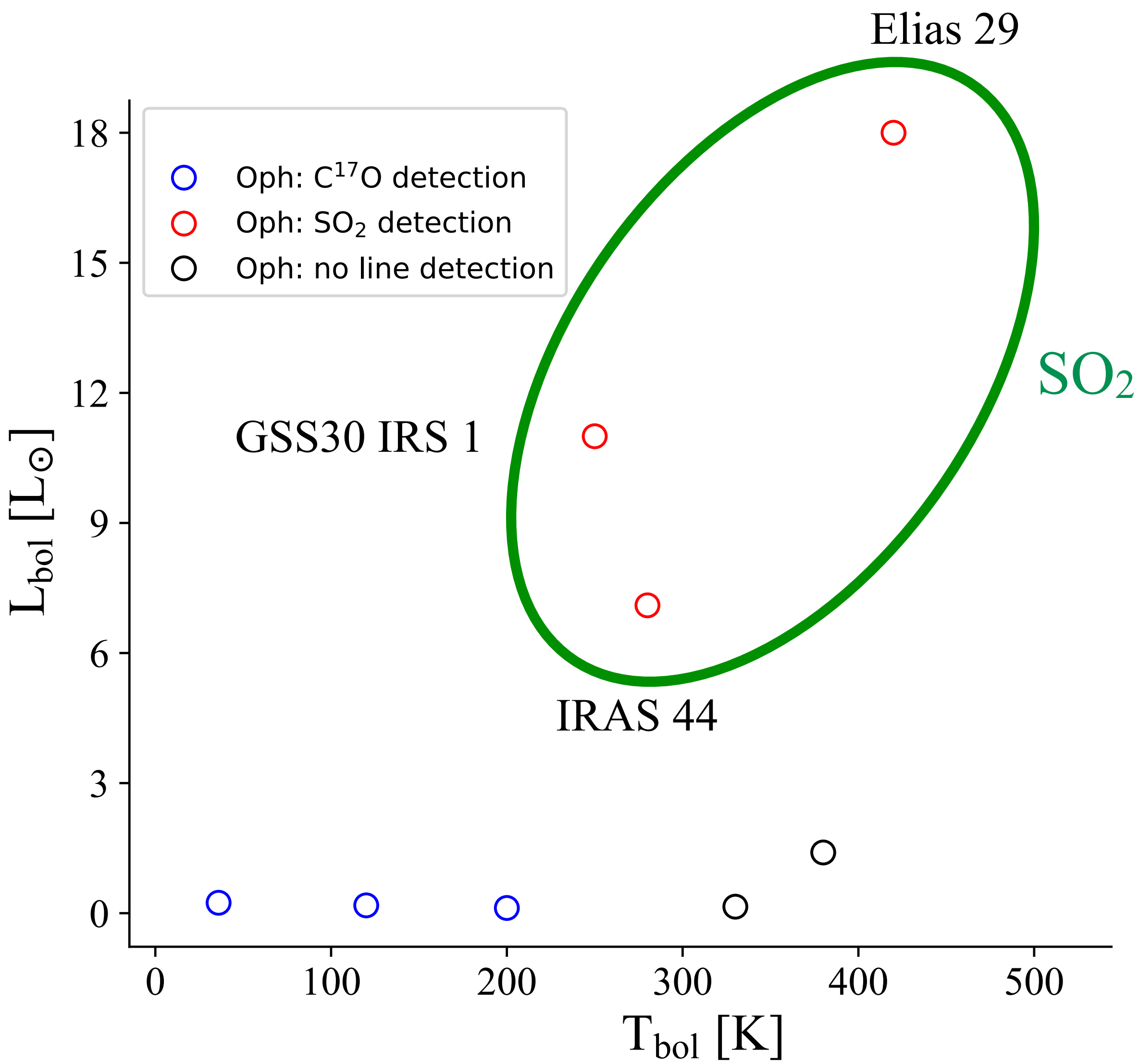
