

# Magnetic Fields within Hub-Filament Systems

Jia-Wei Wang

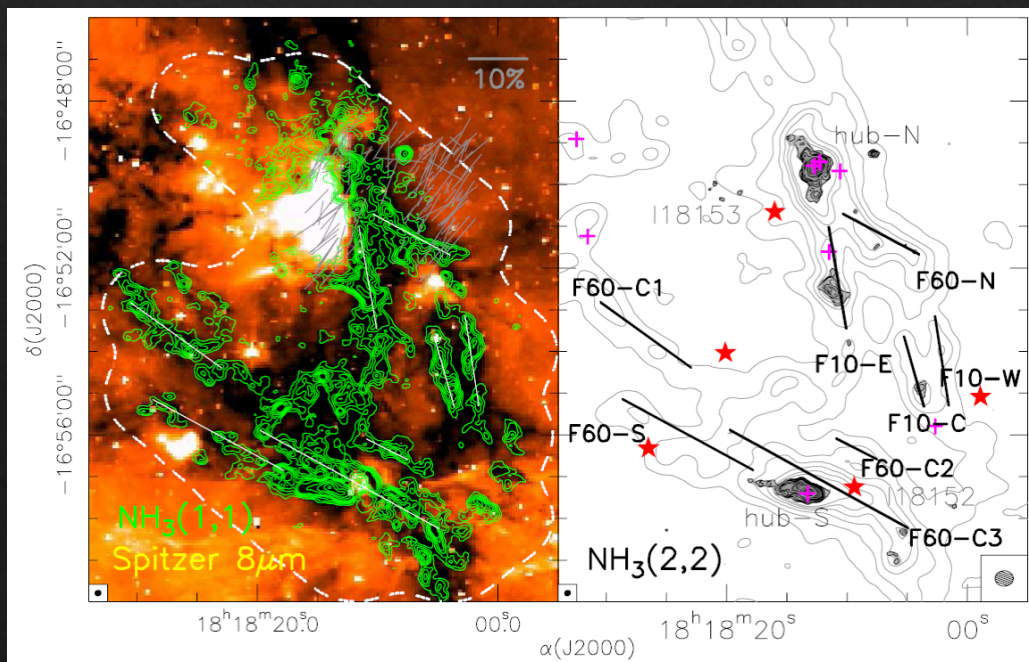
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Kate Pattle (NUI Galway), and the BISTRO consortium

