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# SOFIA and ALMA Investigate the Case of the Masquerading Monster in BYF 73

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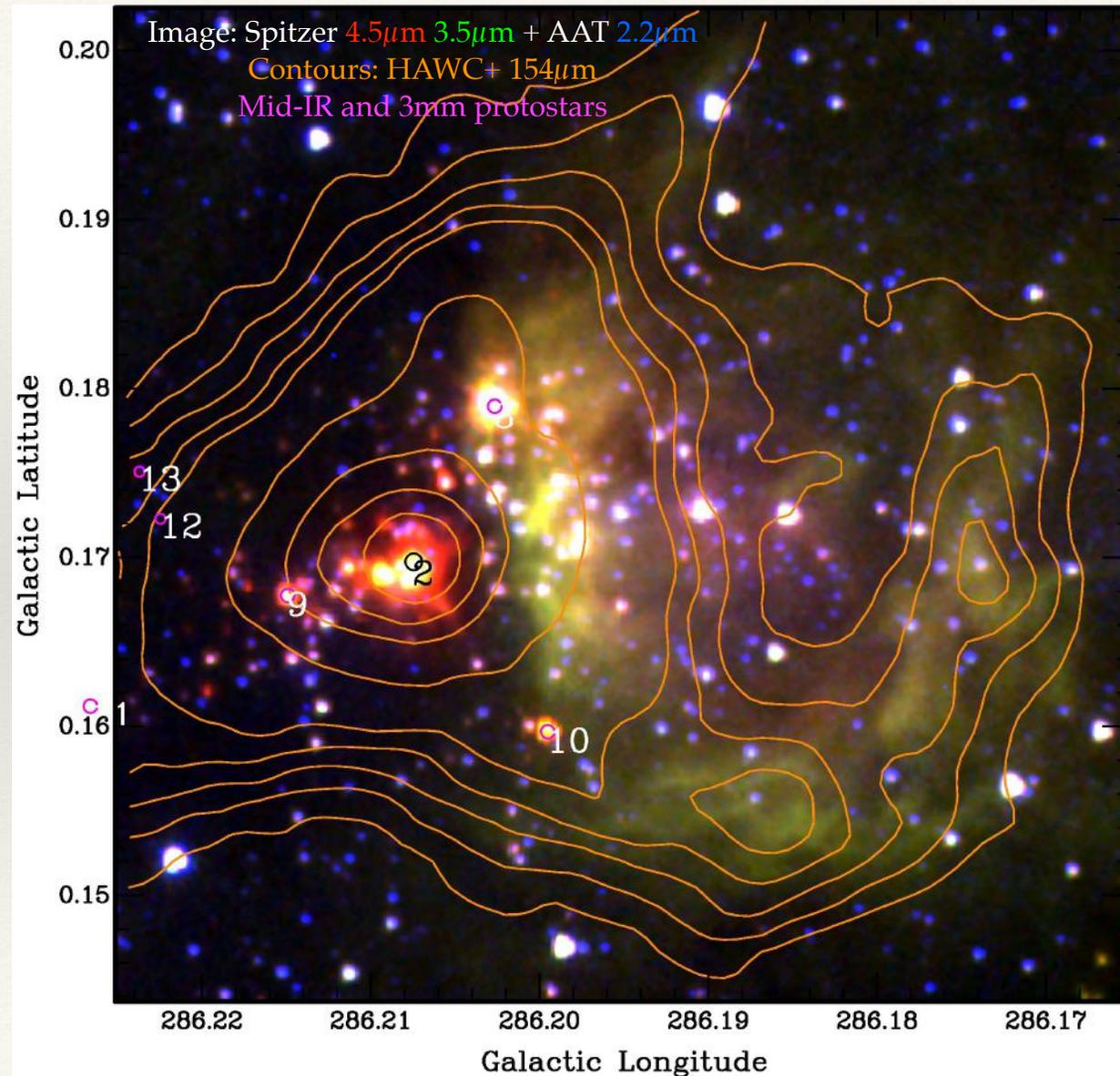
*Thursday 12th January 2023*