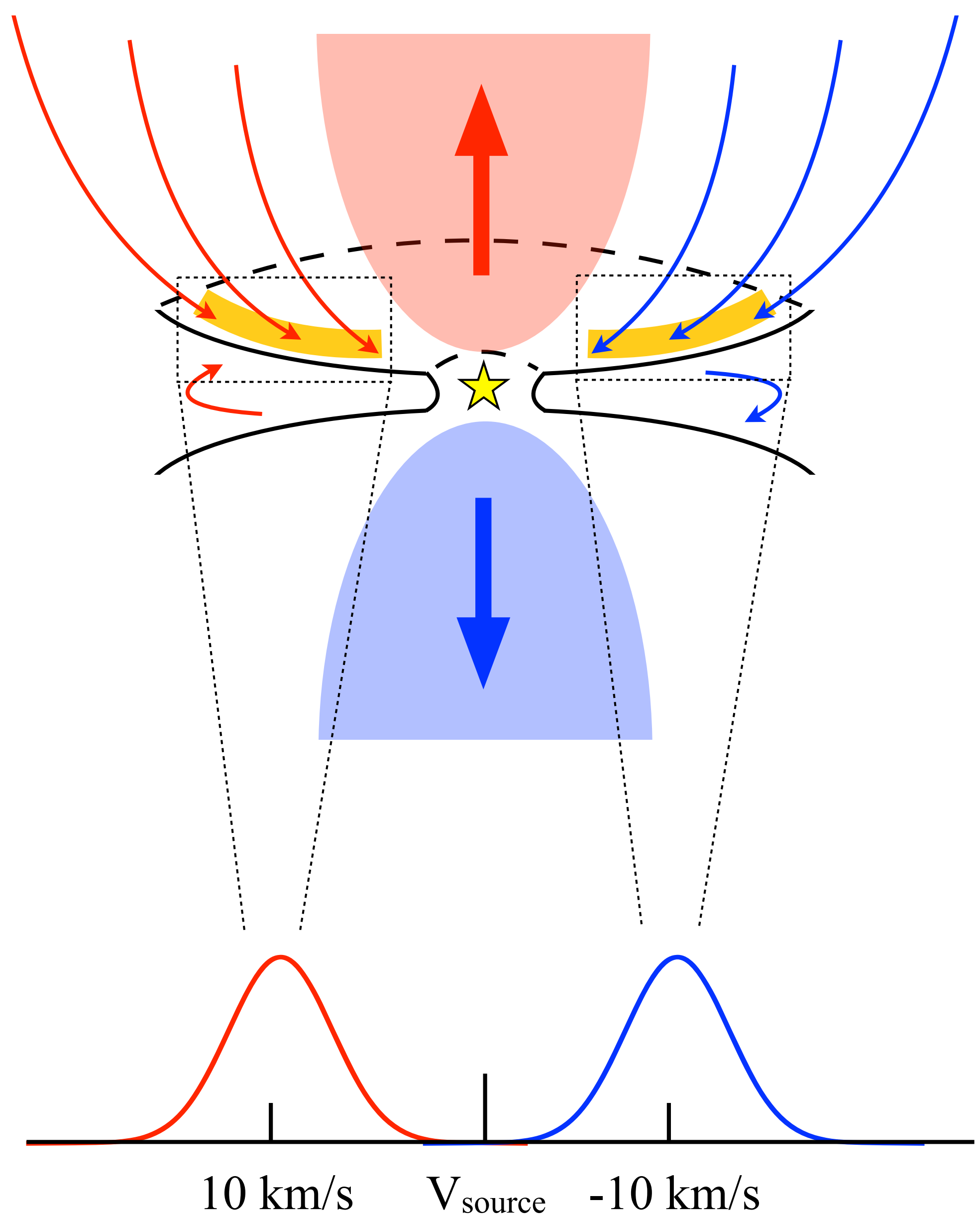