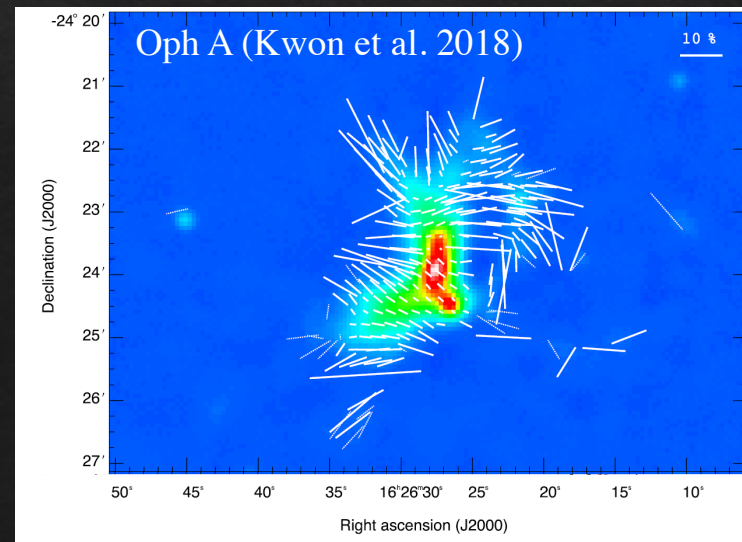
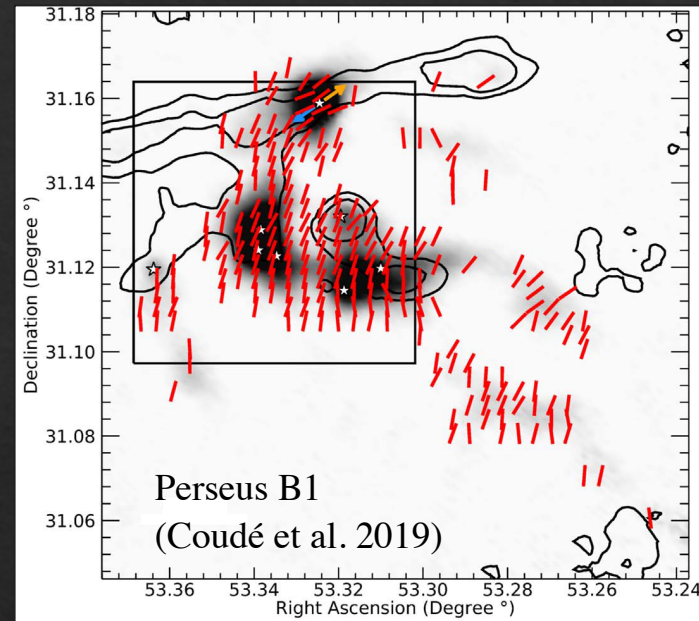
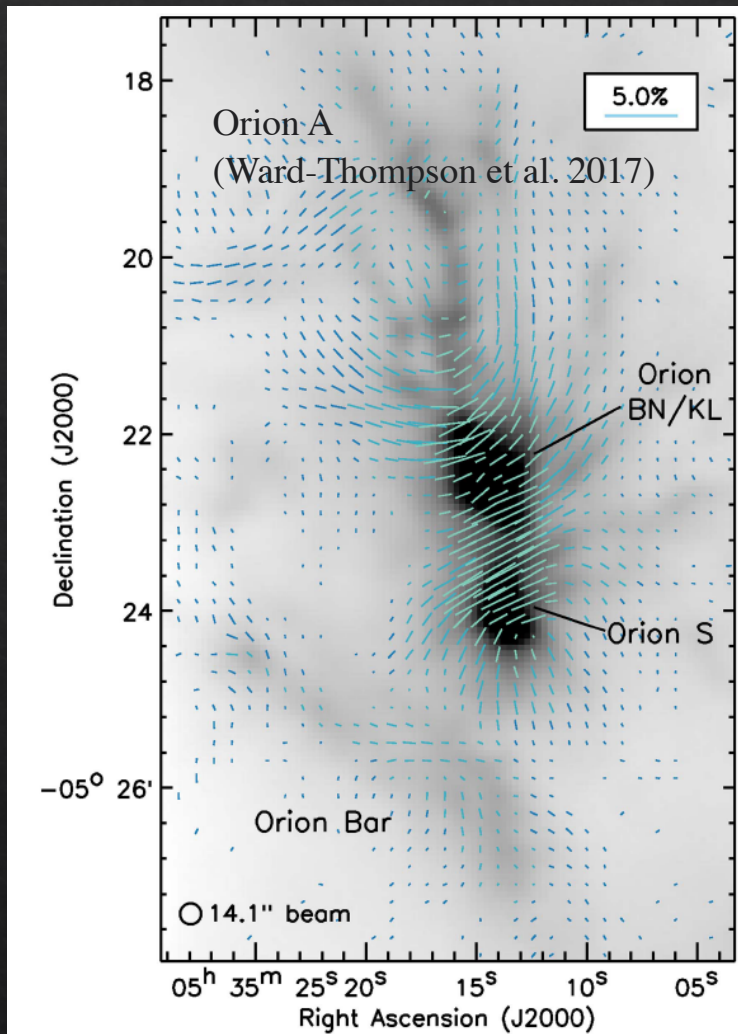
# Hub-Filament Systems

- ◇ Converging filaments intersect in massive hub
- ◇ Potential site of cluster formation
- ◇ Connecting pc-scale filaments to star formation at smaller scale



G14.225-0.506  
(Busquet et al. 2013)

