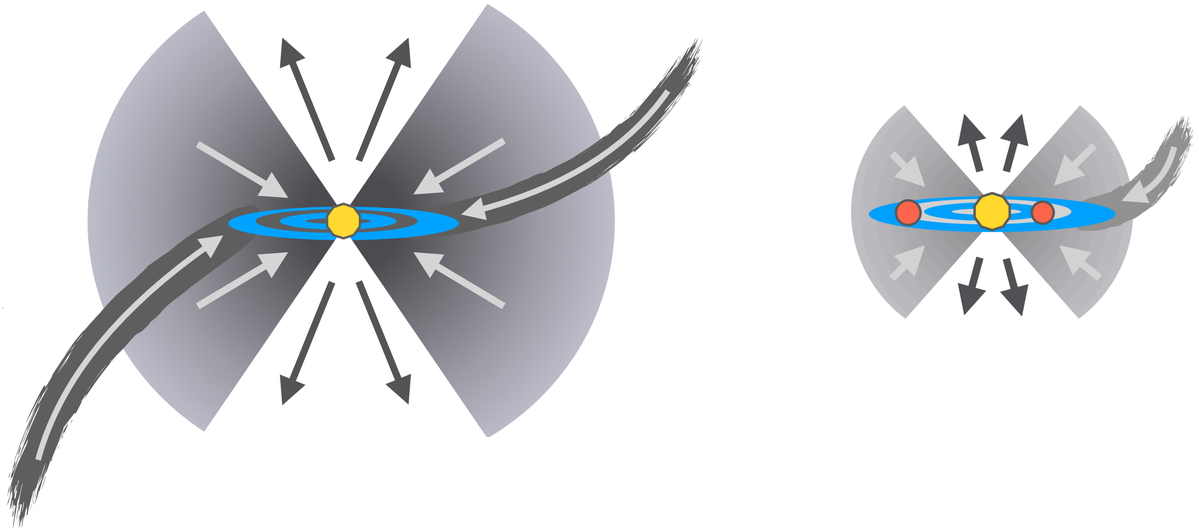
# The role of Streamers in star and disk formation: mirage or reality?



**Jaime Pineda & Dominique Segura-Cox**
Max Planck Institute for Extraterrestrial Physics
Center for Astrochemical Studies (CAS@MPE)
*13/07/21*

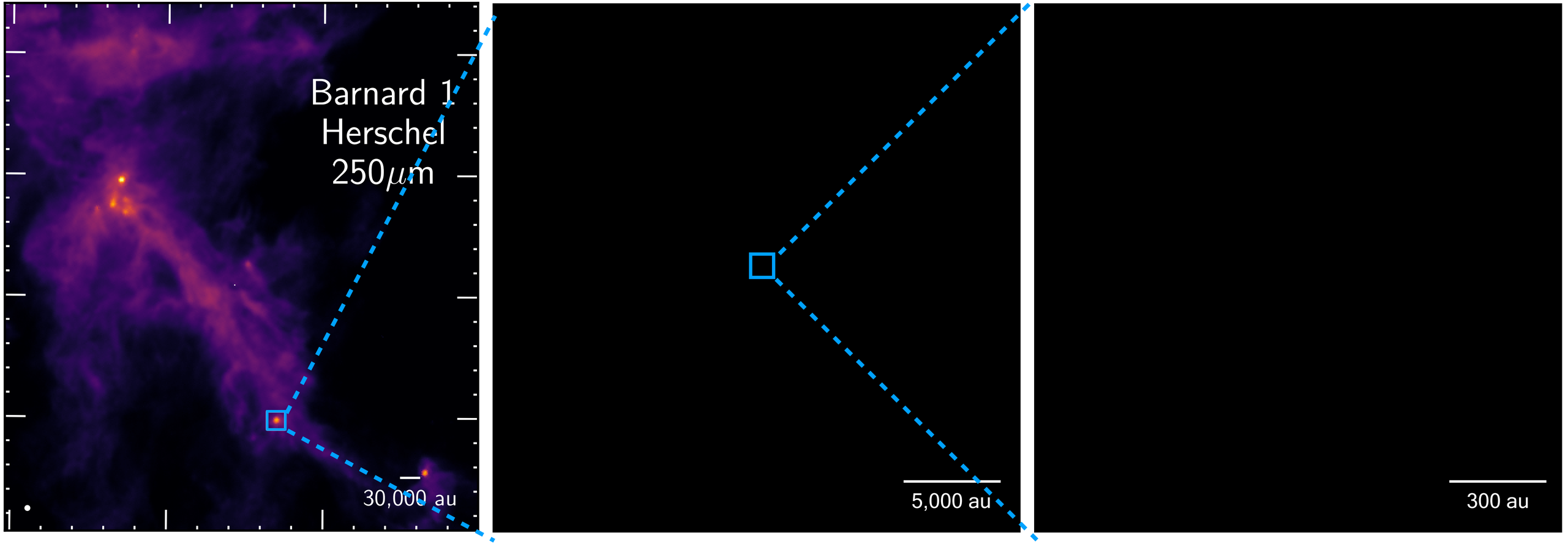
# The Need to Connect Scales

## Per-emb-2 (Class 0)

Filament Scale

Core/Envelope Scale

Disk Scale

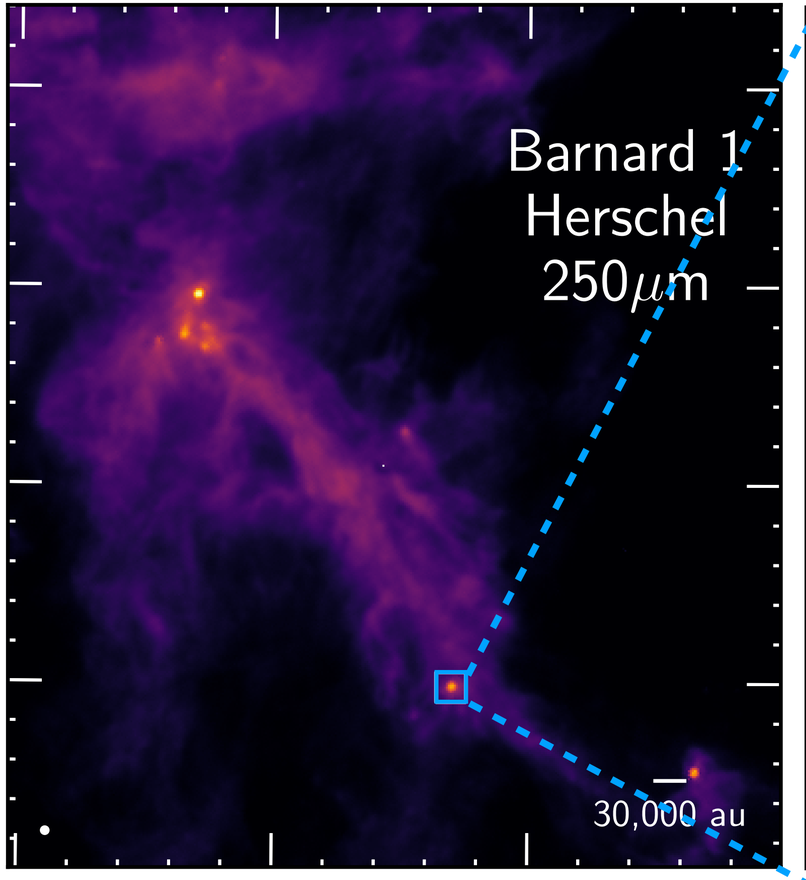



Sadavoy et al. (2012, 2014)

# The Need to Connect Scales

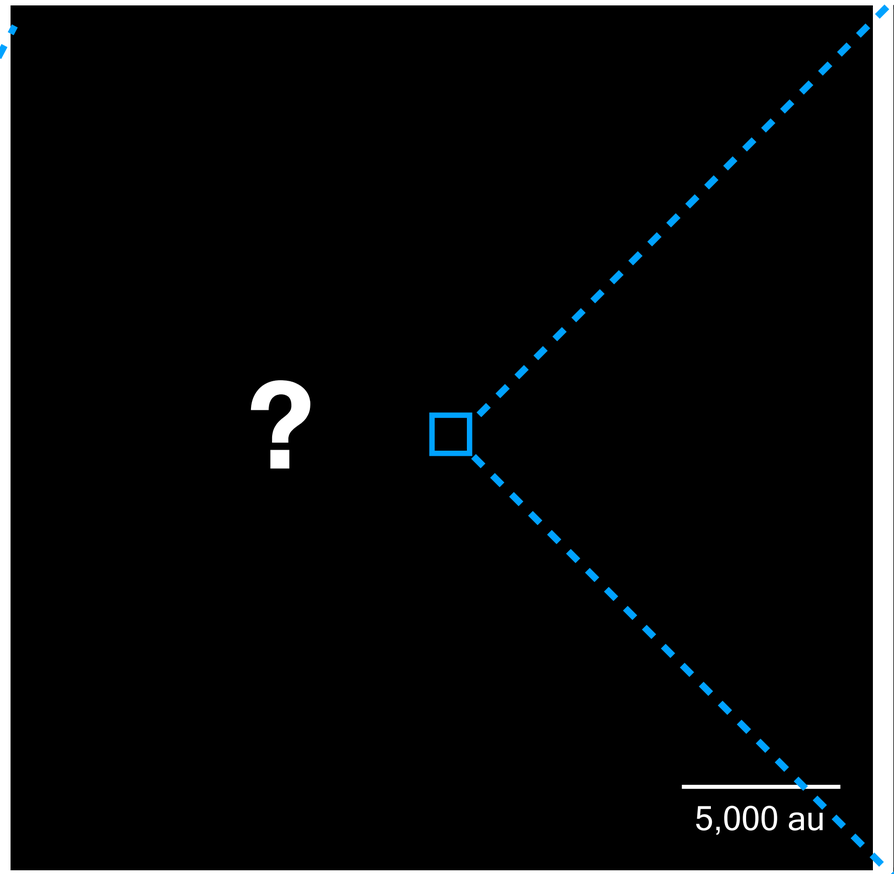
## Per-emb-2 (Class 0)

Filament Scale

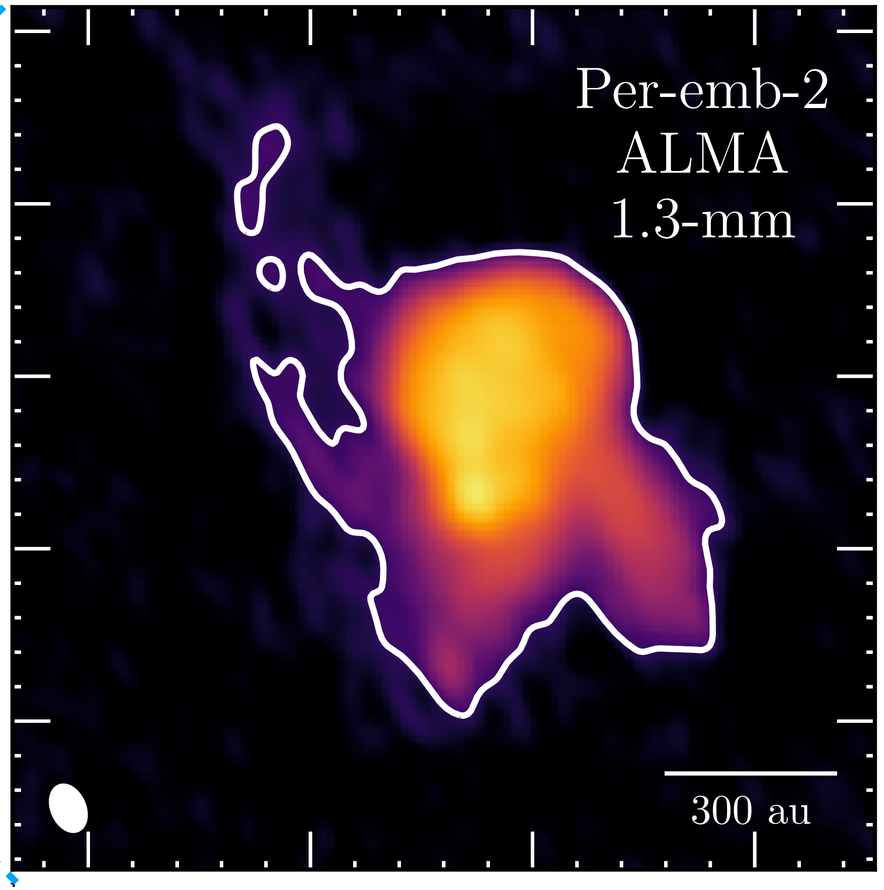



Sadavoy et al. (2012, 2014)