SO_2 is a common shock tracer

Accretion shocks?



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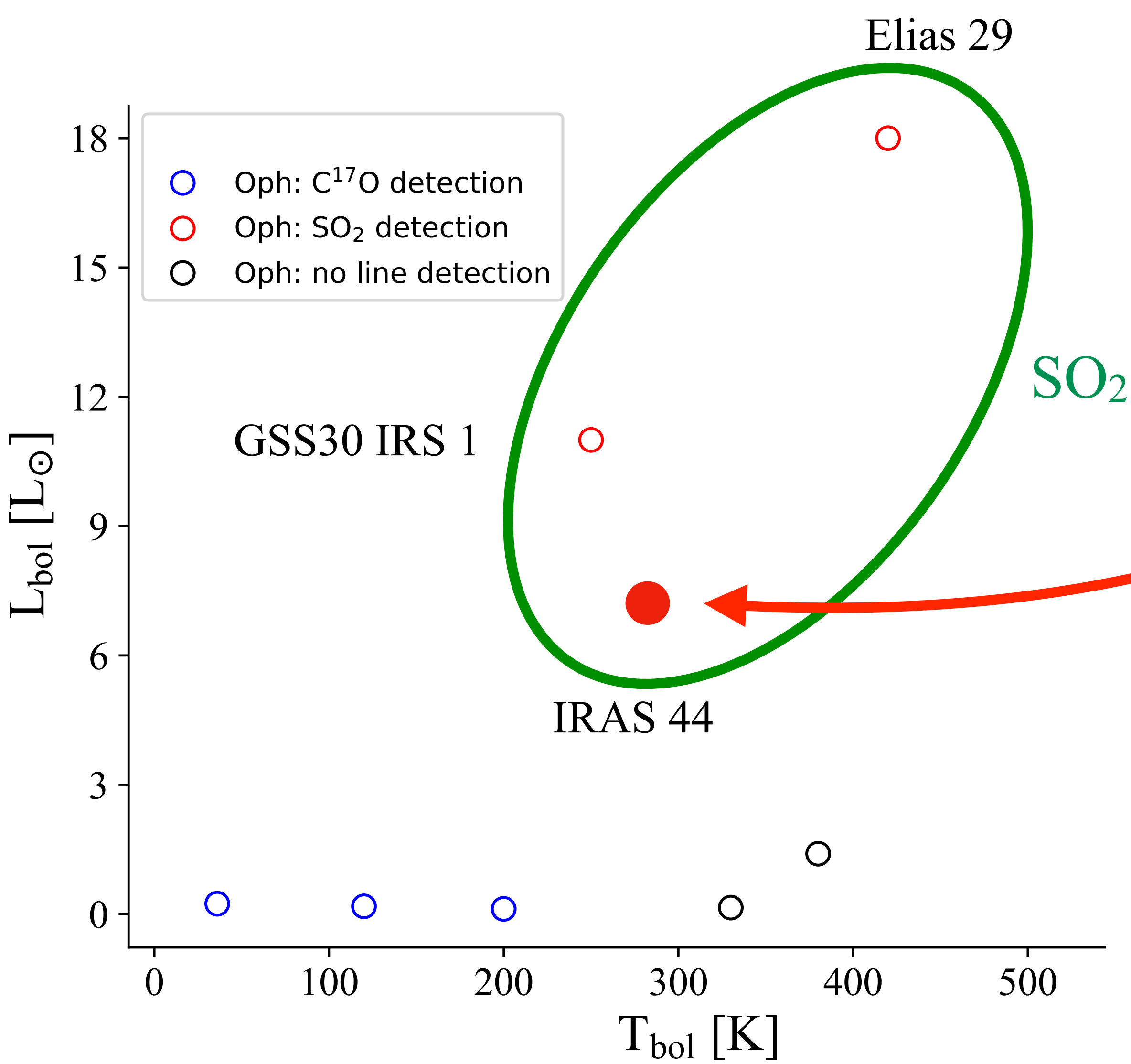