# B-field Revealed by the JCMT BISTRO Survey

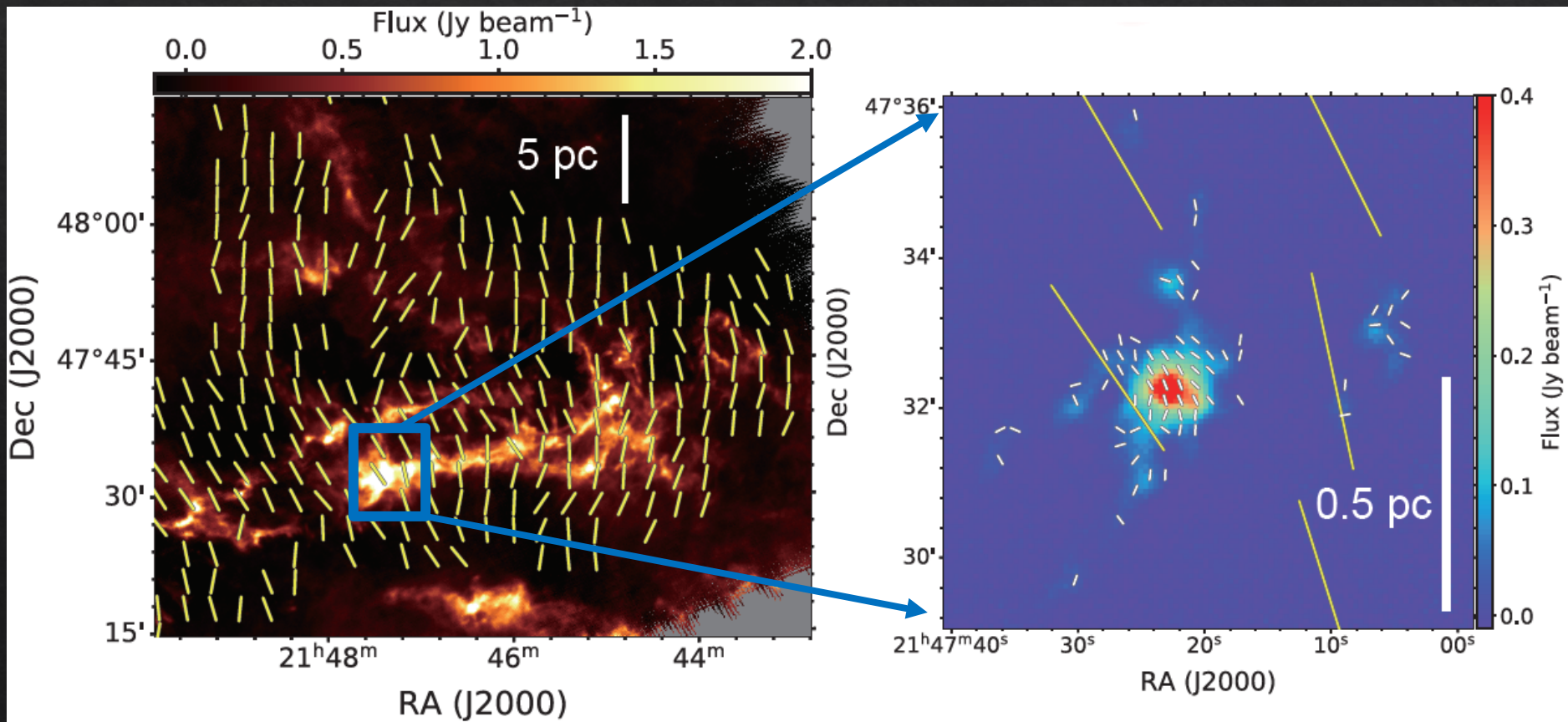




# The IC5146 Hub-Filament System

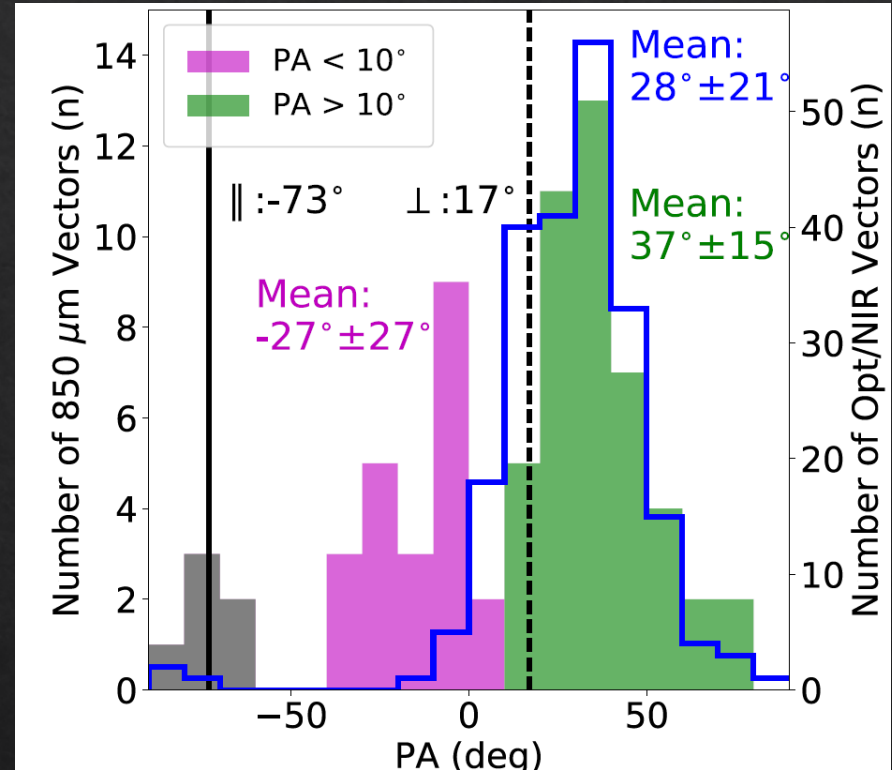