Core/Envelope Scale




Disk Scale

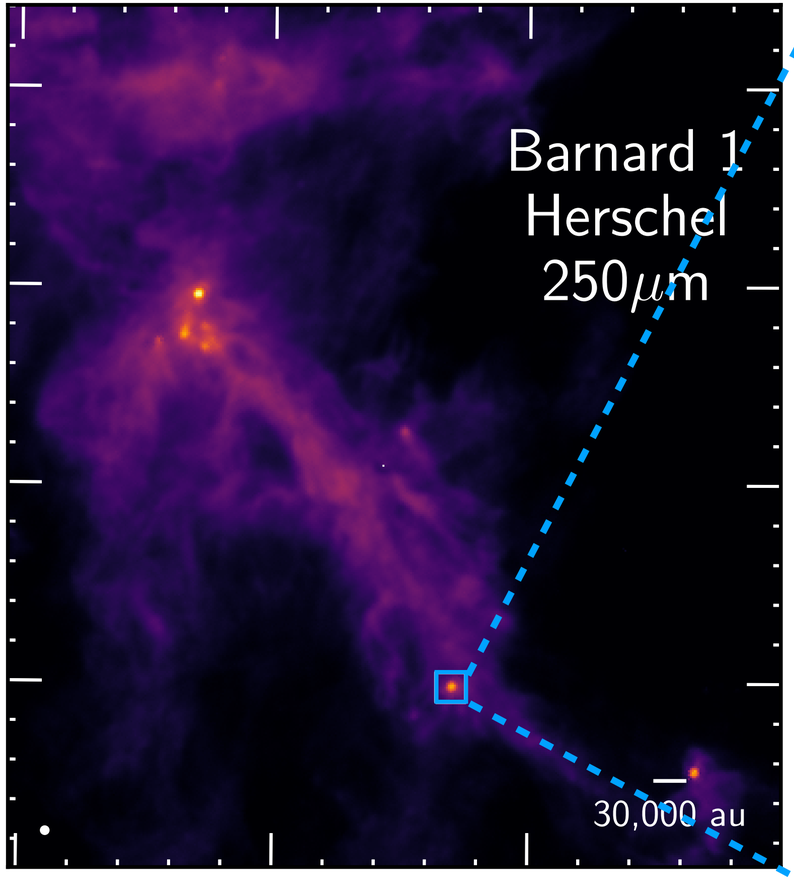



Reprocessed from Tobin et al. (2018)

# Streamers Bridge the Gap

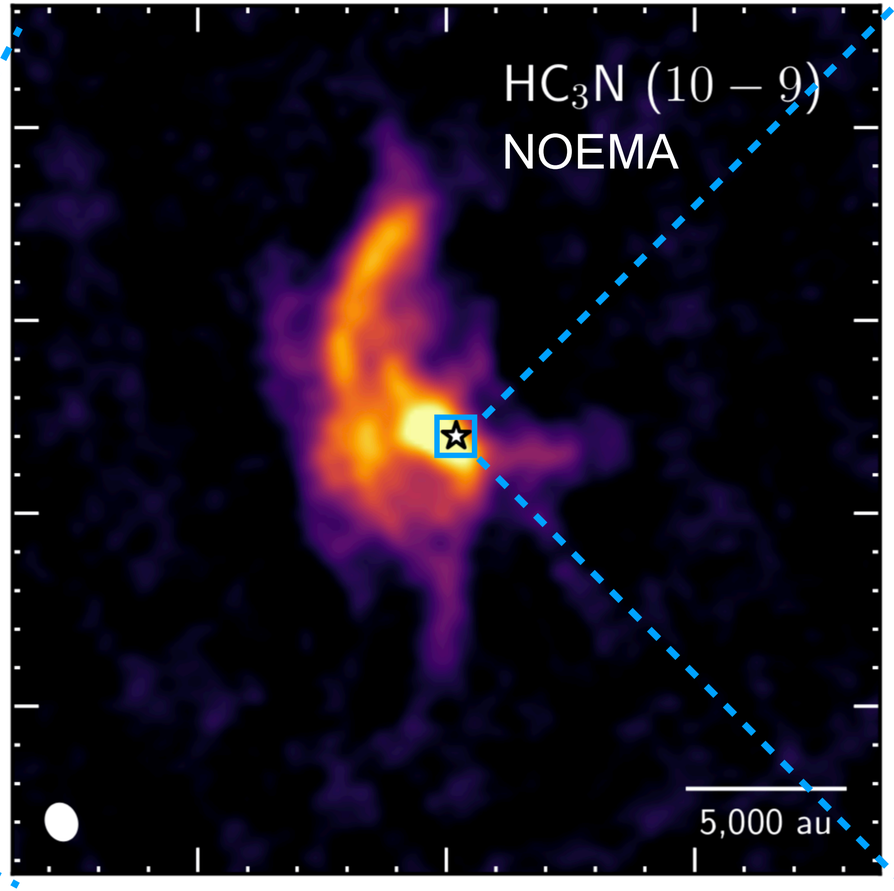
## Per-emb-2 (Class 0)

Filament Scale



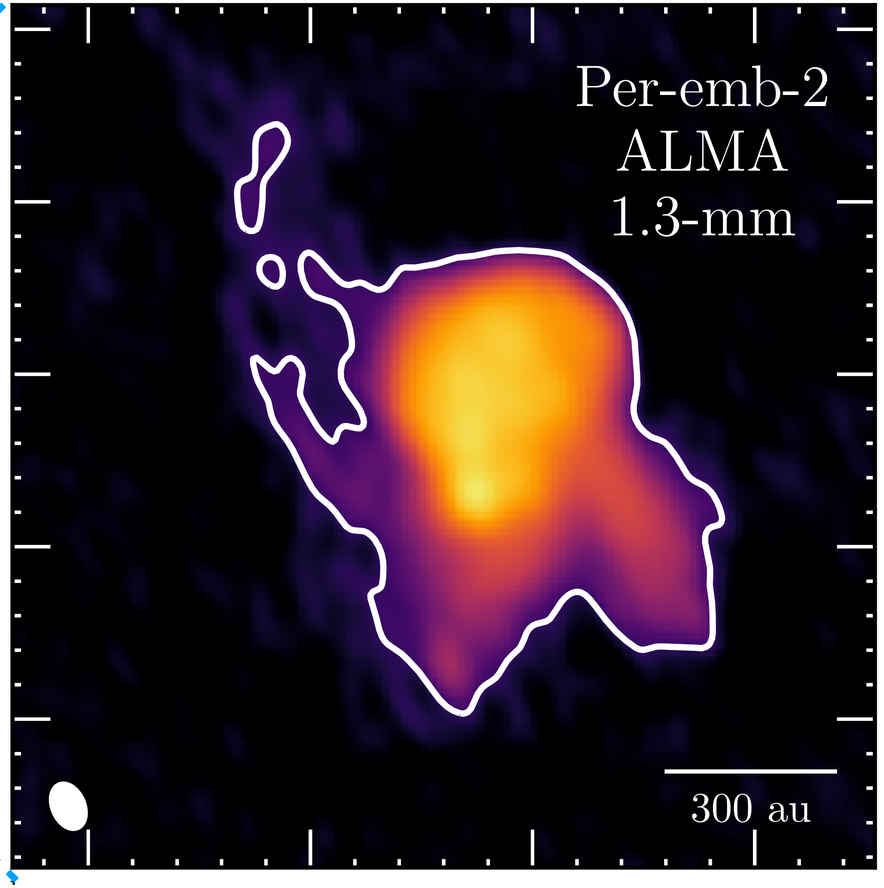

Sadavoy et al. (2012, 2014)

Core/Envelope Scale



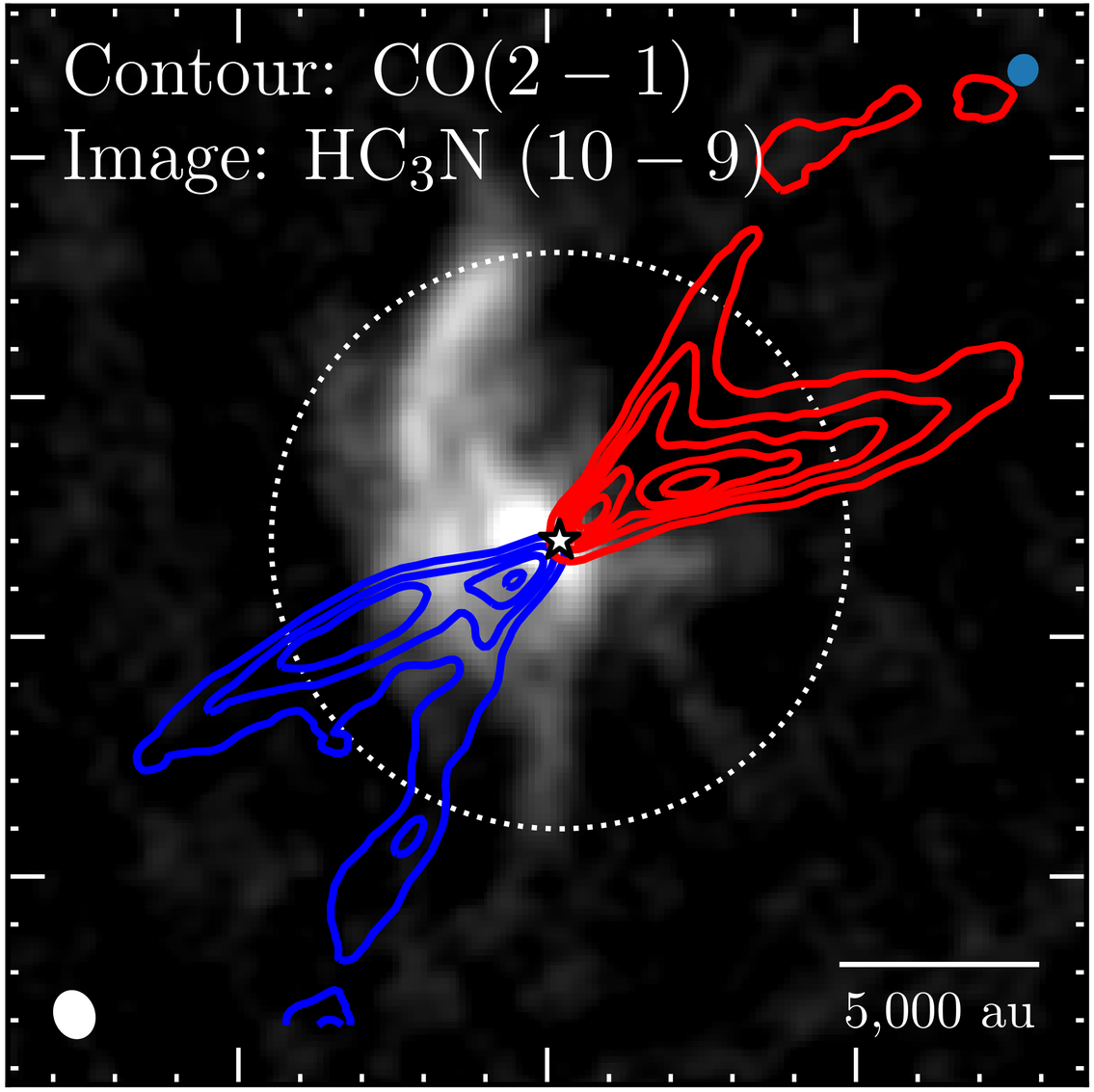

Pineda et al. (2020)