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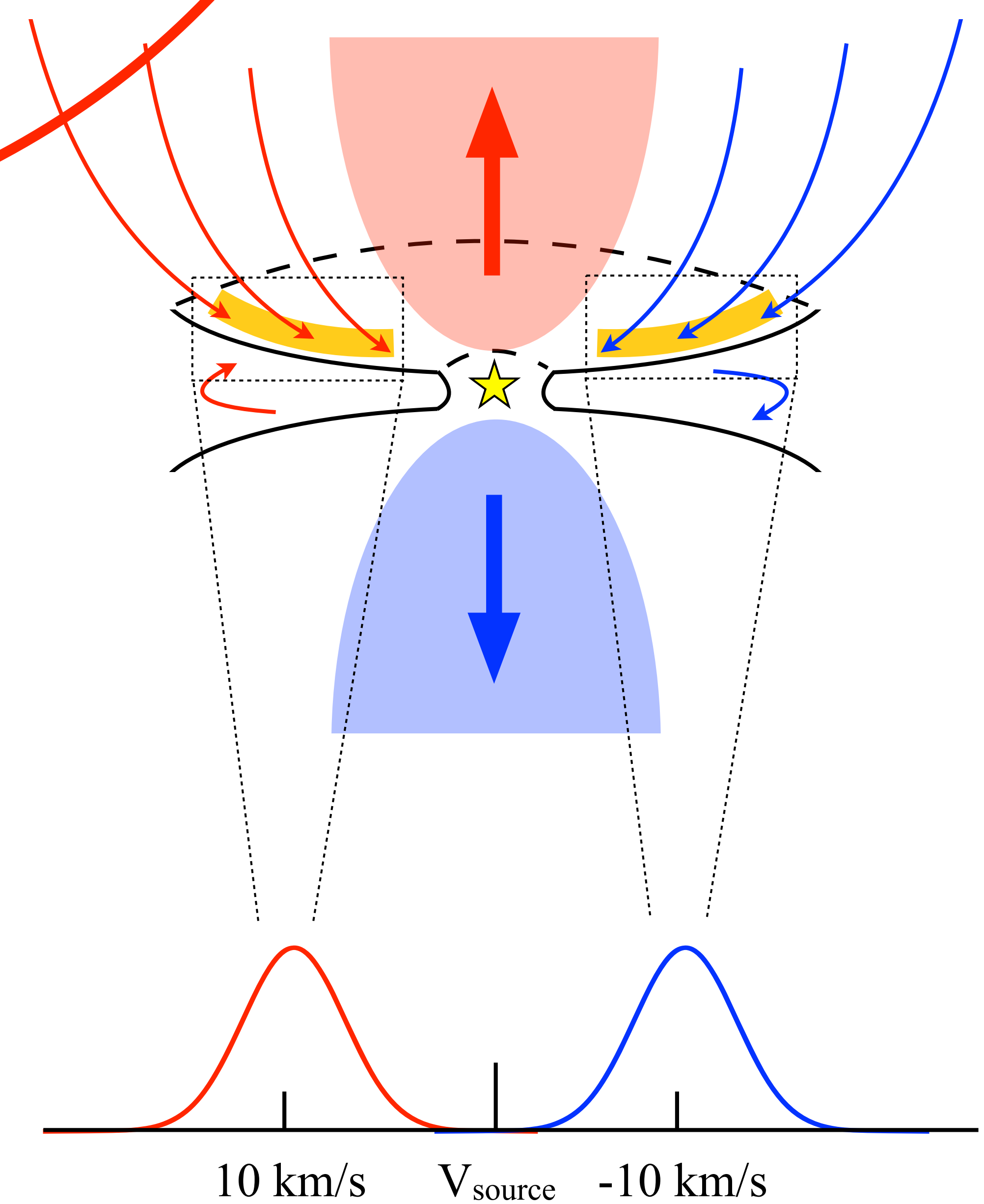