[arXiv:2301.03618](https://arxiv.org/abs/2301.03618) (*ApJ*, in press)

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# Cloud 73 from BYF catalog, CHaMP survey

- ❖ Near eta Carinae, 8150 light years away
- ❖ 20,000  $M_{\odot}$  cold cloud, low-power  $H^+$  nebula adjacent
- ❖ Prior Gemini + SOFIA data show most visible stars are foreground, only a few true protostars
- ❖ Most massive protostar is MIR 2 at 240  $M_{\odot}$ , with **strongest mass inflow known**

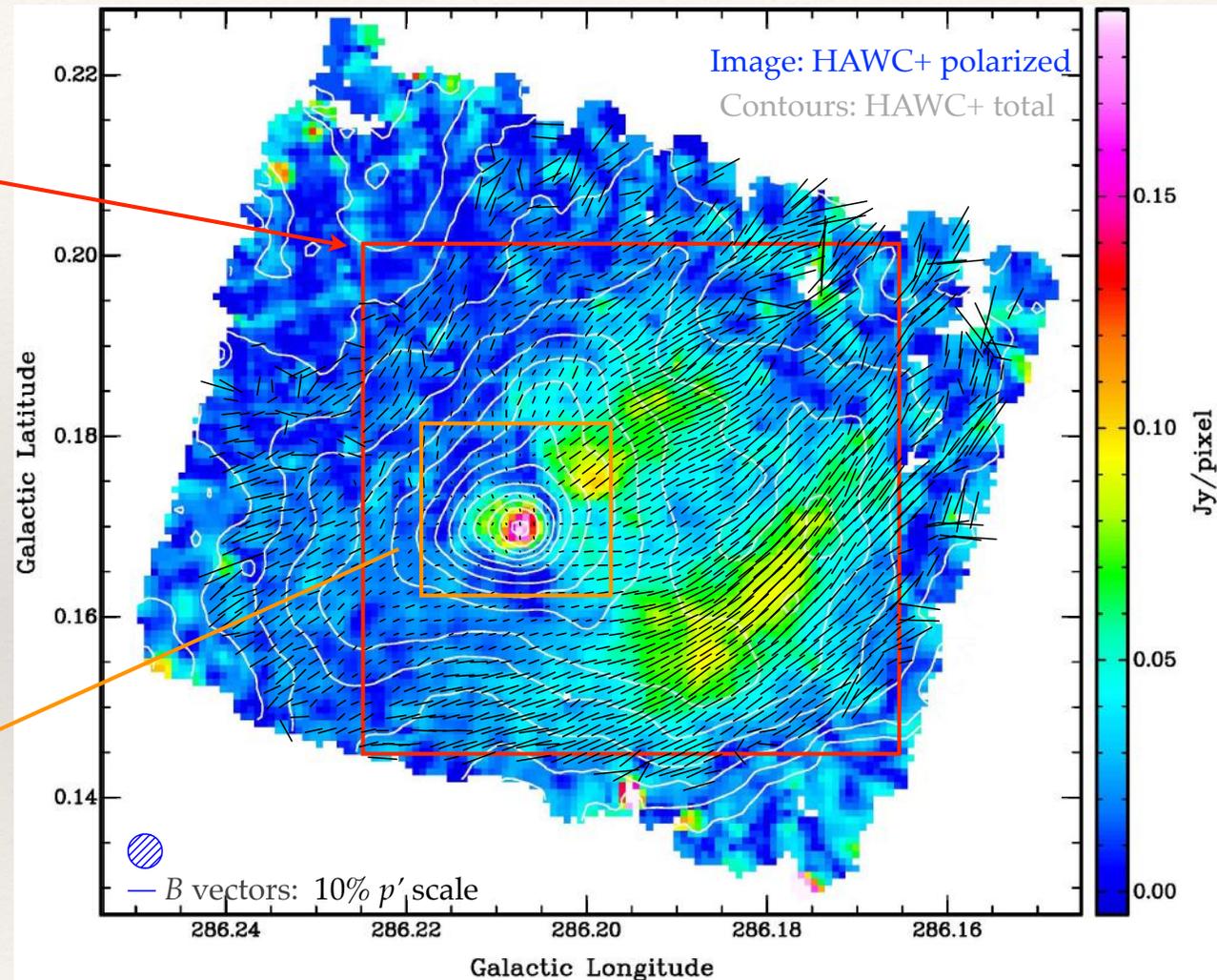
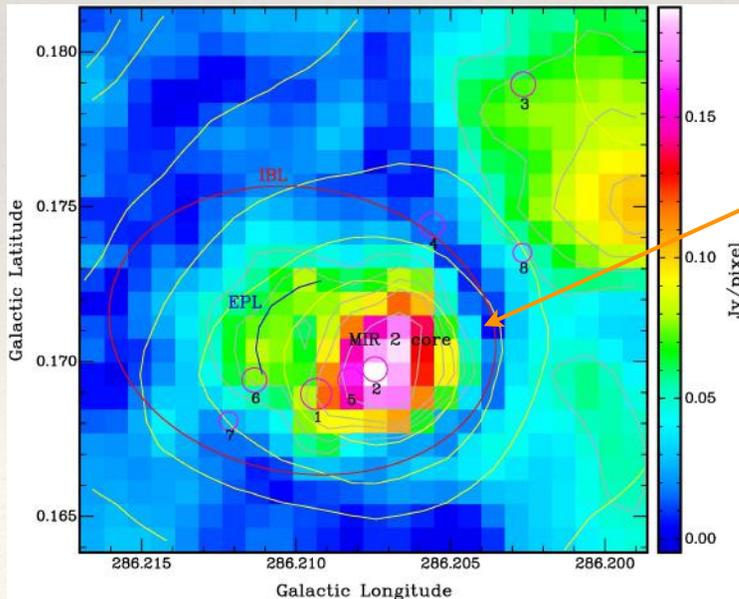