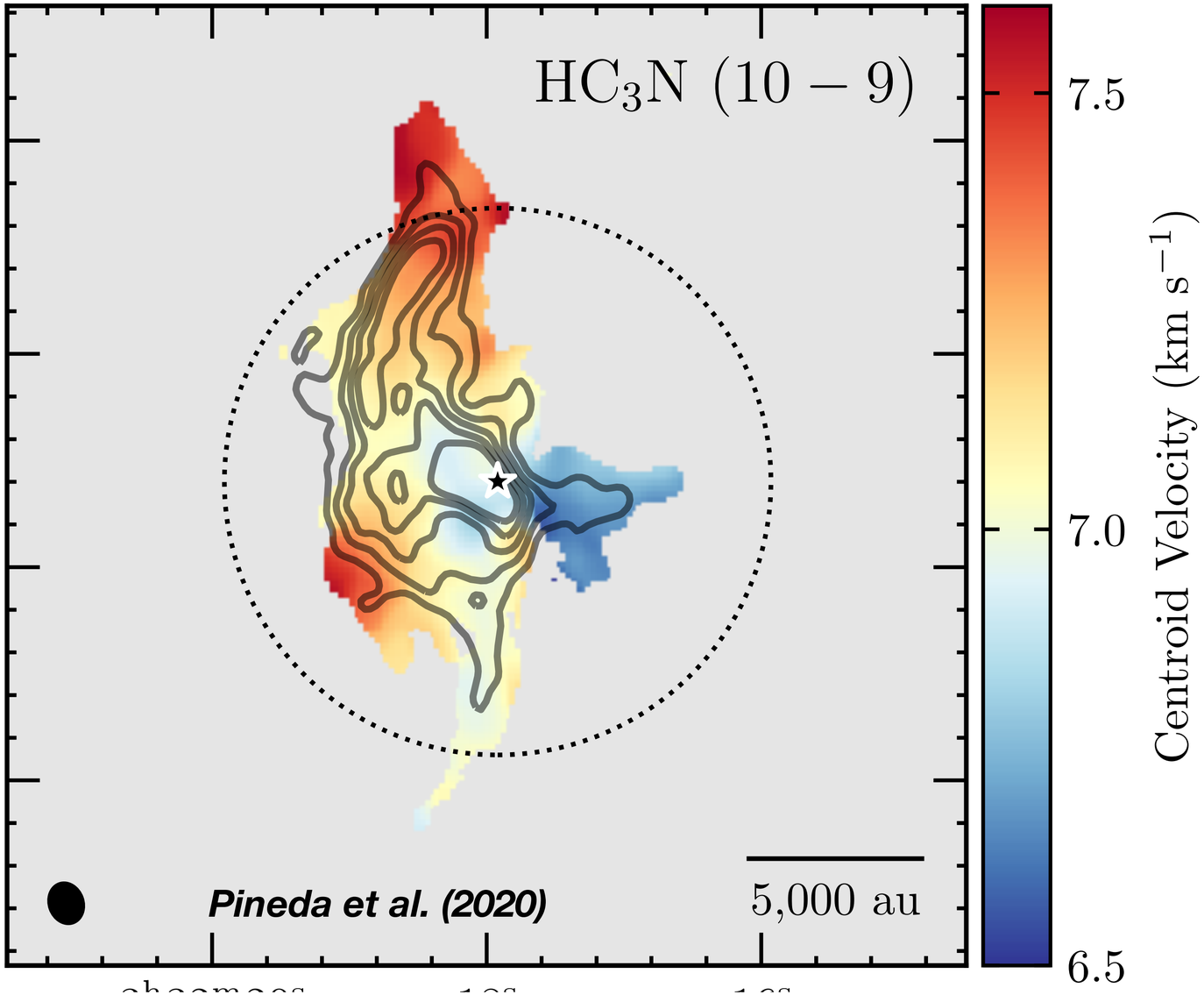
Disk Scale



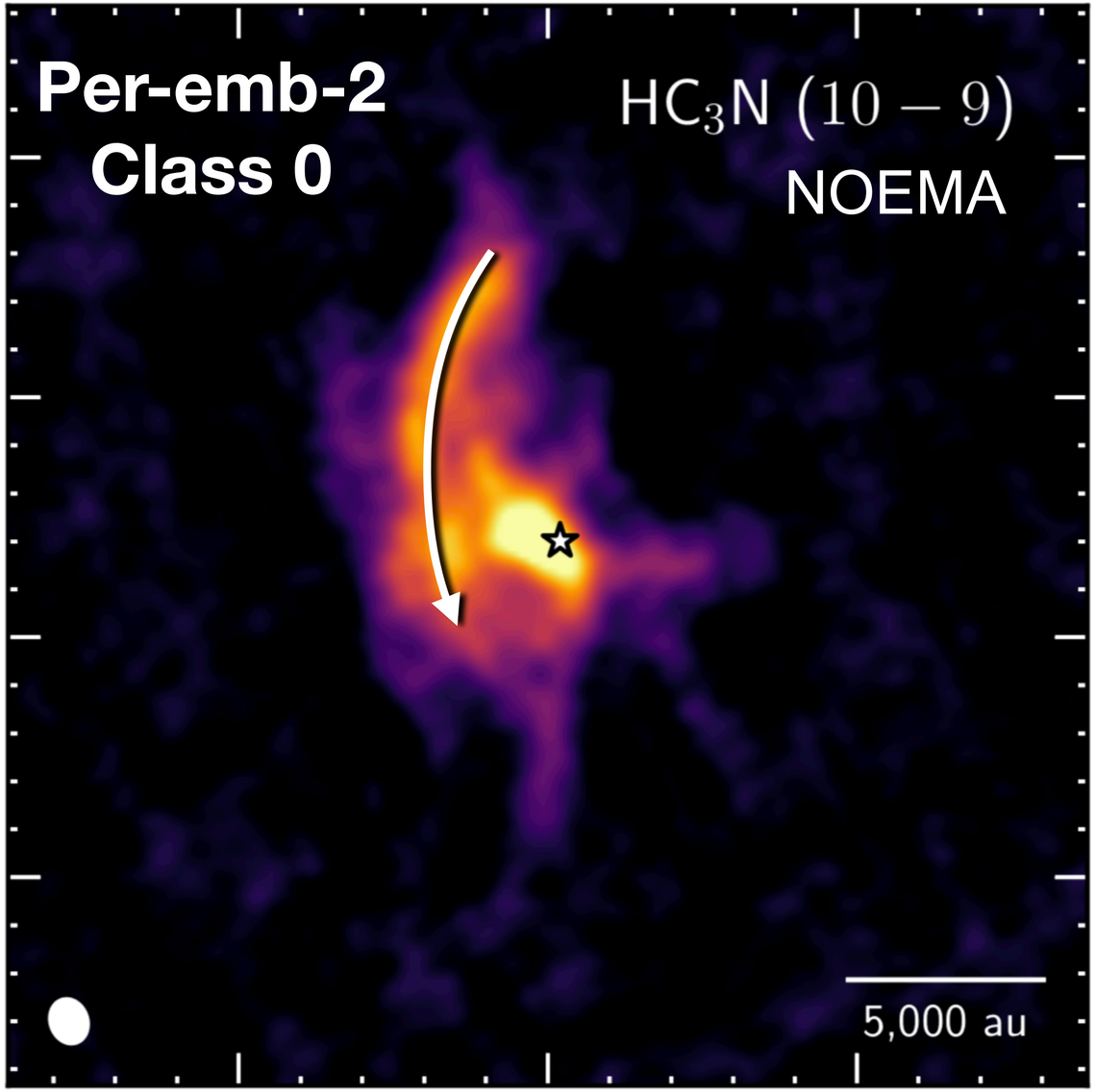

Reprocessed from Tobin et al. (2018)