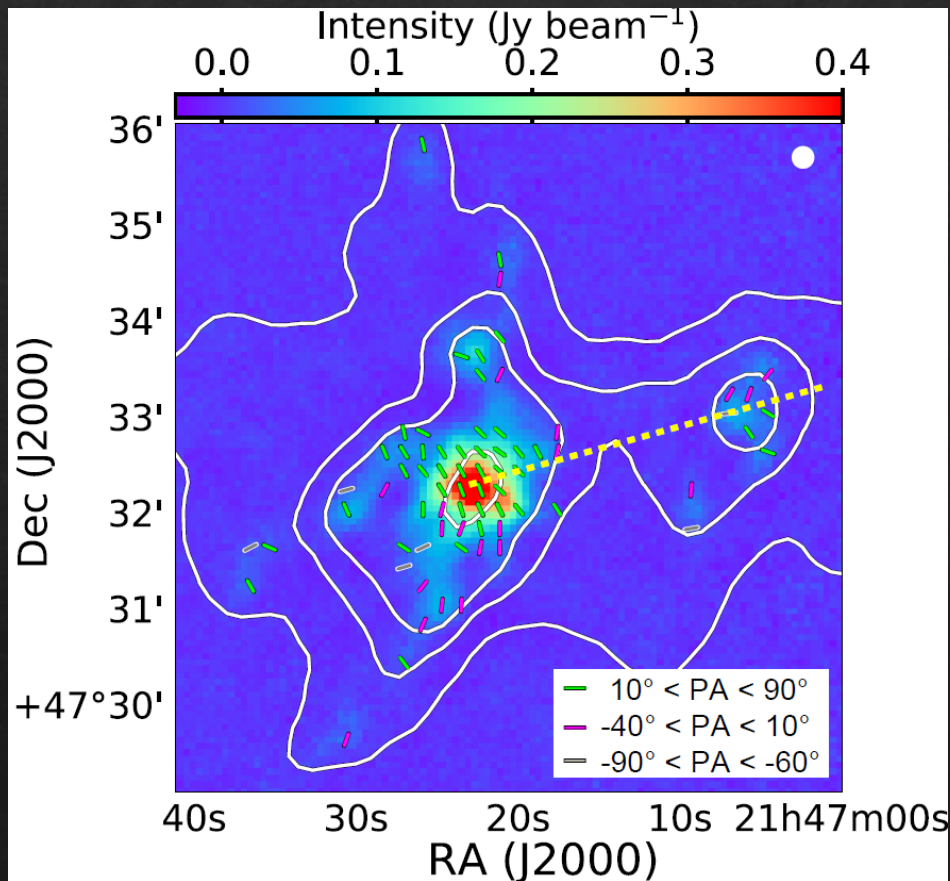
Spatially averaged H-band starlight polarization (Wang et al. 2019, submitted)

JCMT POL-2 850  $\mu\text{m}$  polarization (Wang et al. 2019)