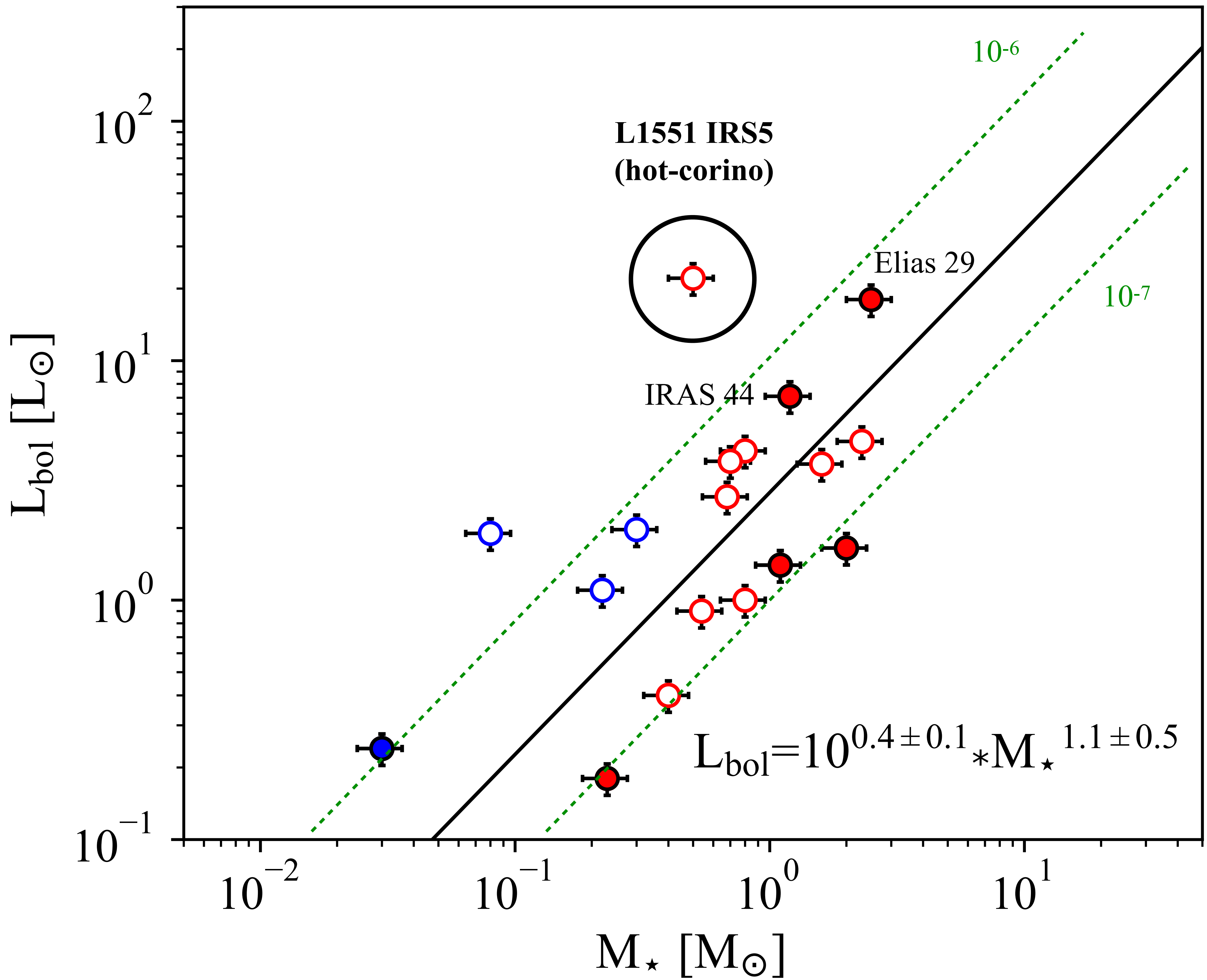
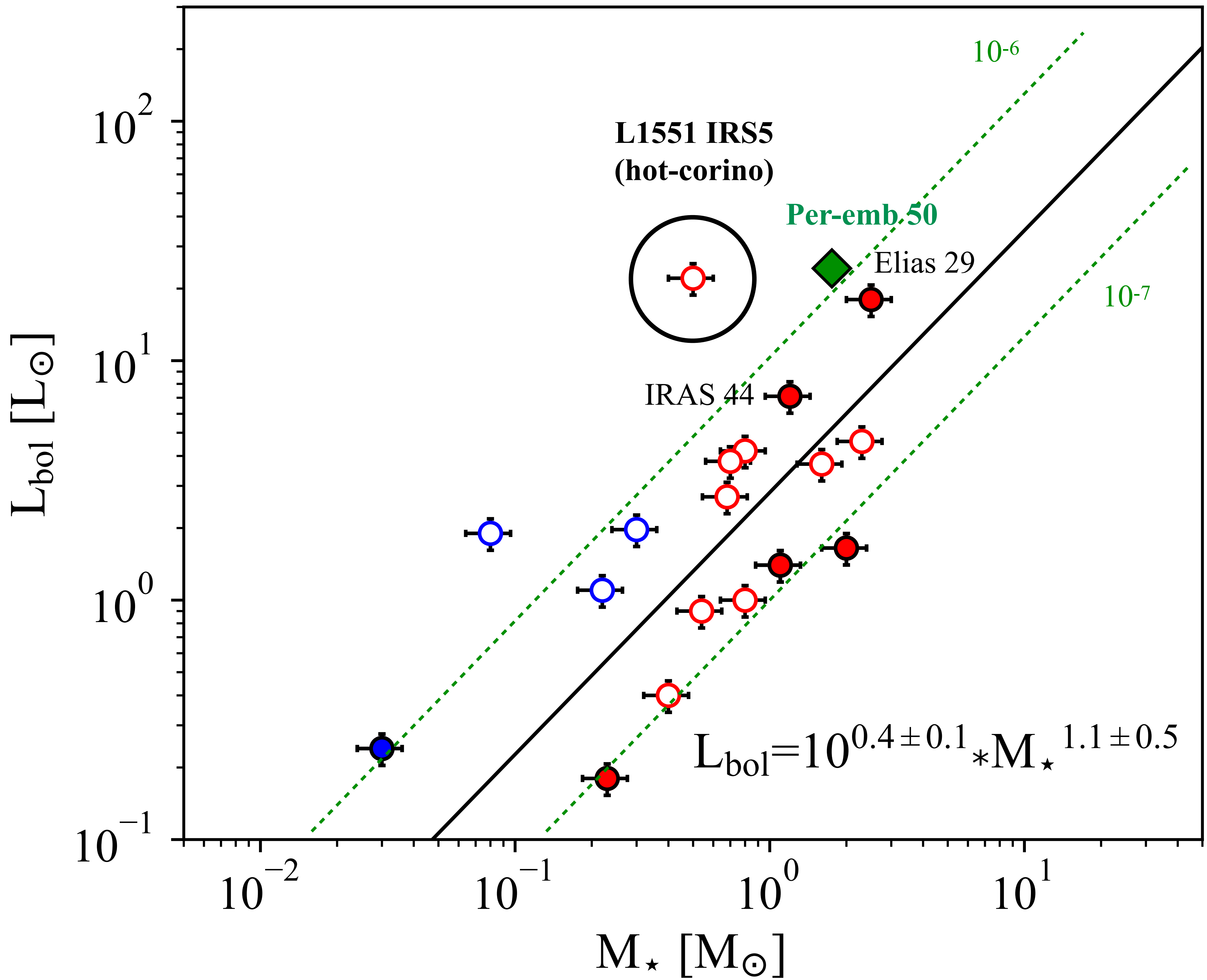