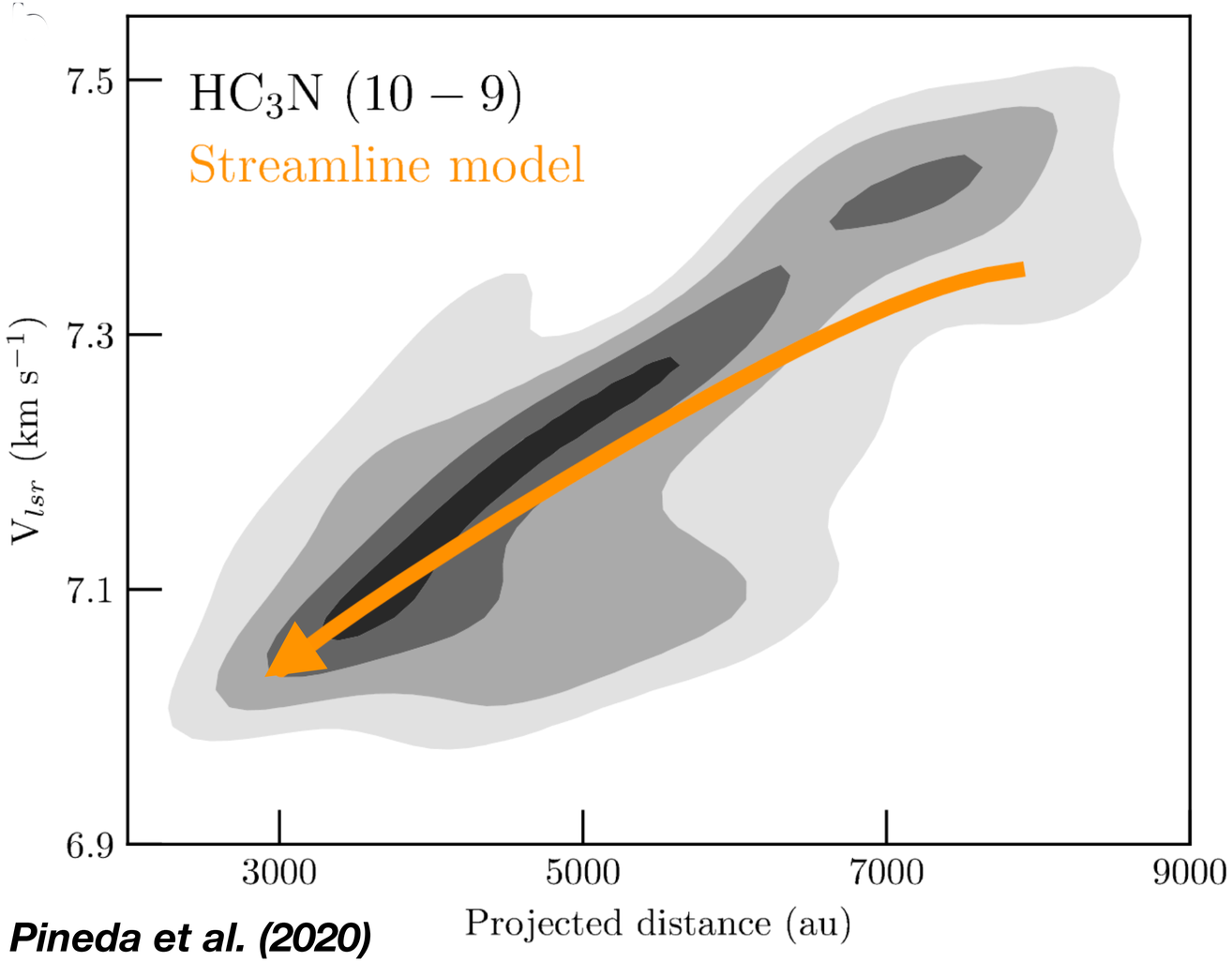
# Streamer: Unrelated to Outflow



# Class 0 Streamer: Infalling Motion

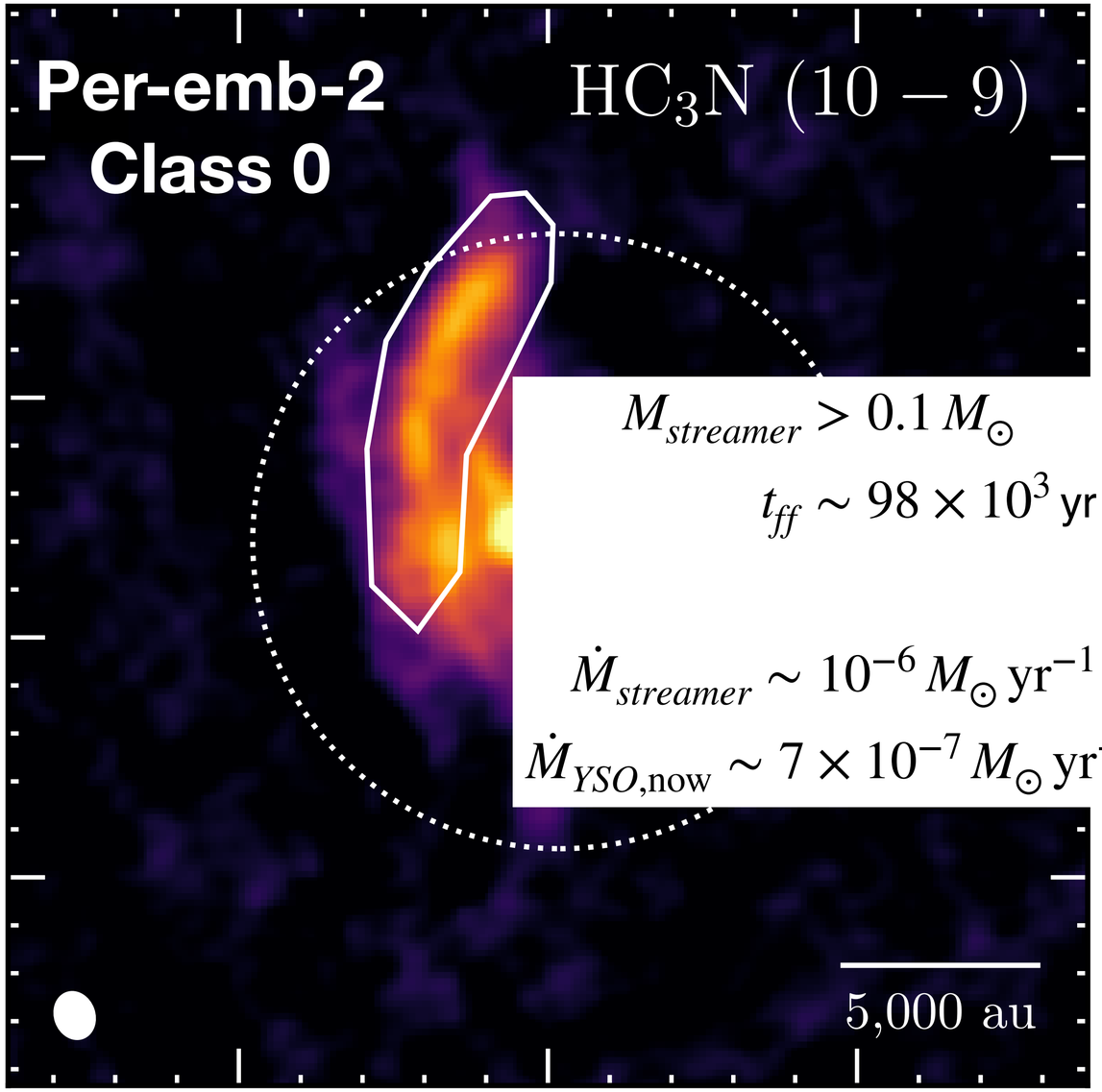


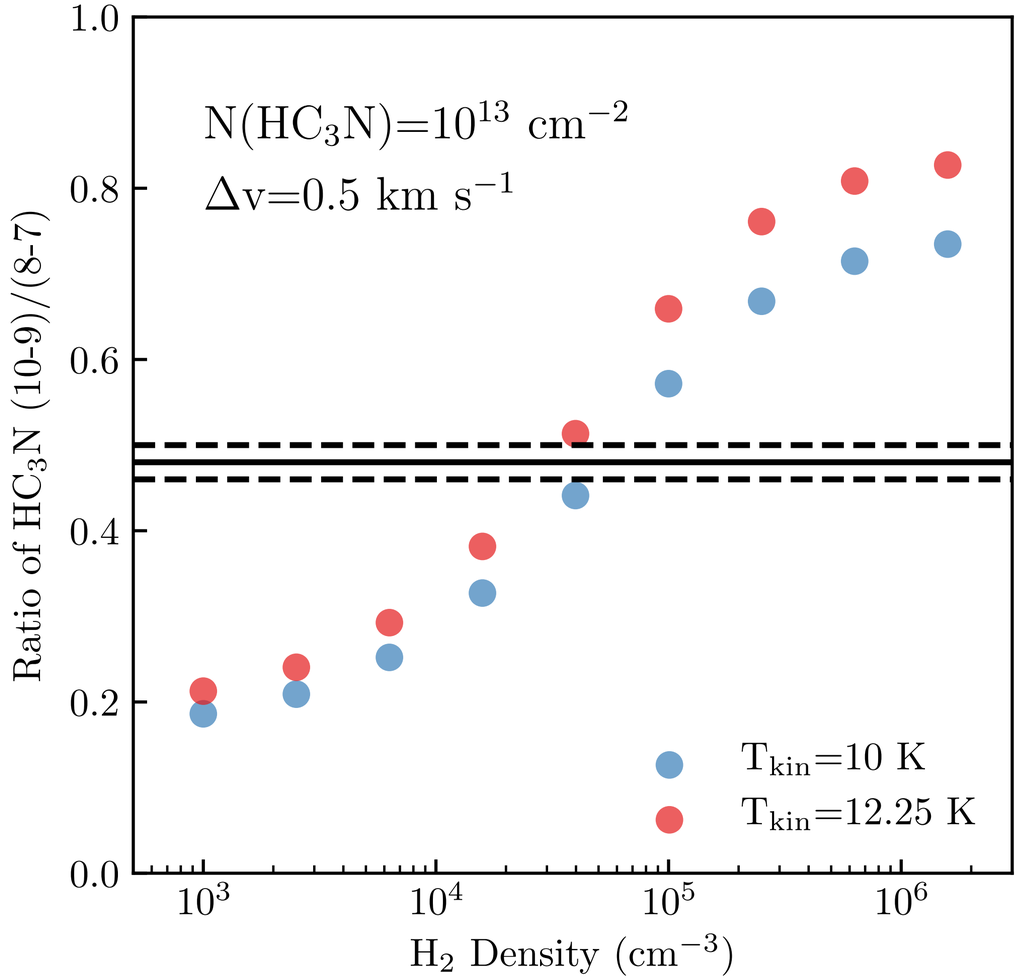




***Pineda et al. (2020)***

**Analytic streamline prescription: *Mendoza et al. (2009)***

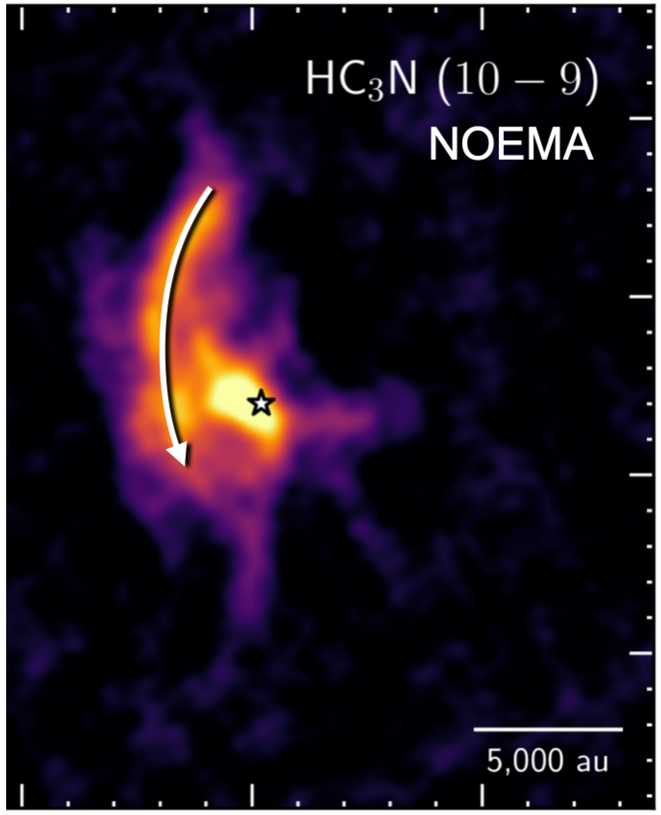
# Streamer Infall Rate is Important




***Pineda et al. (2020)***

# Streamers Important over Multiple Phases




*Pineda et al. (2020)*

Per-emb-2 (Class 0)