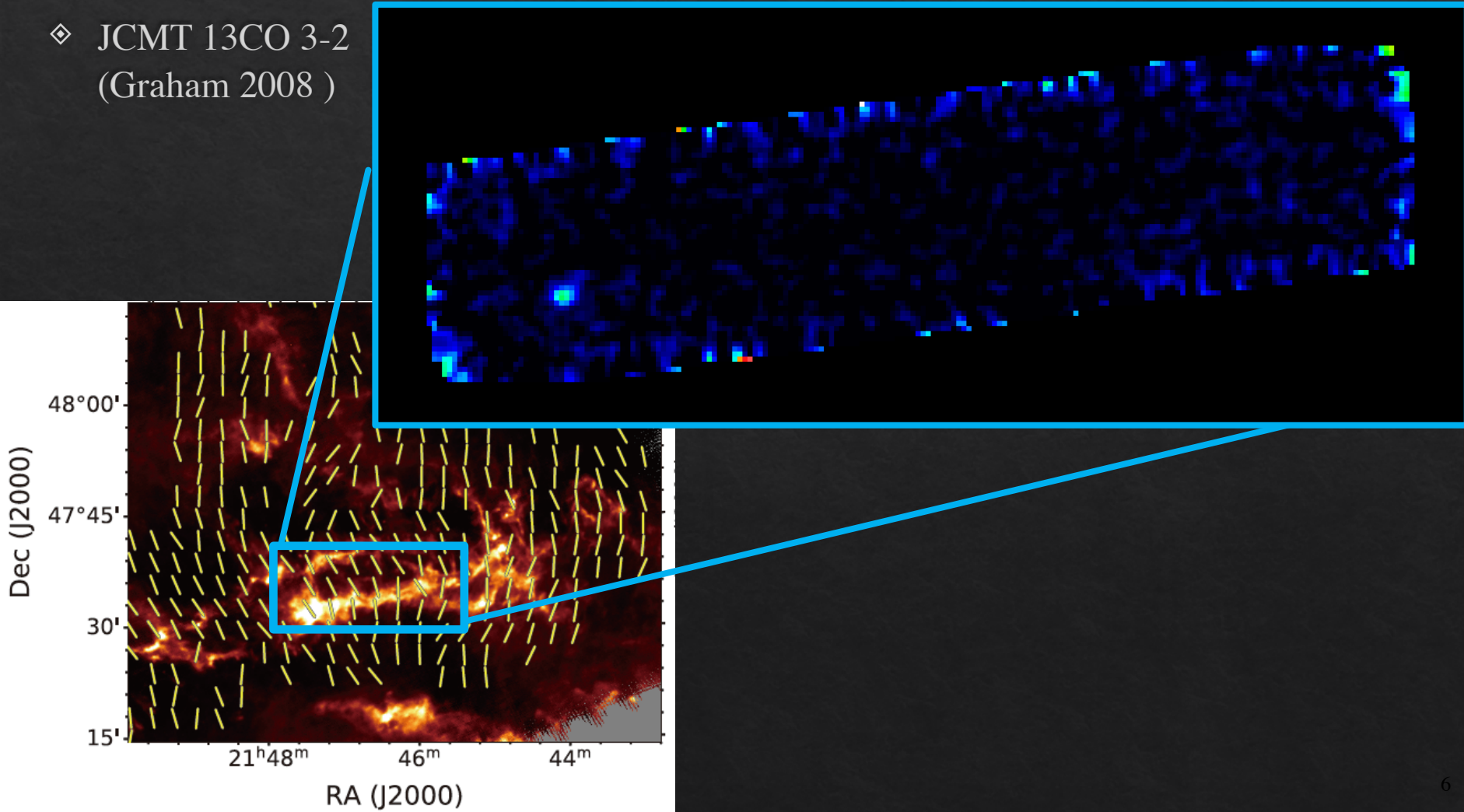
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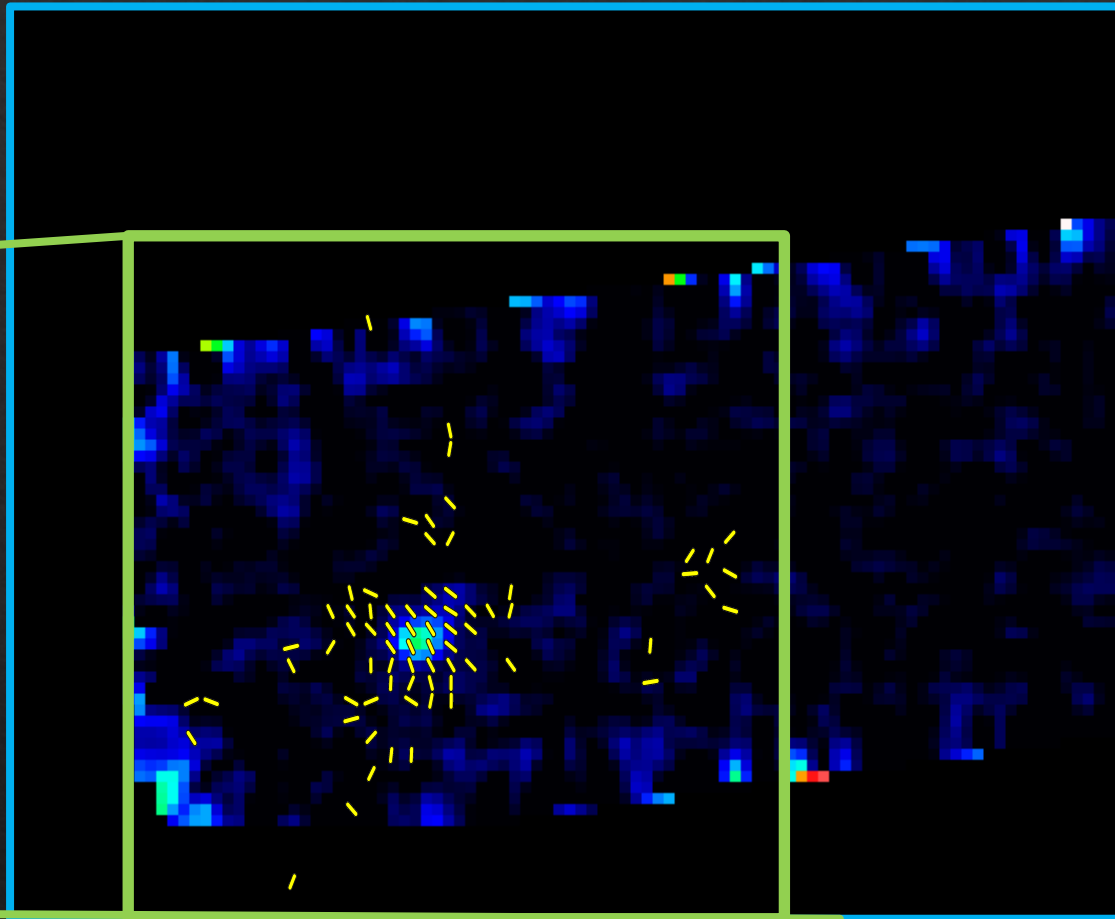