IRS 44: *Artur de la Villarmois et al. (2022)*

SO₂ DETECTED IN SOURCES WITH HIGH L_{bol}



SO2 DETECTED IN SOURCES WITH HIGH Lbol



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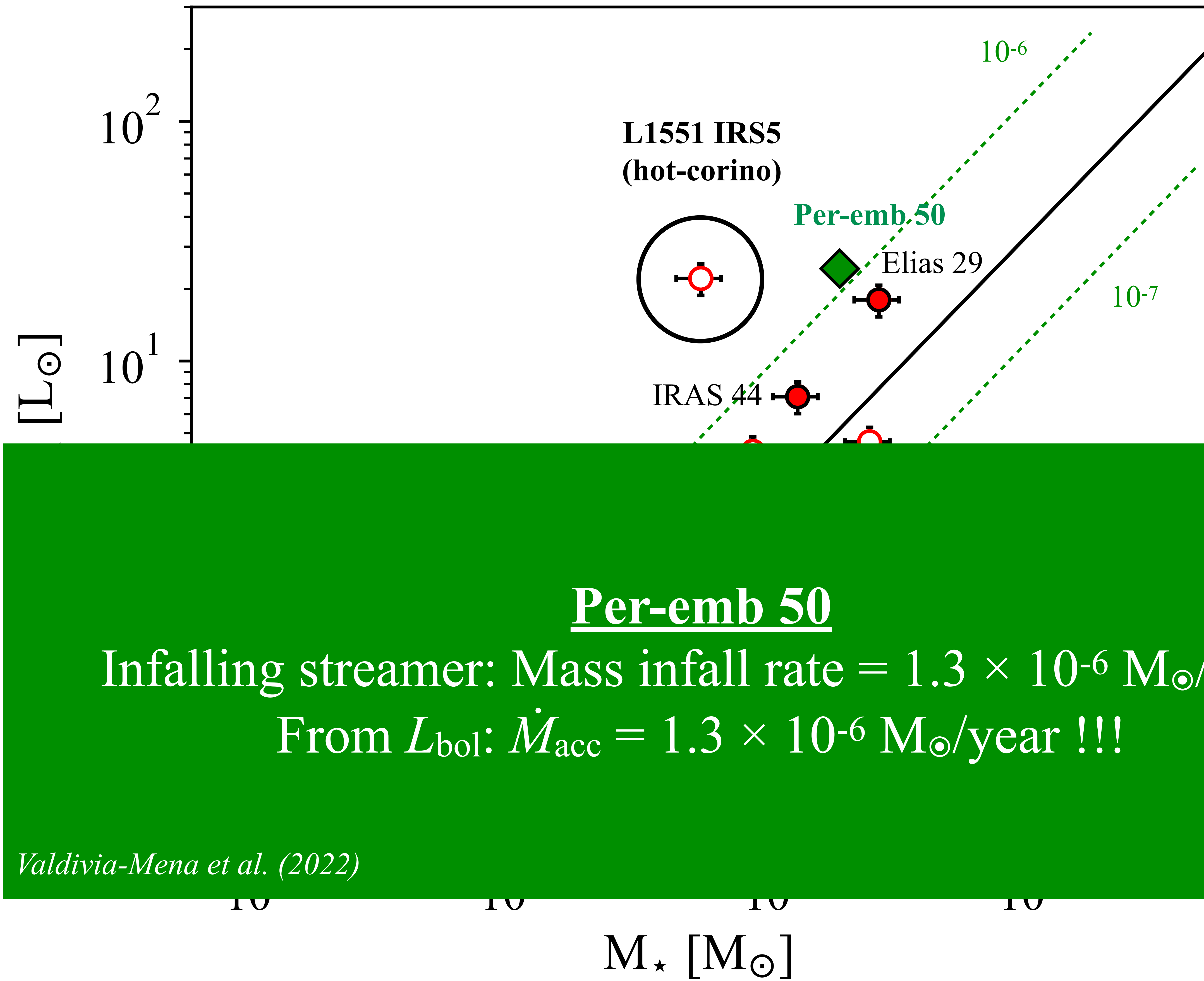