Length of 10 500 au

$\dot{M}_{in} \approx 10^{-6}\, M_\odot\, yr^{-1}$

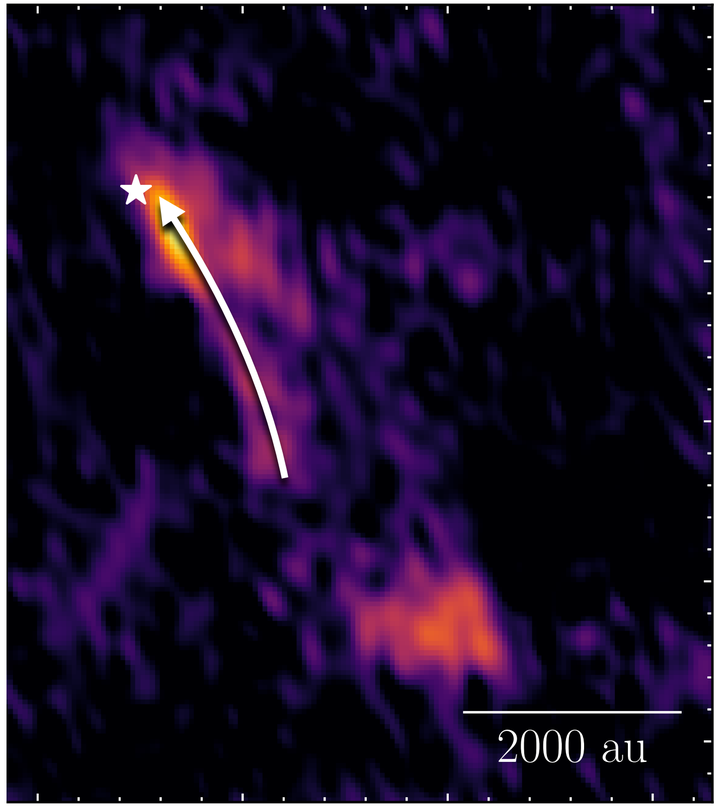
$\dot{M}_{in}/\dot{M}_{acc} \approx 1.4$

Per-emb-50 (Class I)

Length of ~ 3000 au

$\dot{M}_{in} \approx 1.3 \times 10^{-6}\, M_\odot\, yr^{-1}$

$\dot{M}_{in}/\dot{M}_{acc} \approx 1 - 2$




*Valdivia-Mena et al. (2020)*

# Questions about Streamers

**How common are they?**

**How long are streamers?**

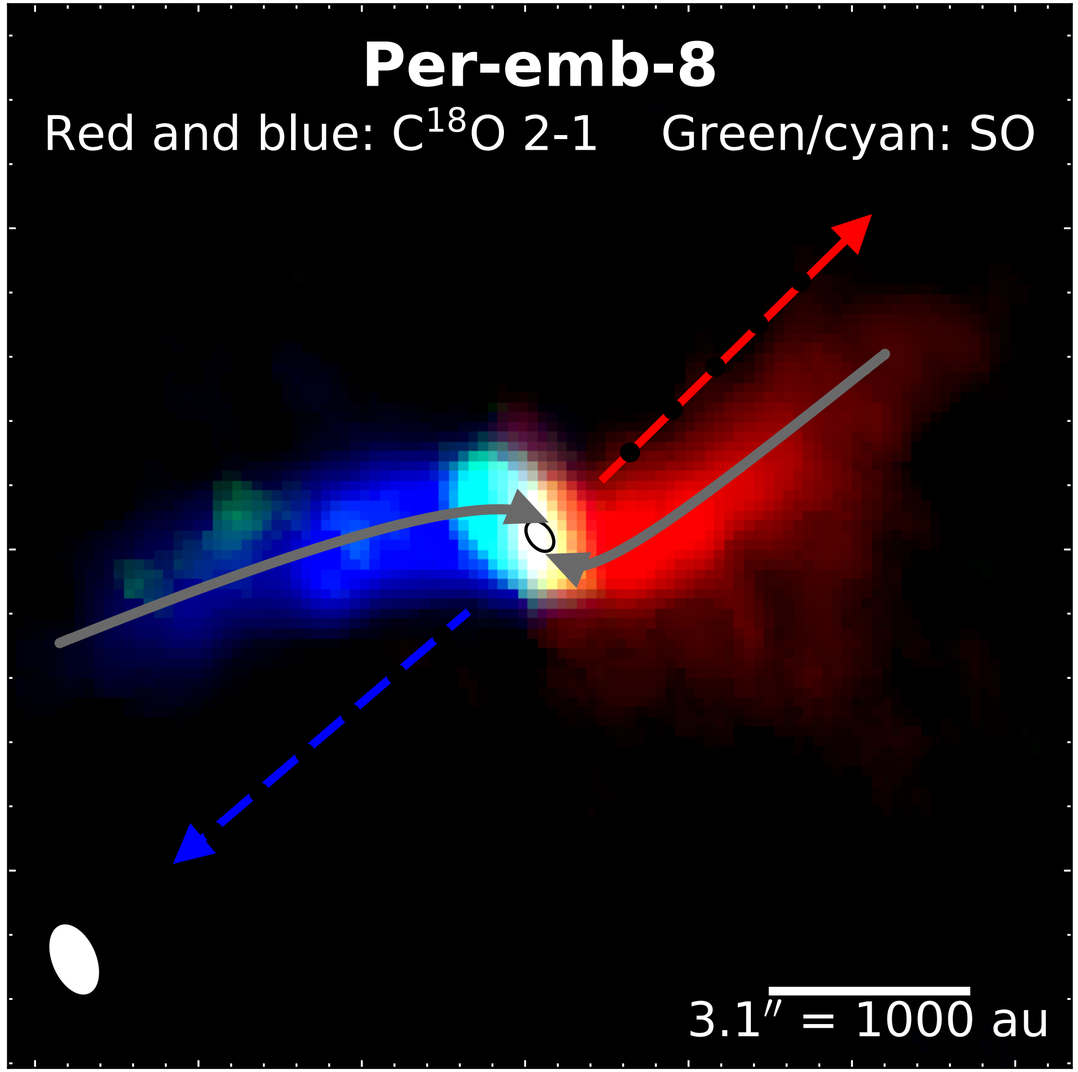
**What are the best tracers to find streamers?**