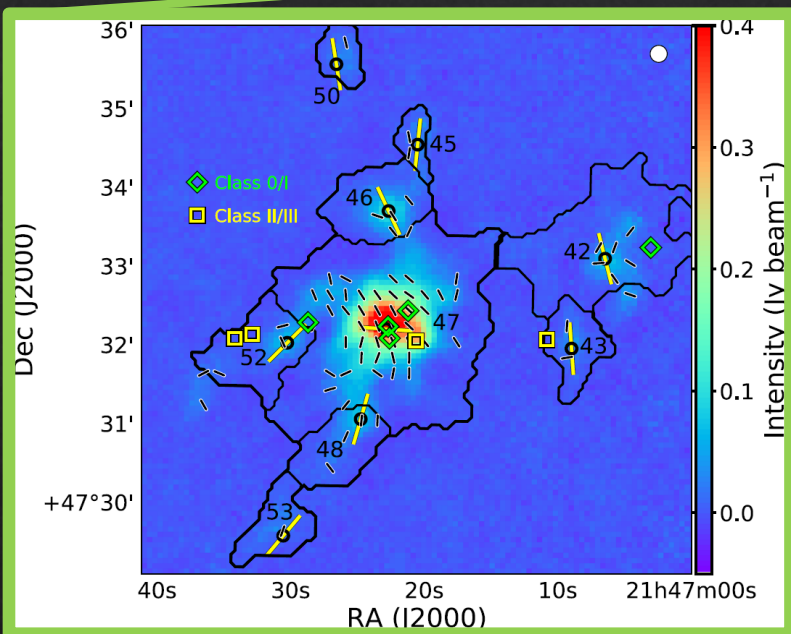
- ◆ Filled Histogram: POL-2 data
- ◆ Step Histogram: Opt/NIR data within the POL-2 field of view ( $D = 11'$ )