# SOFIA far-IR maps warm dust

Polarization maps magnetic fields

Zoom-out from last slide:  
strong polarization in  $H^+$  nebula

Zoom-in to **MIR 2 core**: sharp  
boundary with zero magnetic  
field; weak polarization in core +  
eastern lobe (EPL)



# ALMA maps cold dust

Zoom back out:

ALMA mosaic

HAWC+ contours

→ Very few cold protostars besides MIR 2, but a massive “Streamer” and “Hole”

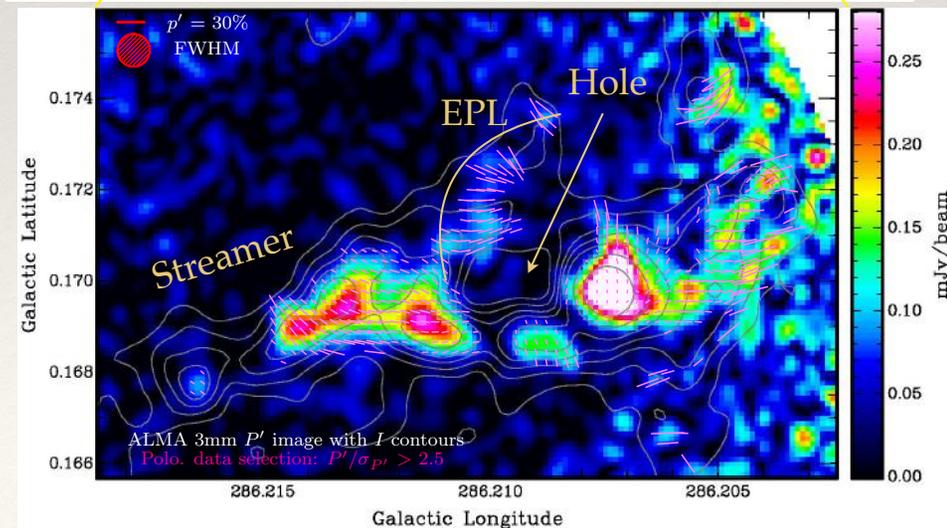
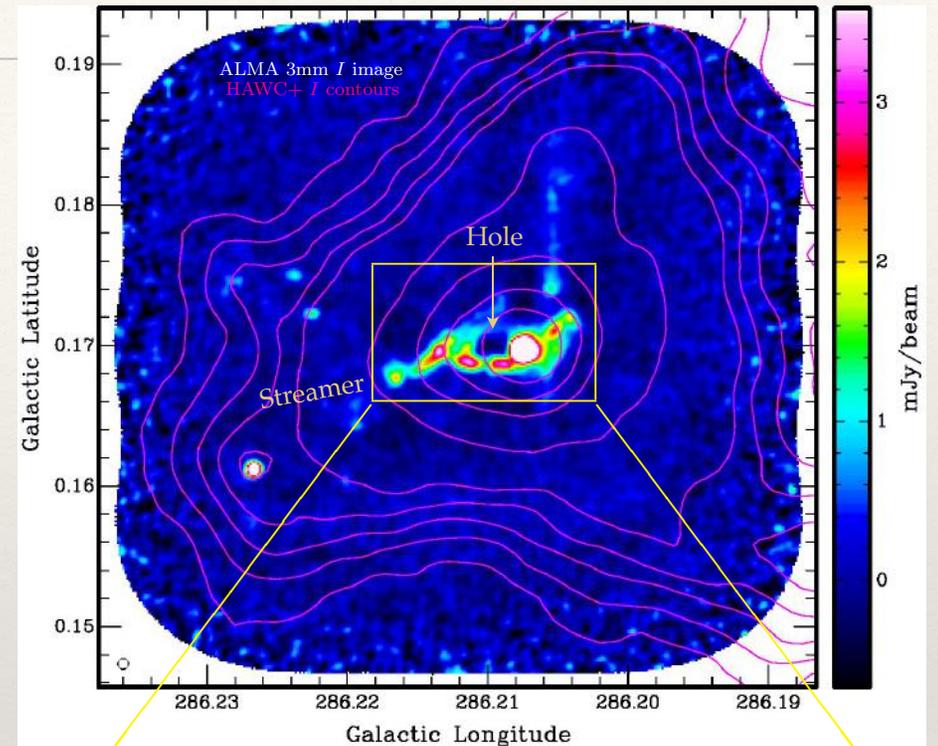
Zoom back in:

ALMA polarization in cold dust

Contours: ALMA mosaic

Magnetic field: strong signal!