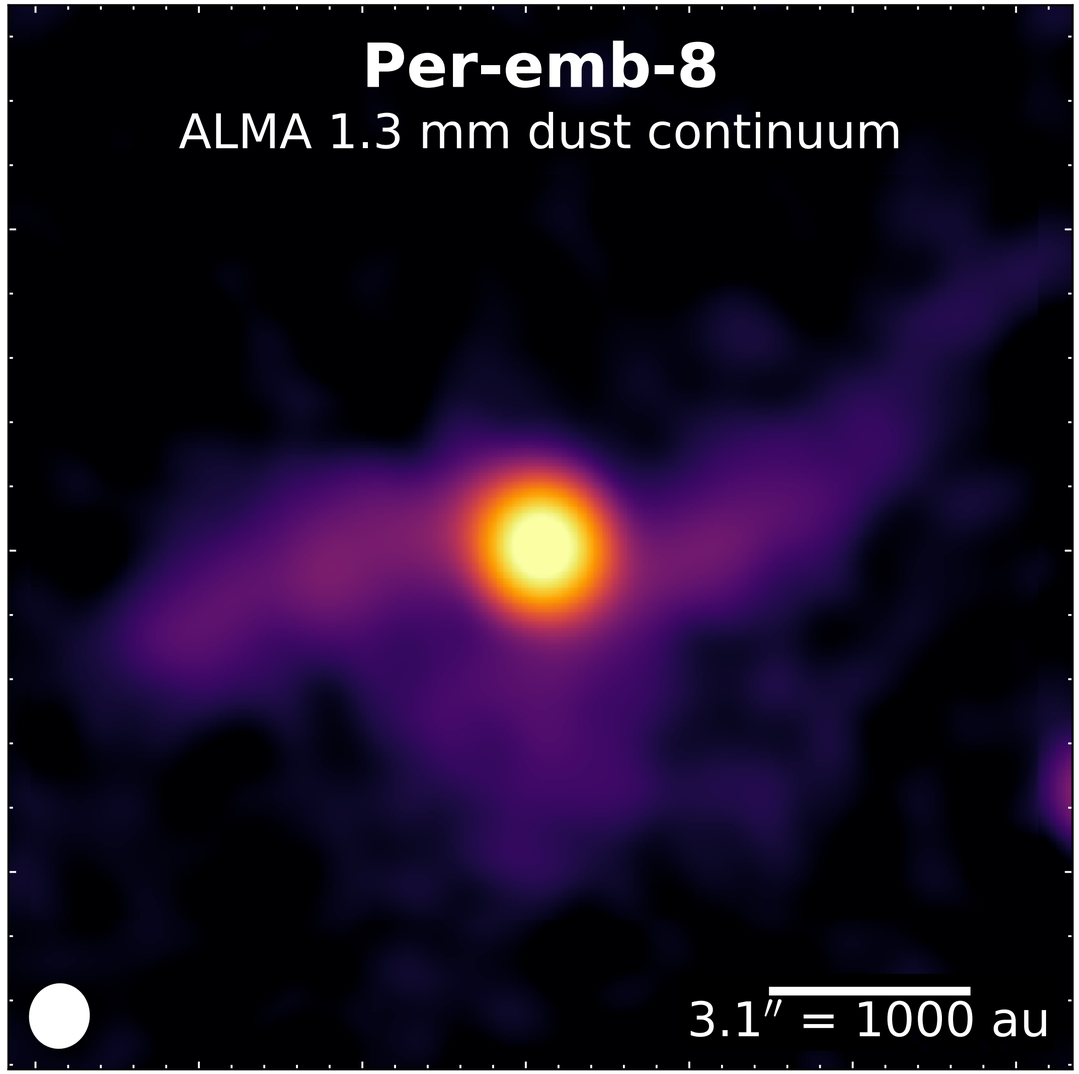
**How dominant are they in the mass accretion process?**

**Do they modify the chemical composition of the disk?**

**Are streamers present in previous numerical simulations?**

# Infalling Streamers with Dust?



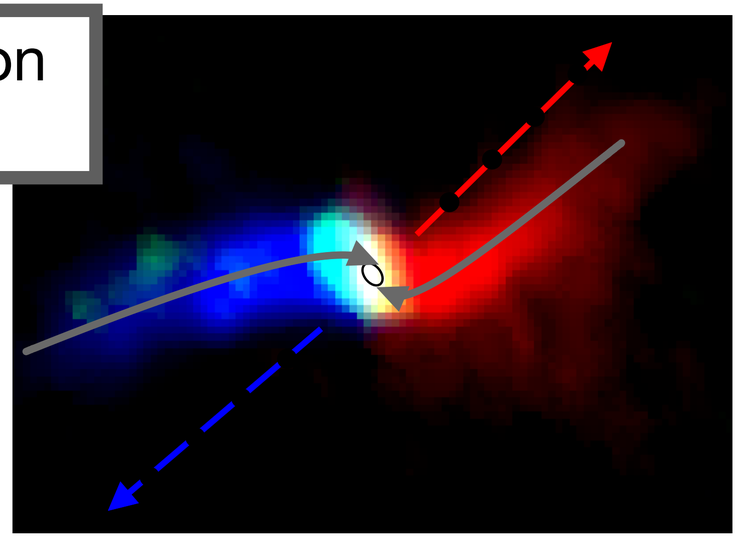

***Segura-Cox et al. in prep***

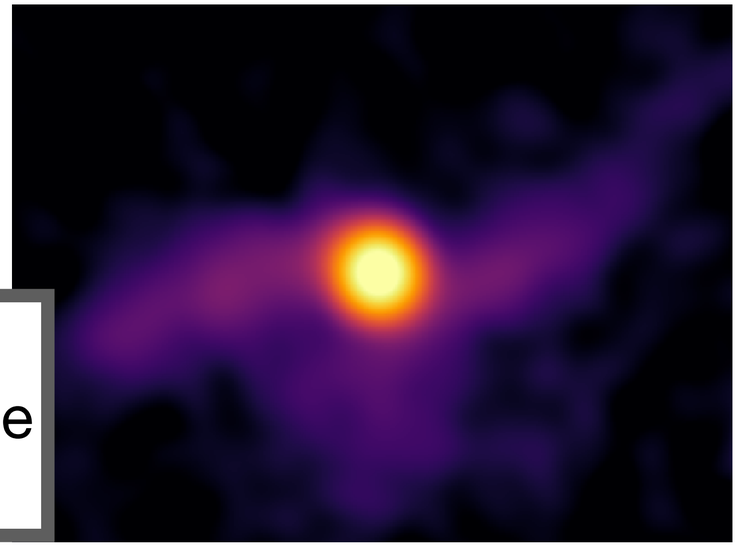
# Measure the Magnetic Field?

velocity dispersion
+ 3D geometry

**B-field orientation + strength**

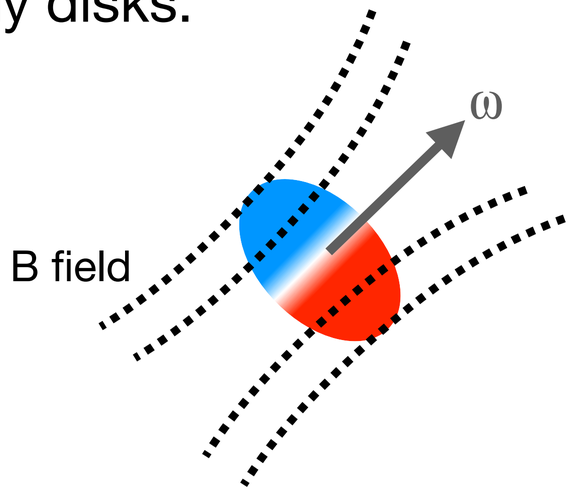
density + polarization angle dispersion





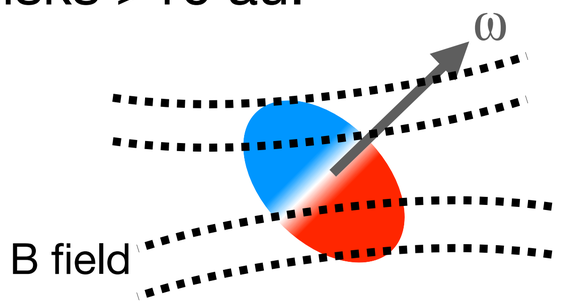
*Segura-Cox et al. in prep*

To get tiny disks:




and/or
strong field

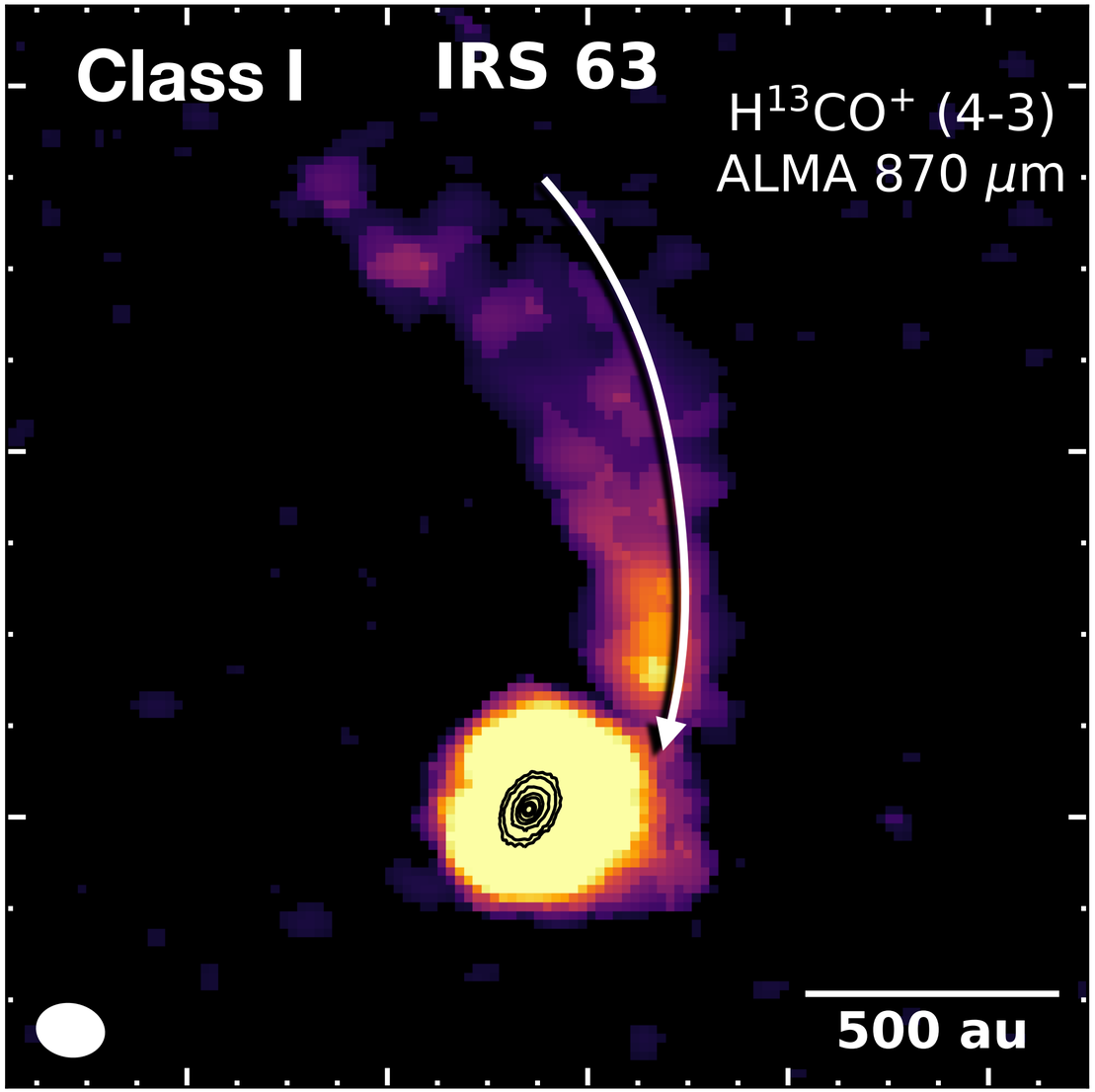
To get disks >10 au:

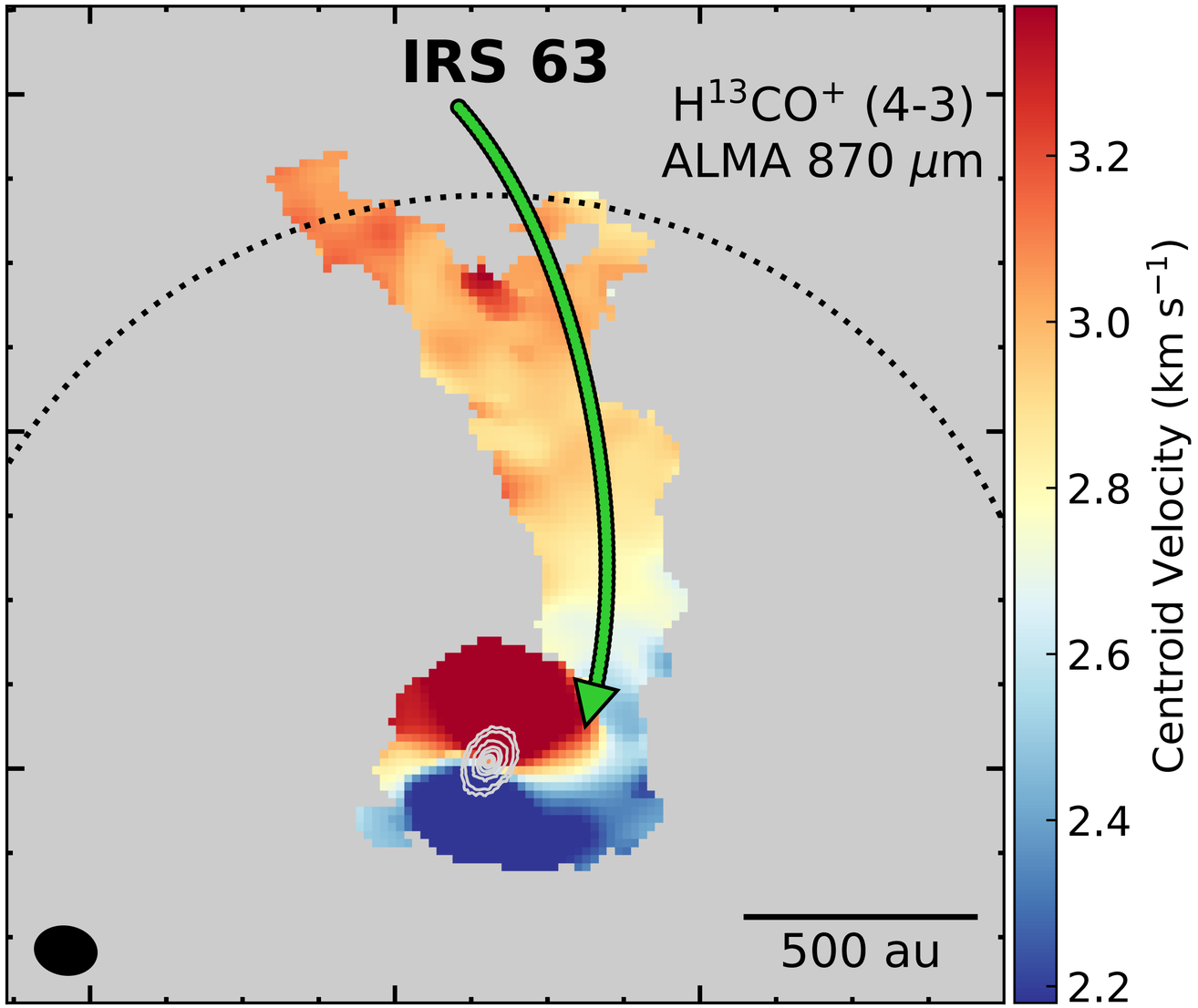



and/or
weak field

*Joos et al. 2012, Li et al. 2013*

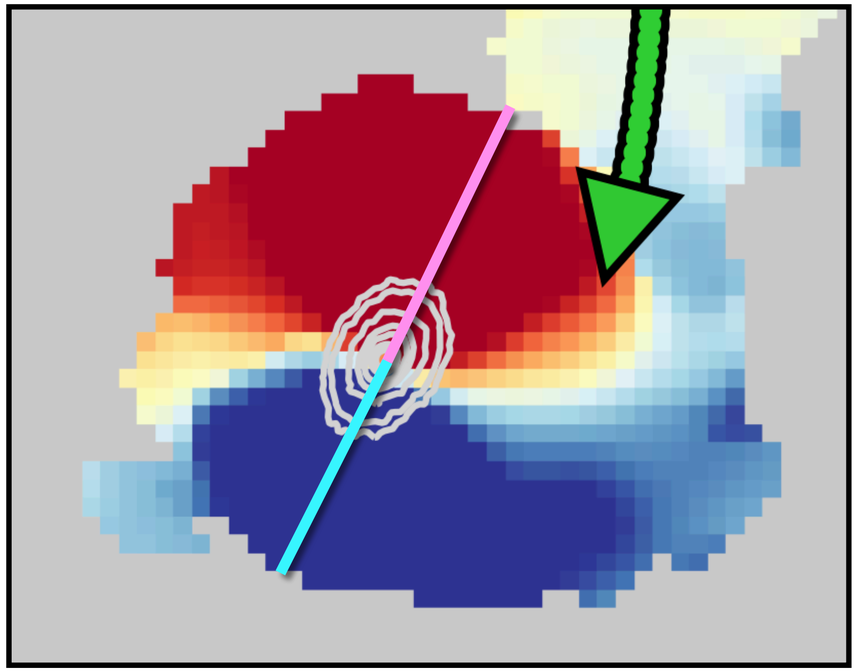
# A Streamer Smoothly Joining the Disk

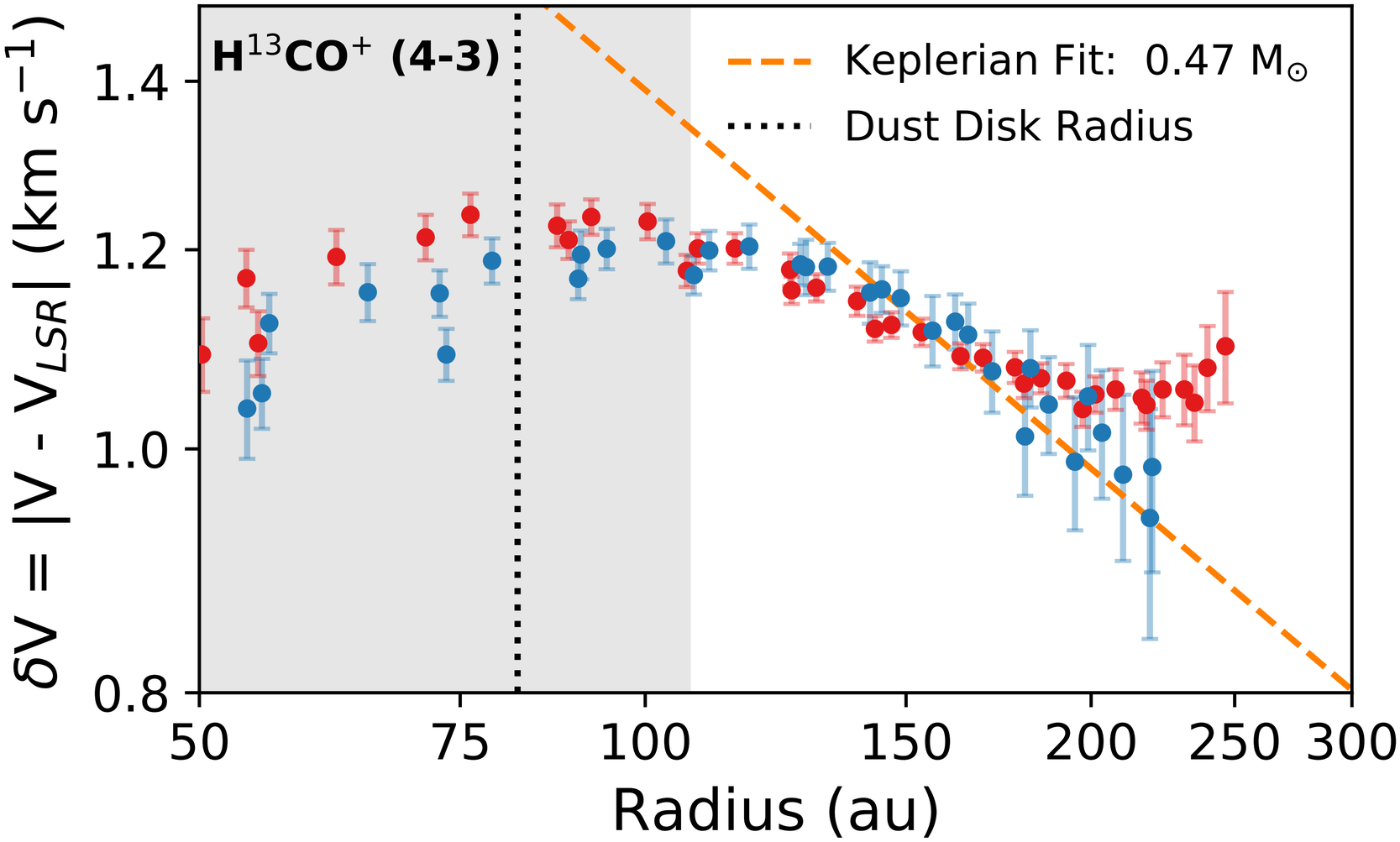



*Segura-Cox et al. in prep*

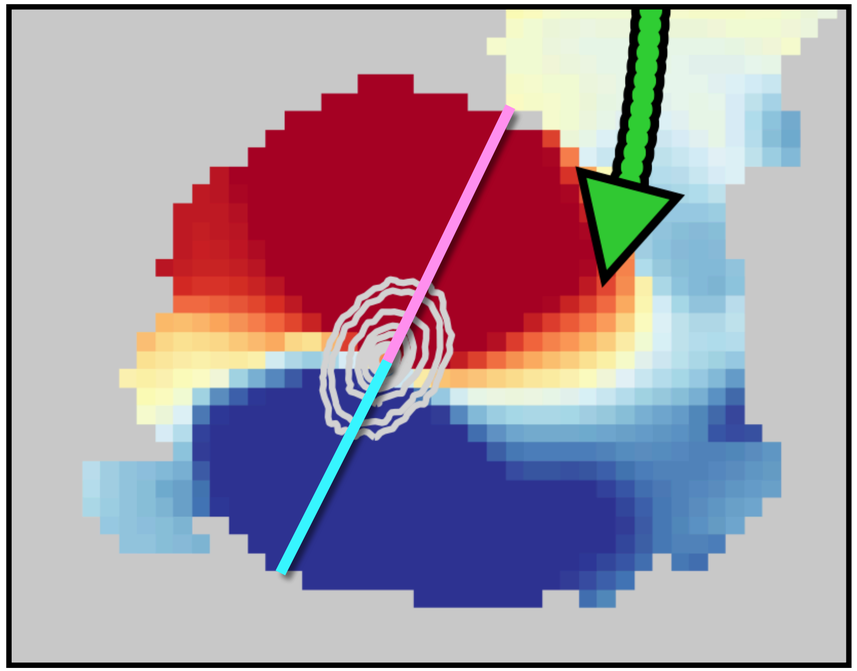
# Asymmetry in the Gas Disk

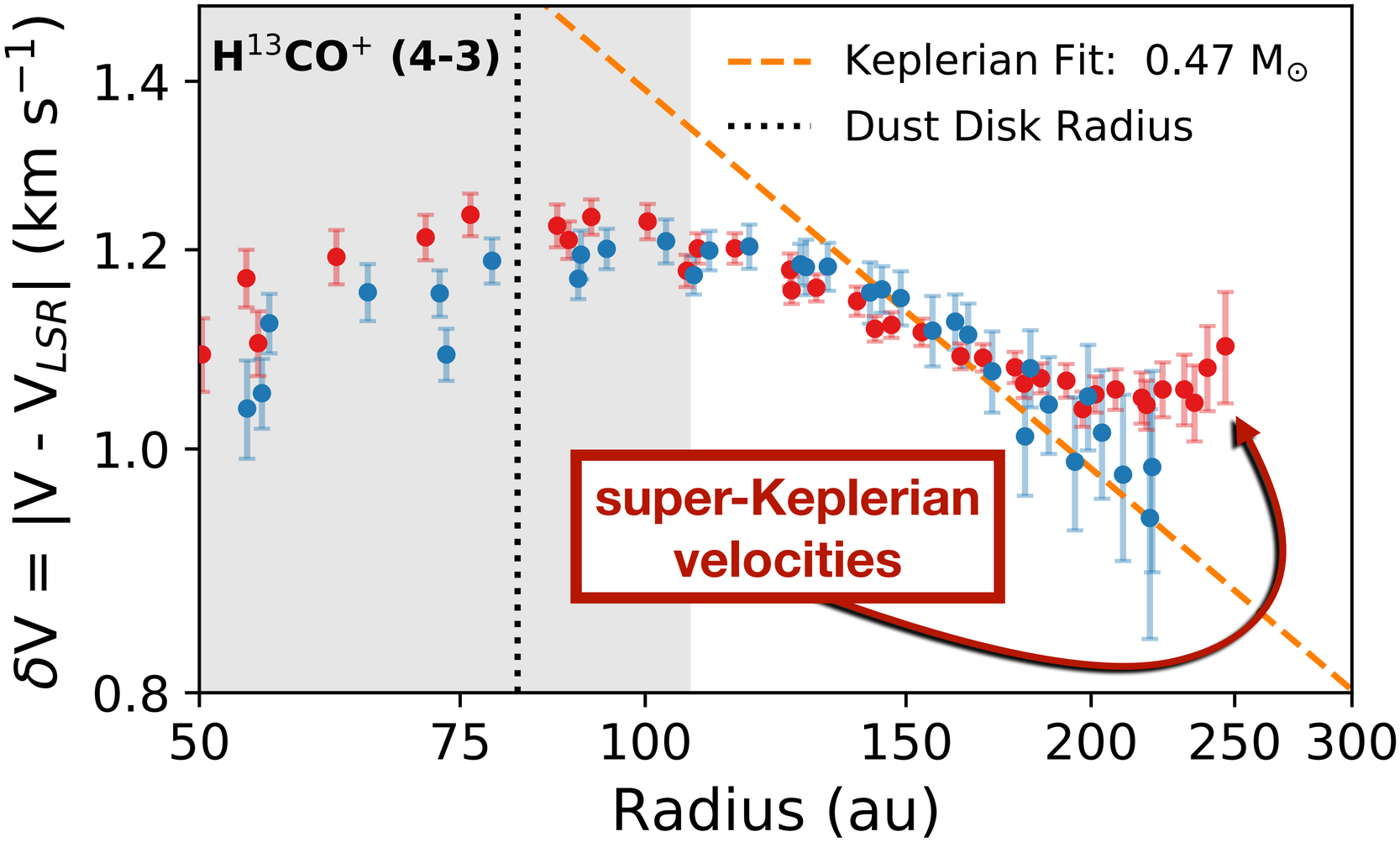





***Segura-Cox et al. in prep***

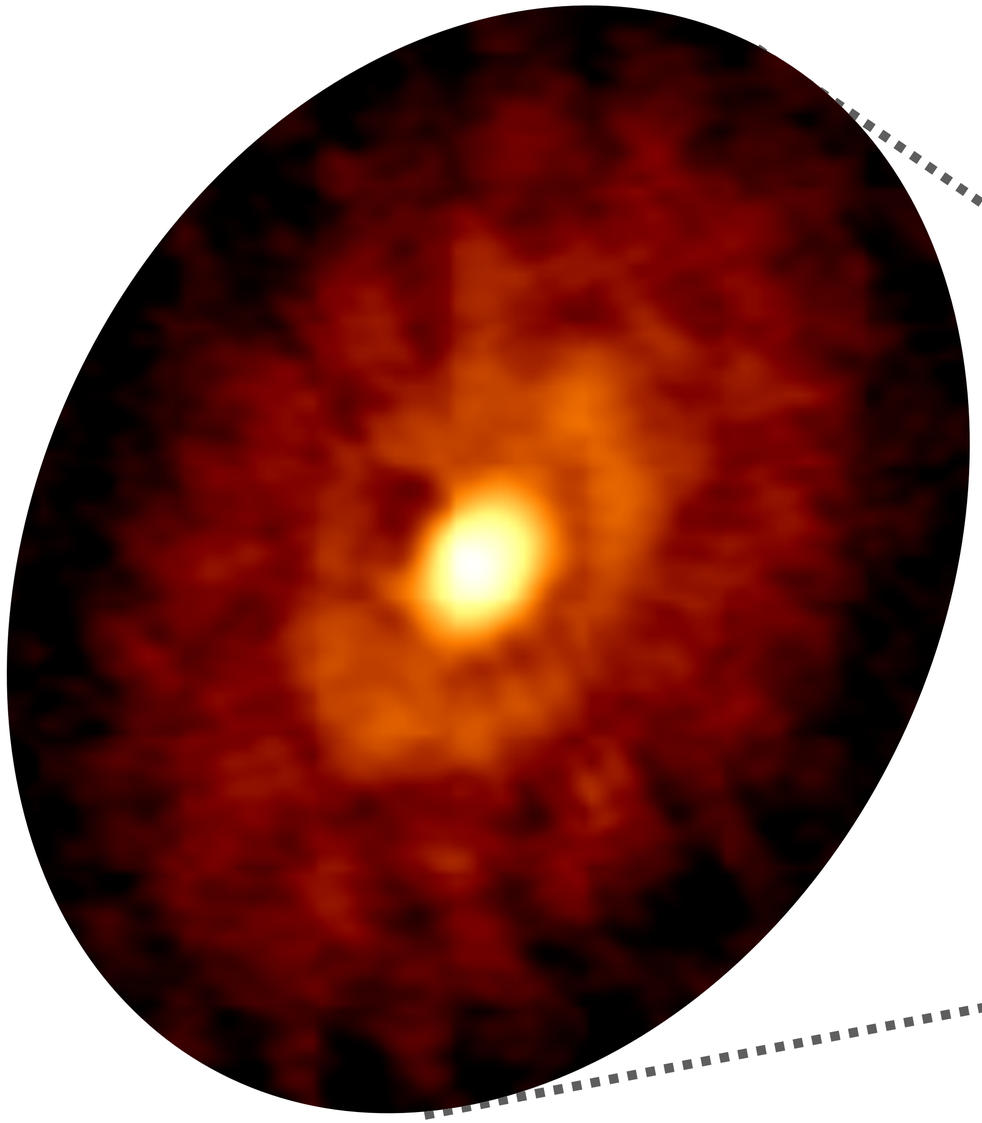
# Streamer Causes Gas Disk to Spread?