# Gas Kinematics along the pc-scale filament

◇ JCMT 13CO 3-2  
(Graham 2008 )



# Gas Kinematics around the sub-pc HFS



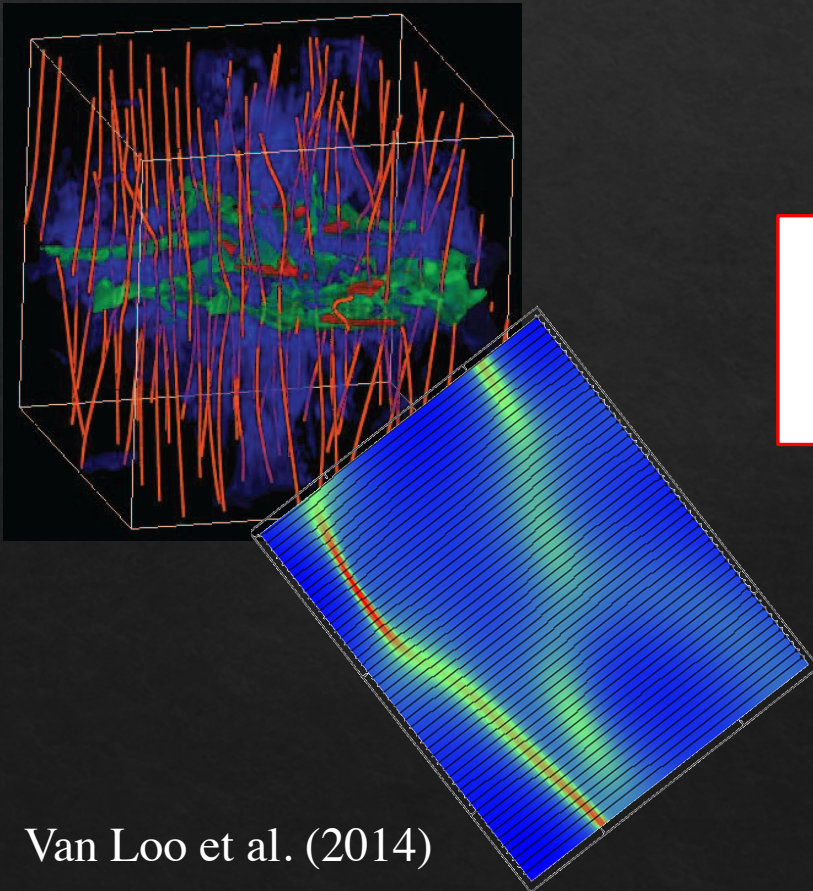


# Possible Scenario from Filaments to Cores?

at pc-scale

B-Field regulated collapse/fragmentation

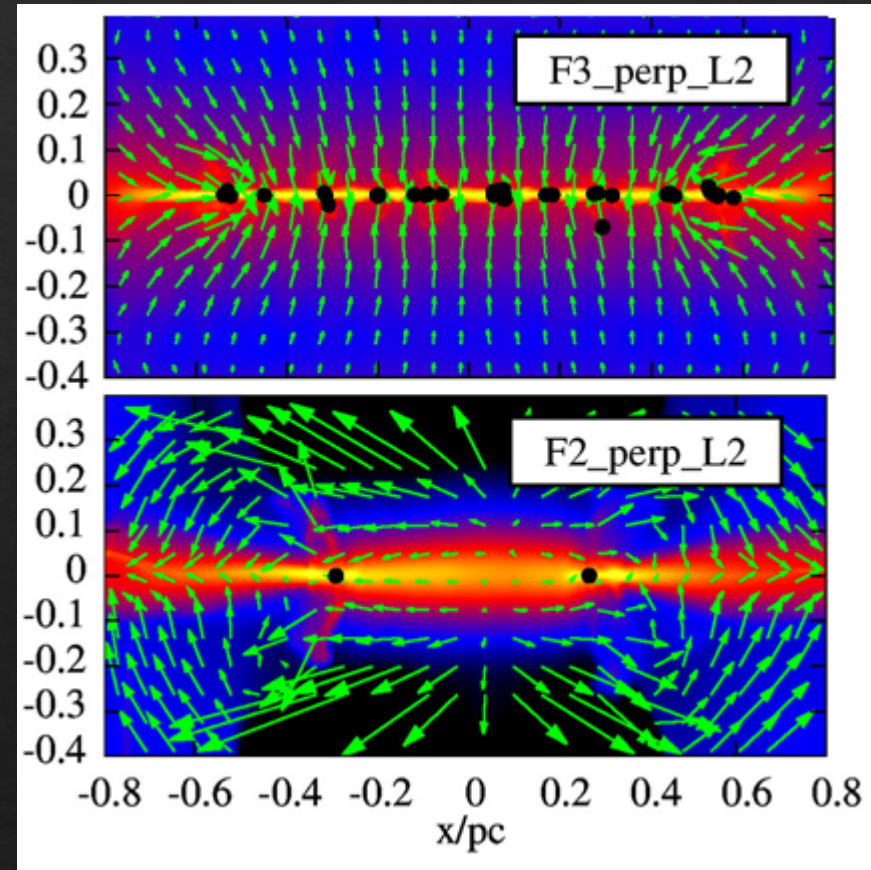
Nakamura & Li (2008)