→ Limited polarized emission area

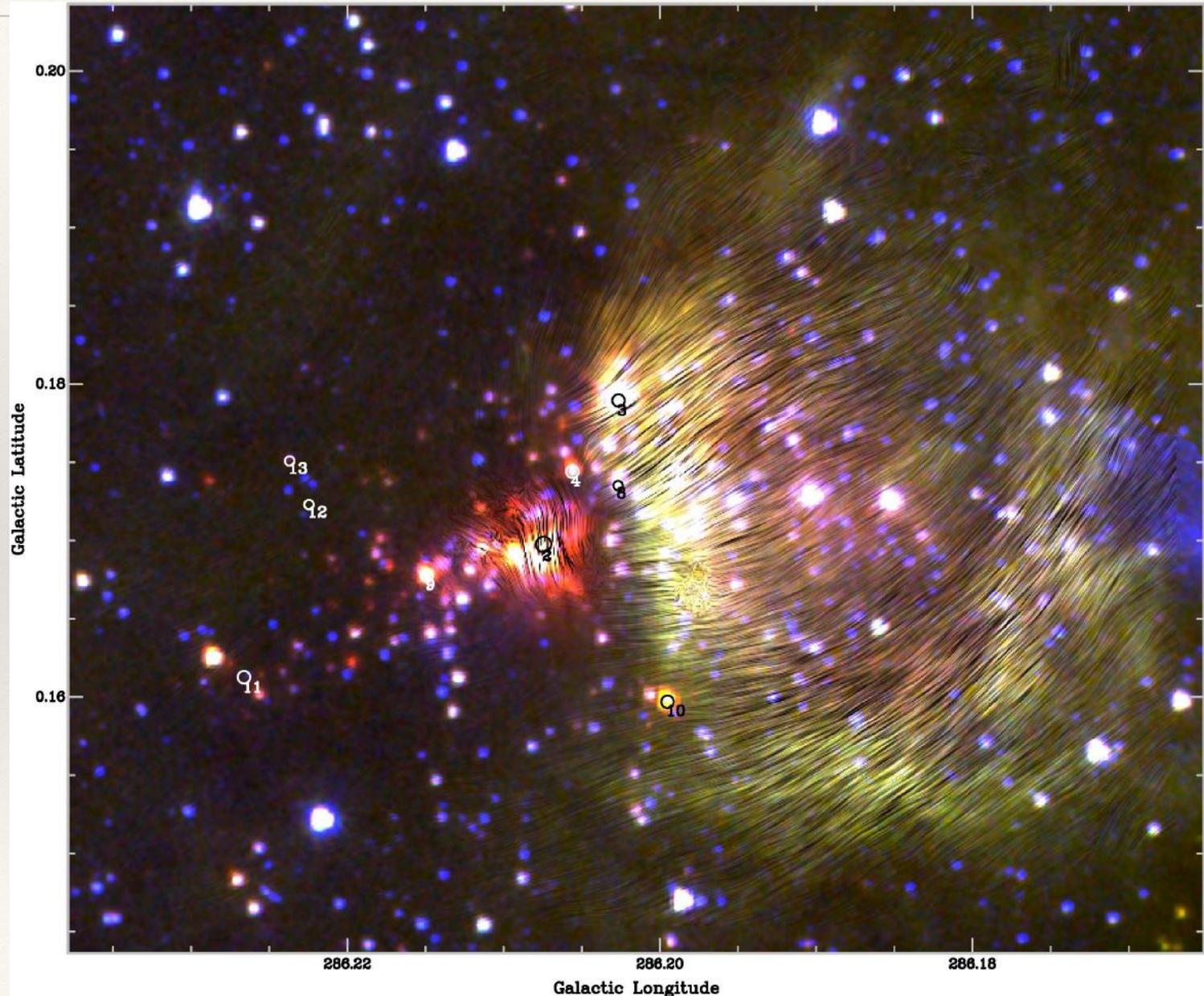


# Infrared composite with field lines

Background =  
same **Spitzer** +  
**AAT** from earlier

Overlaid  
magnetic field  
pattern from  
SOFIA / HAWC+  
far-IR warm dust

Numbered  
protostars from  
Gemini + ALMA



# Spitzer-SOFIA-ALMA composite with field lines

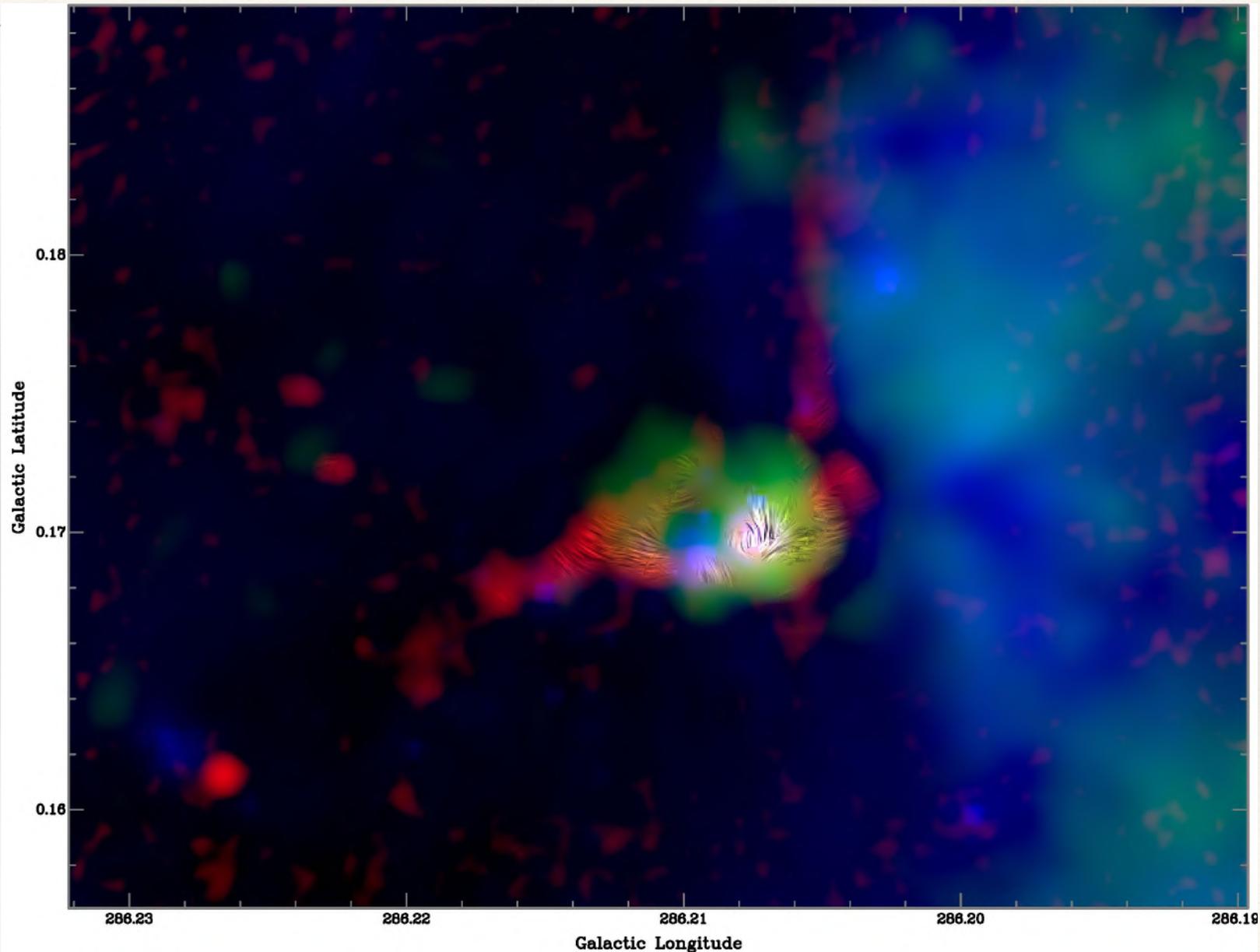
Background =

ALMA

SOFIA

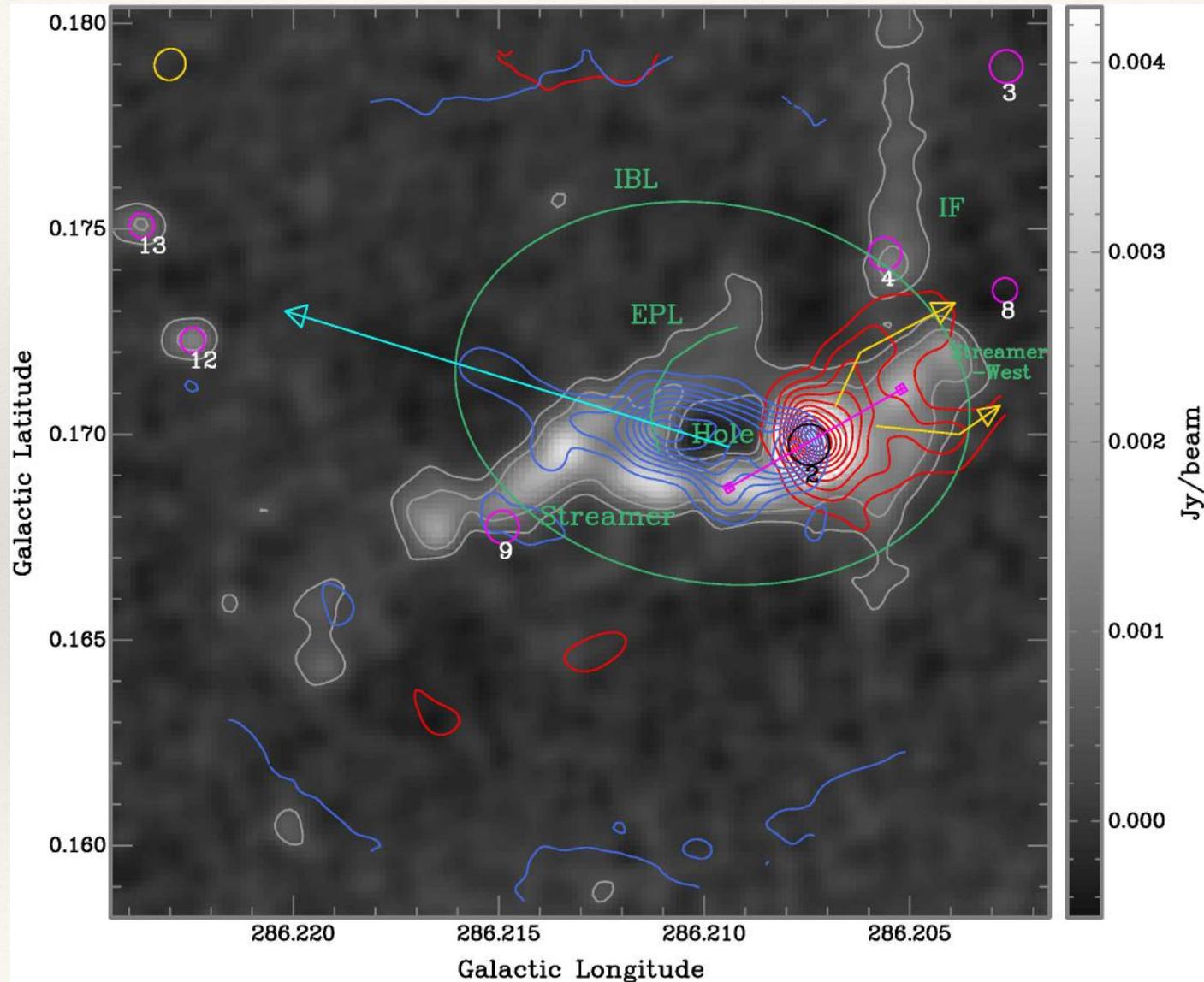
Spitzer

Overlaid  
magnetic field  