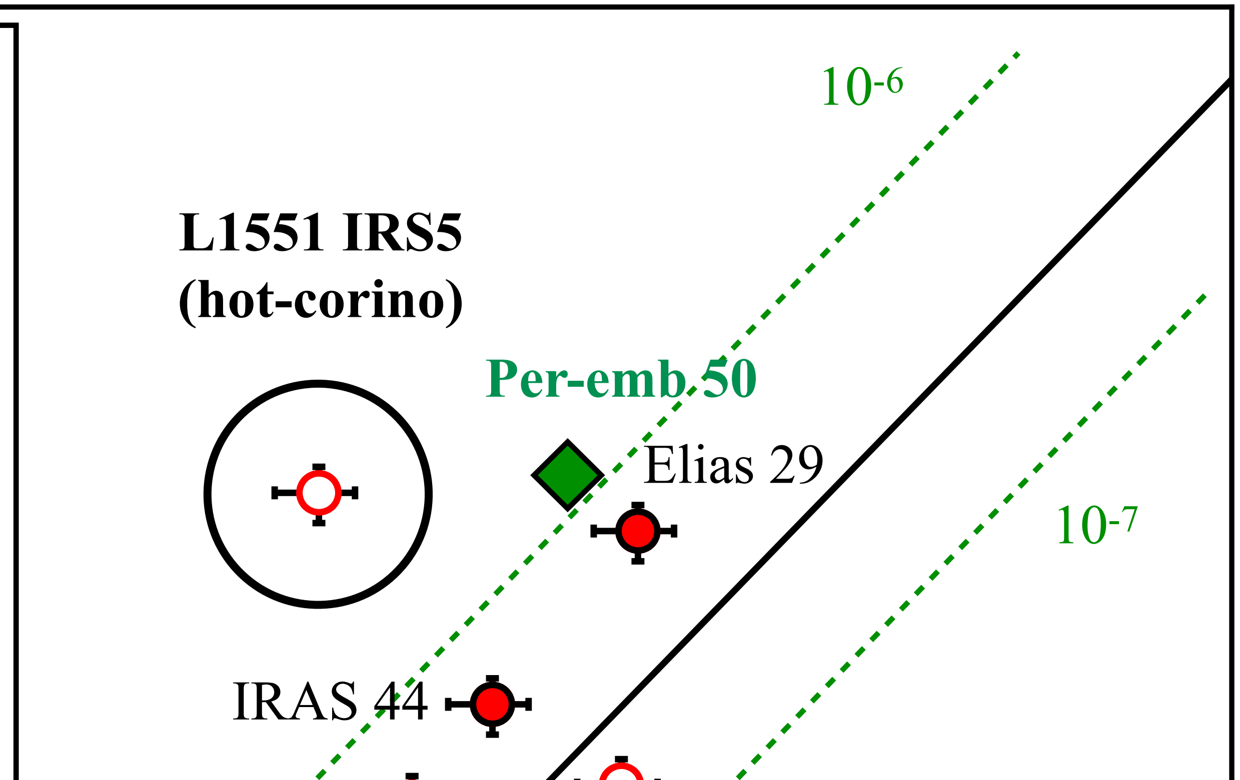
Per-emb 50

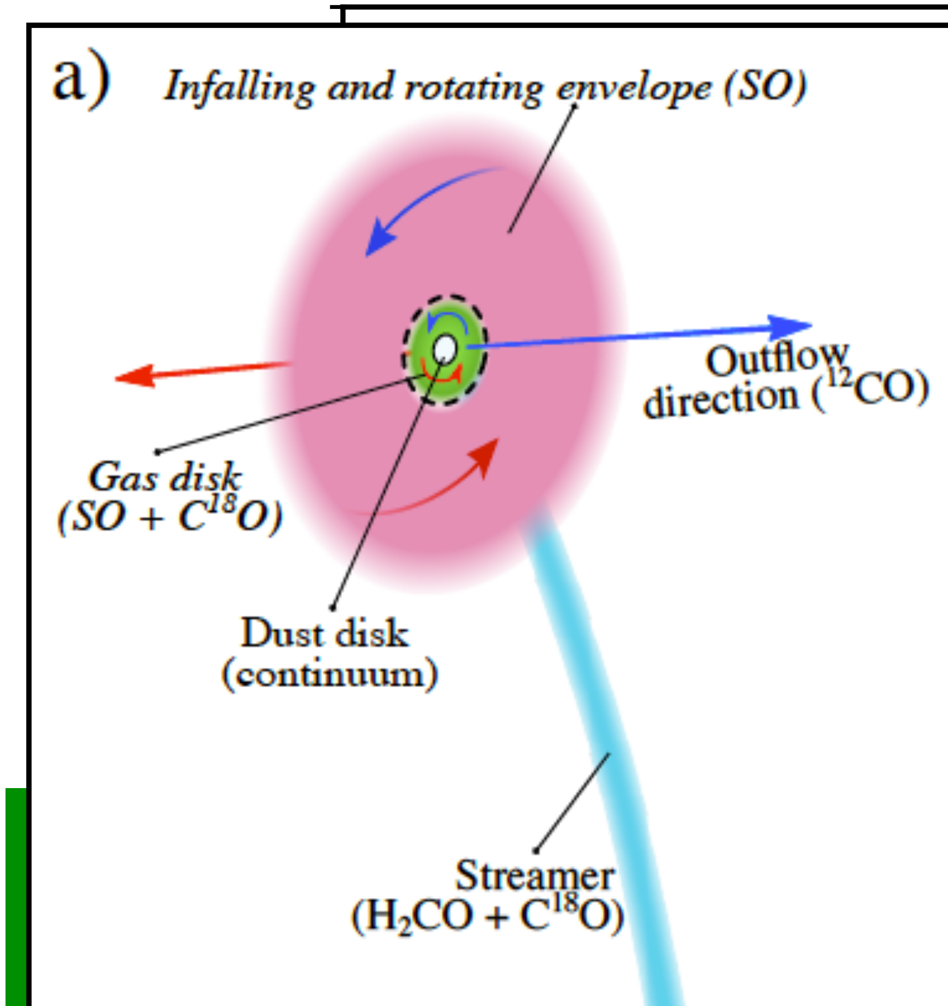
Infalling streamer: Mass infall rate = 1.3×10^{-6} M⊙/year

From L_{bol}: $\dot{M}_{acc} = 1.3 \times 10^{-6}$ M⊙/year !!!

Valdivia-Mena et al. (2022)

SO_2 DETECTED IN SOURCES WITH HIGH L_{bol}





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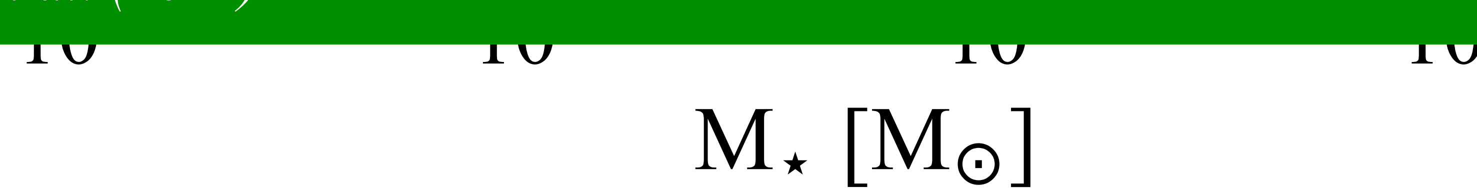

TAKE HOME MESSAGES

Detection of disk tracers is essential to separate the disk from the envelope component and to estimate $M_\star$

$<\dot{M}_{\rm acc}>$ is too low for the accretion to be constant in time
$\Rrightarrow$ Episodic accretion bursts

$t_{quiescent} > t_{active}$

SO_2 molecules seem to be linked to high $\dot{M}_{\rm acc}$, accretion shocks, and the presence of infalling streamers

Streamers: $\dot{M}_{\rm infall}$ vs. $\dot{M}_{\rm acc}$?