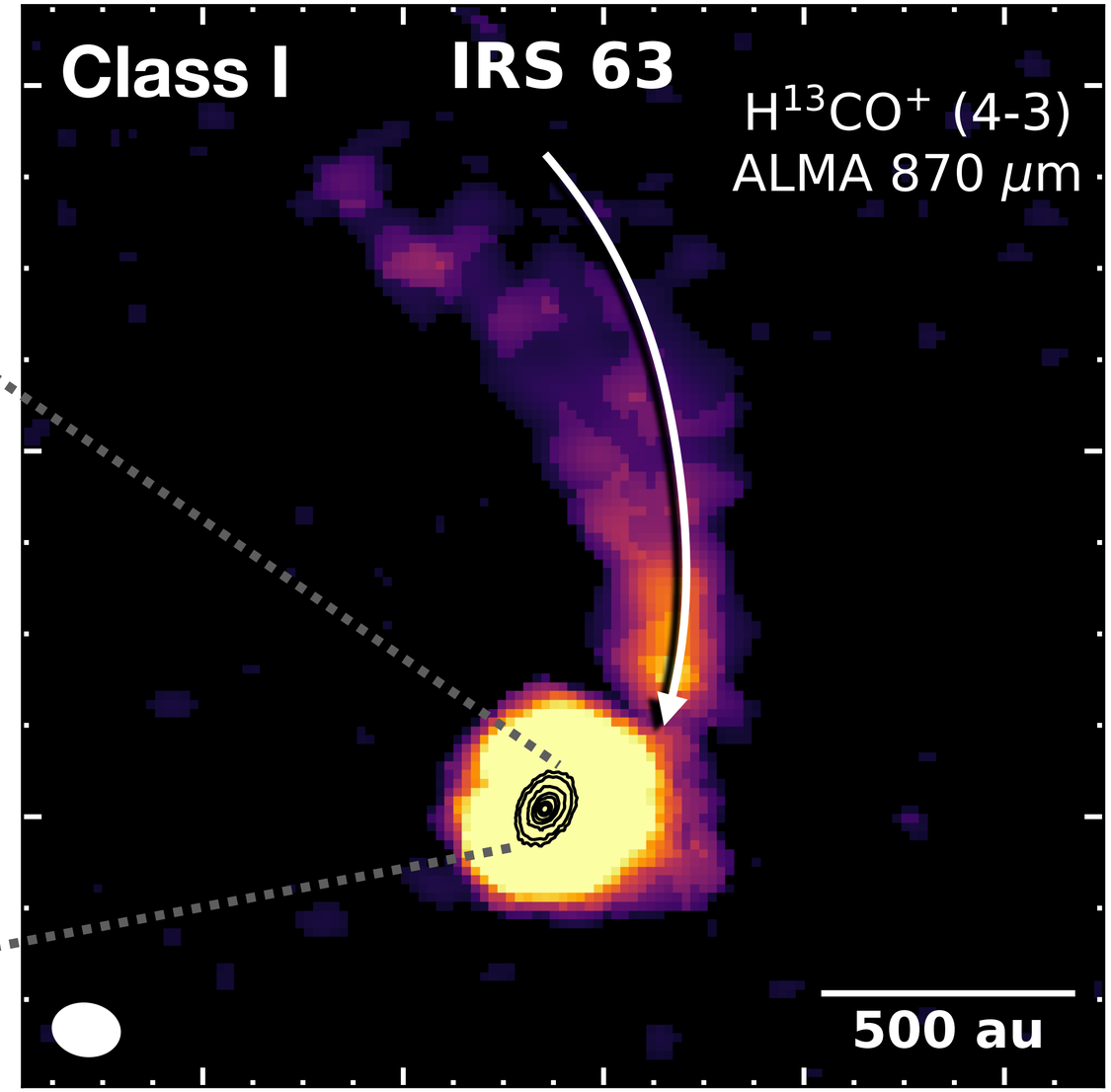





*Segura-Cox et al. in prep*

# Streamer Feeds a Ringed Disk





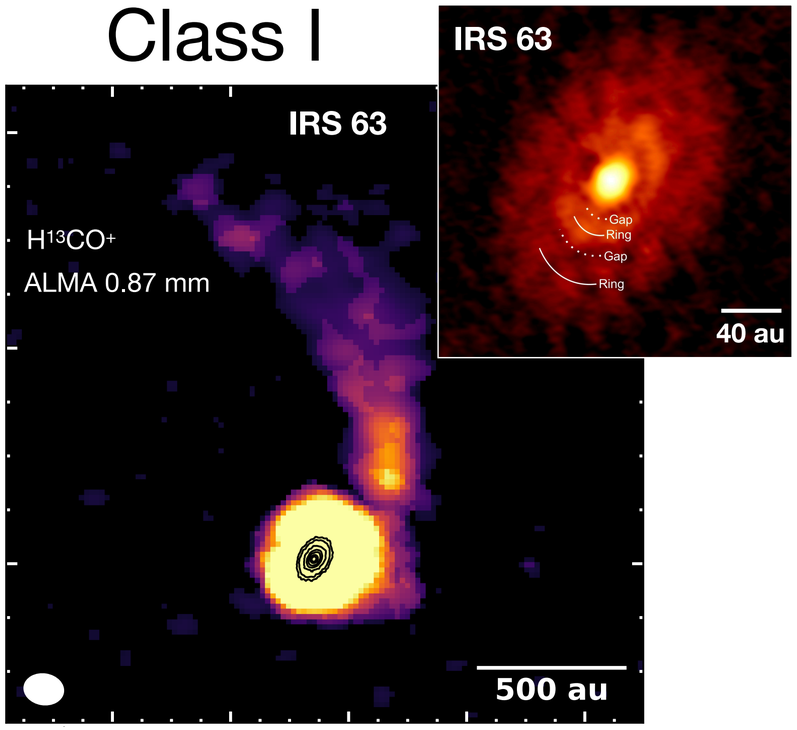

*Segura-Cox et al. (2020)*

*Segura-Cox et al. in prep*

# More Young Rings & Streamers

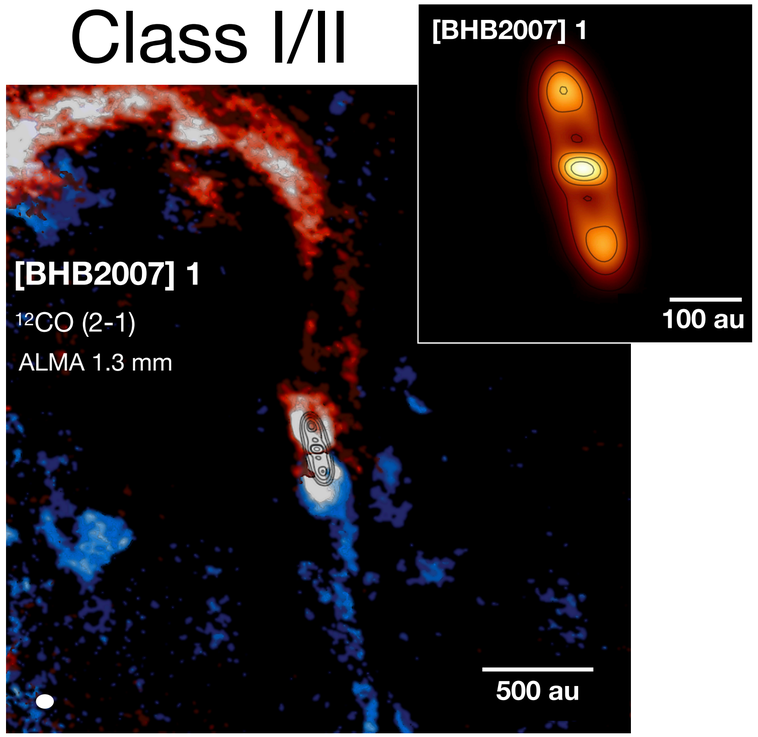
**Could these streamers help form the young dust rings?**

## Class I



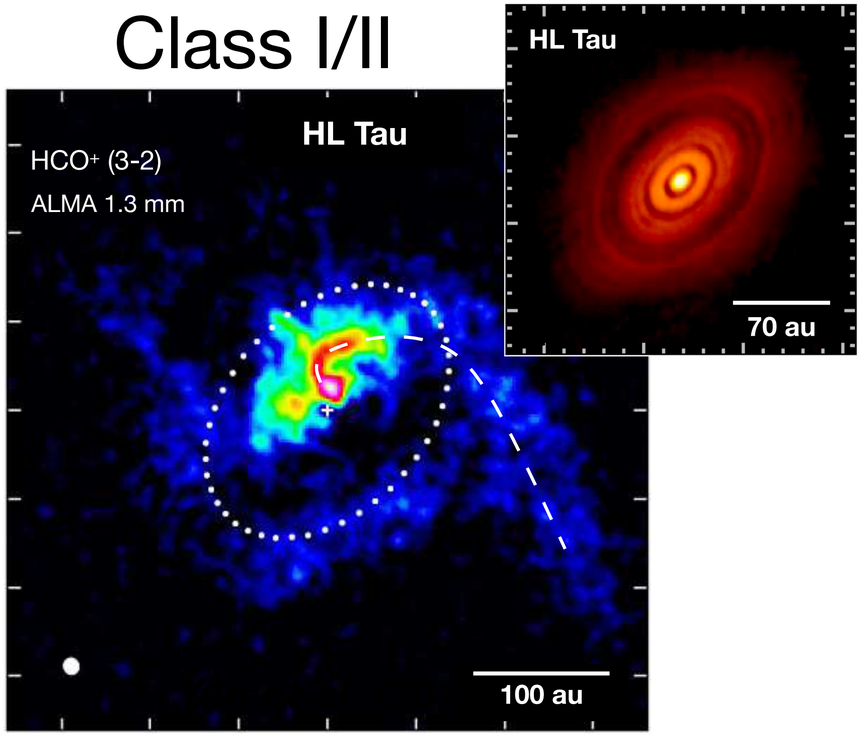

*Segura-Cox et al. in prep*
*Segura-Cox et al. (2020)*

## Class I/II



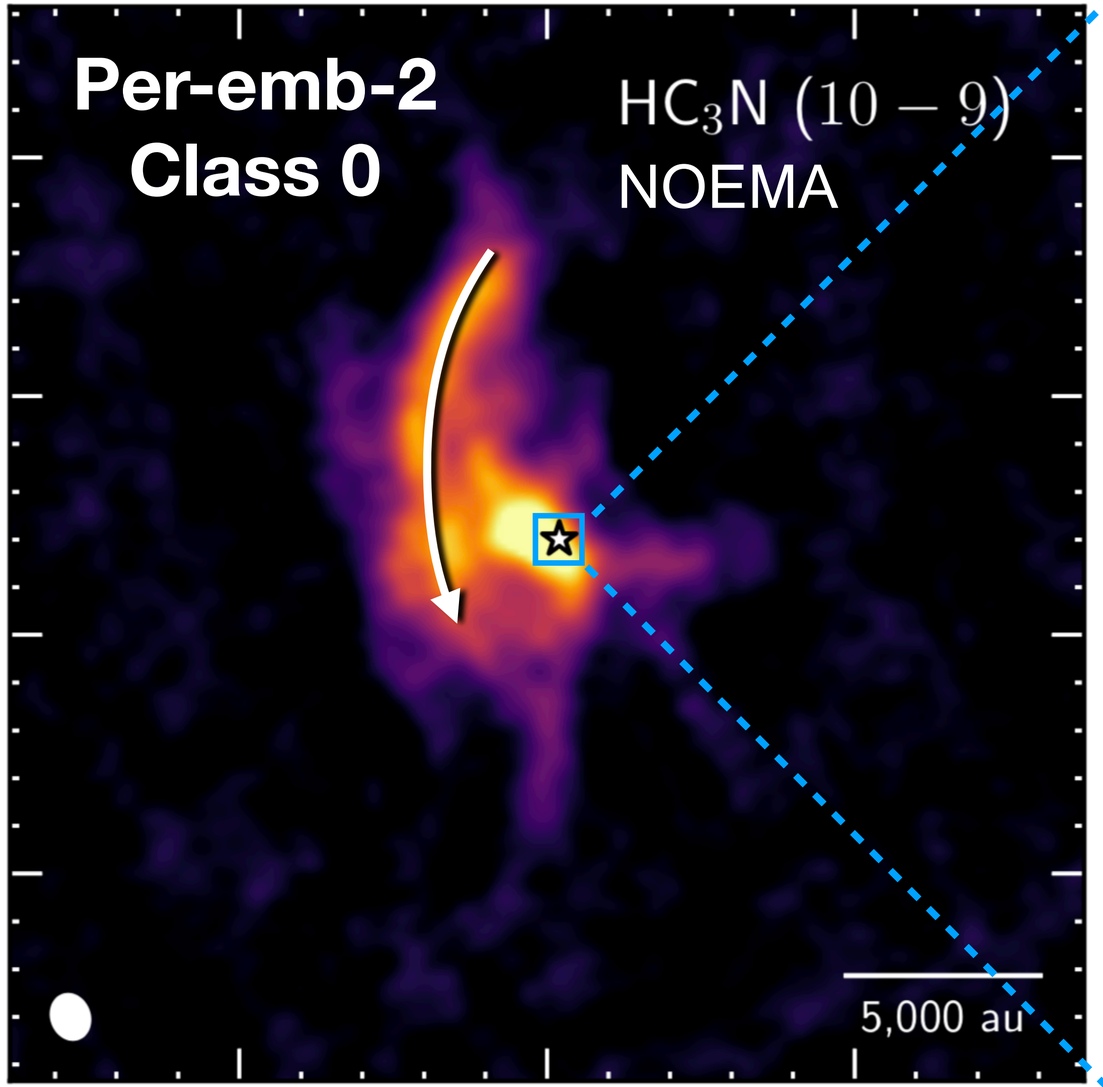

*Alves et al. (2020)*

## Class I/II

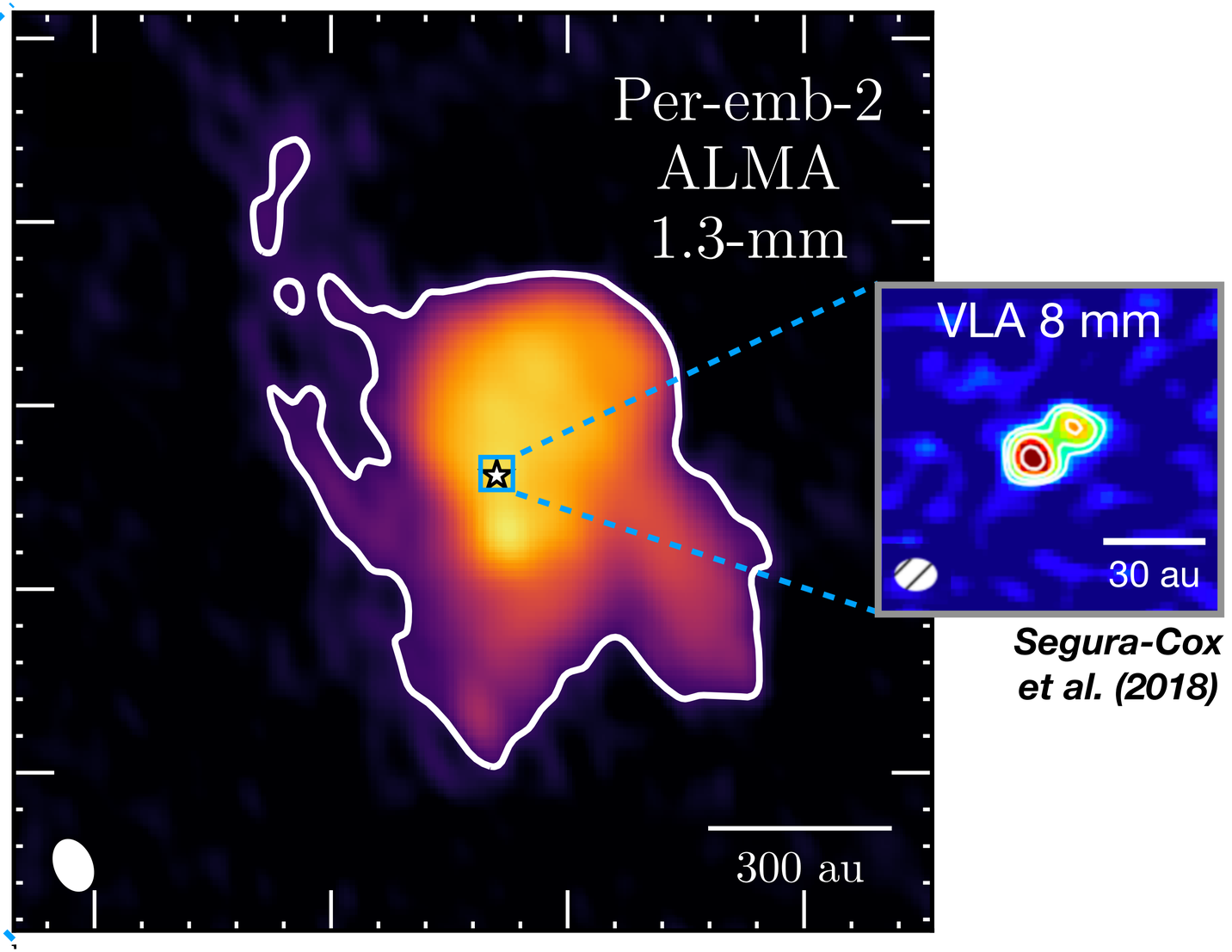



*Yen et al. (2019)*
*ALMA Partnership et al. (2015)*

# Not Always a Well-Formed Disk




Pineda et al. (2020)




Reprocessed from Tobin et al. (2018)

*Segura-Cox et al. (2018)*

# More Questions: Streamers + Disks

**Can streamers let us observe how the magnetic field matters in disk formation?**

**Do streamers cause gas disks to spread?**

**Can streamers form concentric rings, or can they make disks unstable?**