pattern from  
ALMA cold  
dust



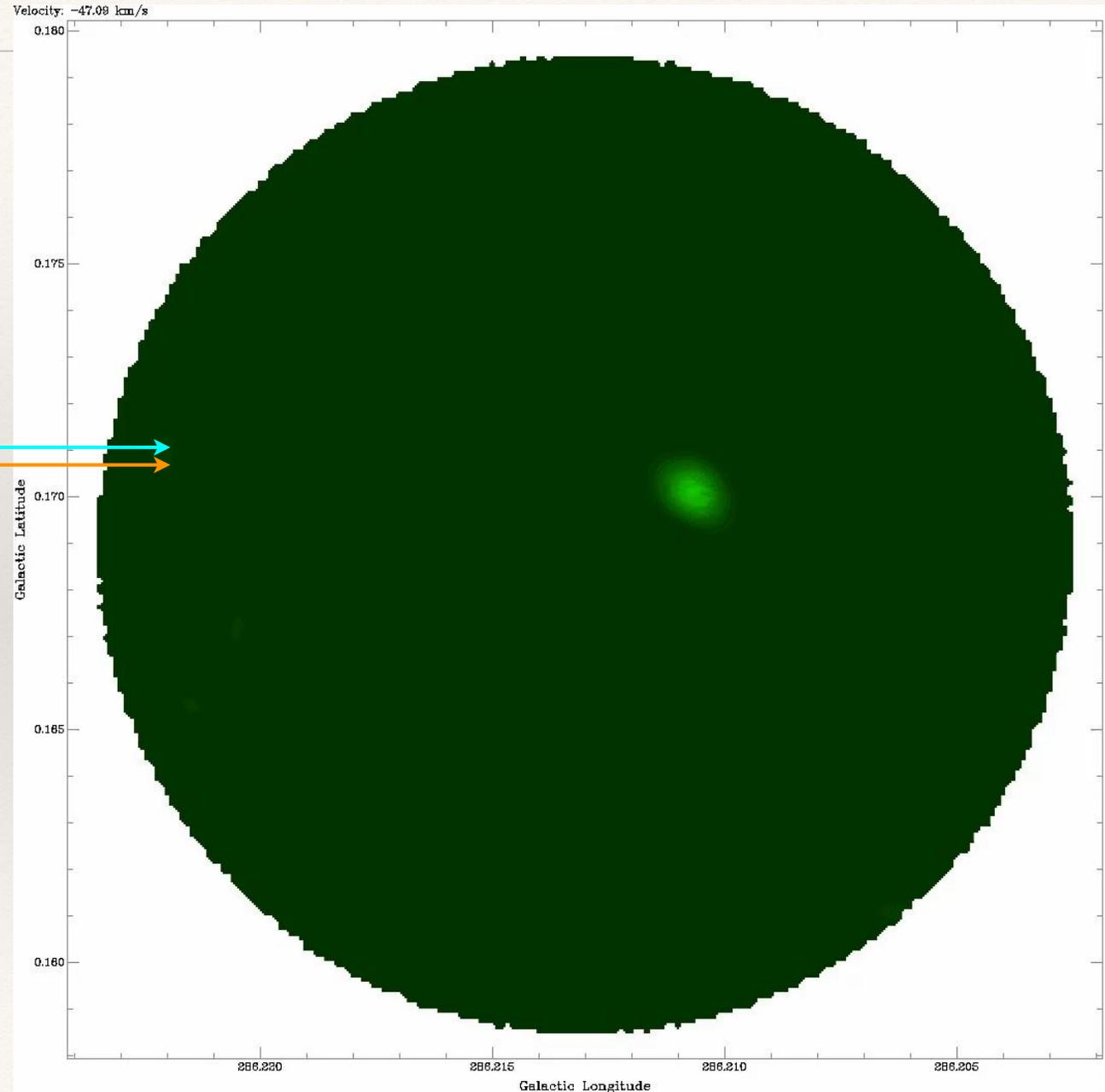
# ALMA spectroscopy

- ❖ Doppler-shifted gas (carbon monoxide, CO): a distorted **bipolar outflow** from MIR 2
- ❖ Also **gas infall** much faster than expected, implying 4–6x larger protostellar mass than thought, 950–1350  $M_{\odot}$ . MIR 2 is a **masquerading monster!**
- ❖ The **EPL** seems to be a “splash” effect of the **deflection** of the **blue-shifted** gas away from the **outflow axis** by the massive **Streamer**. The **red-shifted** gas is also **deflected**
- ❖ The magnetic field points radially to MIR 2 through the EPL, mostly along the Streamer, and along MIR 2’s outflow axis (next slide)



# Polo-spectroscopy: the GK effect

- ❖ **Goldreich-Kylafis effect** produces strongly polarized emission in CO maps, mapping the magnetic field in the outflow
- ❖ Background images = ALMA Doppler-shifted CO emission (unshifted emission is very opaque)
- ❖ Overlaid magnetic field pattern from ALMA Doppler-shifted polarized CO
- ❖ **Magnetic energy dominates** the kinetic energy of the outflow near MIR 2; outflow probably magnetically driven



## Contacts & info —

paper at [arXiv:2301.03618](https://arxiv.org/abs/2301.03618) (in press at *The Astrophysical Journal*)

images+movies at [gemelli.spacescience.org/~pbarnes/research/champ/papers/](https://gemelli.spacescience.org/~pbarnes/research/champ/papers/)

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