Van Loo et al. (2014)

at sub-pc-scale

Filament fragmentation



Seifried et al. (2015)

# Another Story: G33.92+0.11

- ◇ Massive ( $\sim 3000 M_{\odot}$ ) hub-filament system
- ◇ Surrounded by spiral arm-like accretion streams
- ◇ Isolated system
- ◇ Distance : 7.1 kpc

Why 7.1 kpc object?

For a typical 5 x 1 pc filament:

at 500 pc

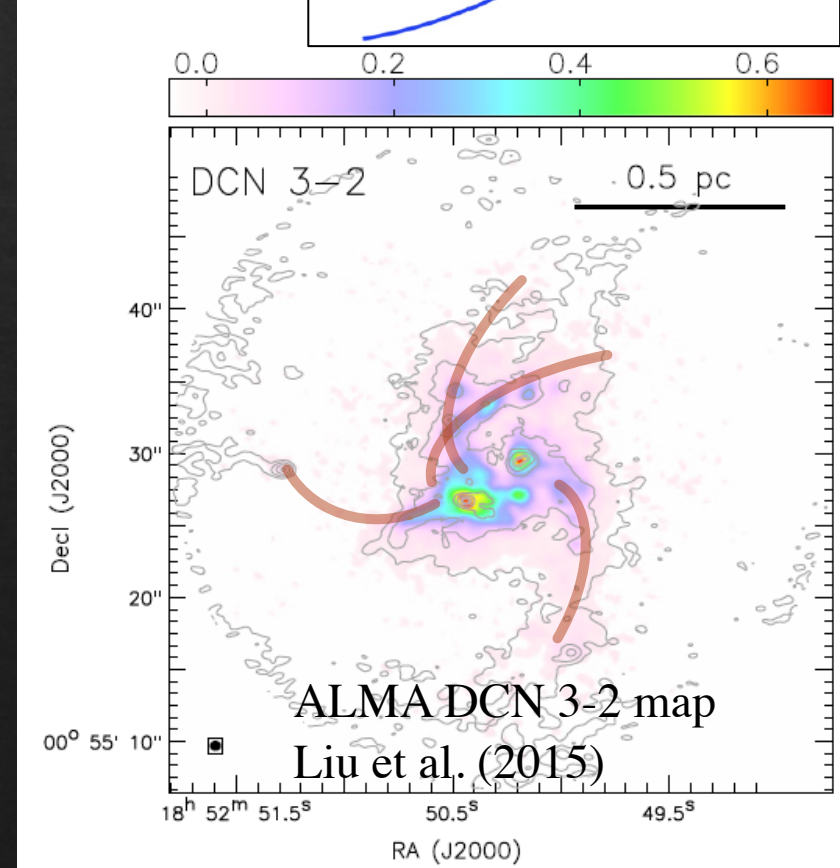
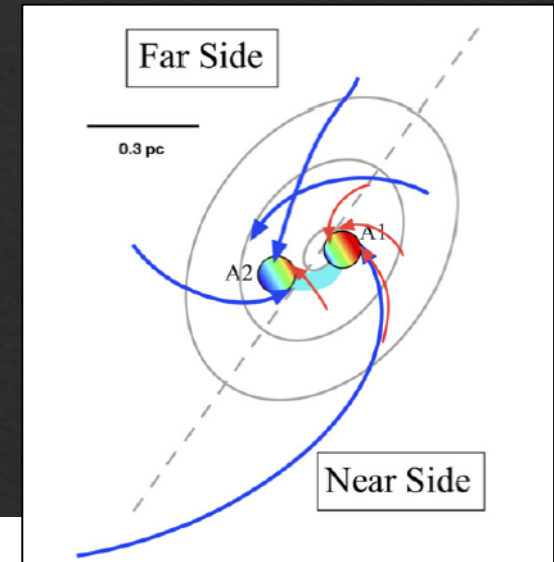
at 7 kpc

34' x 7'

2.5' x 0.5'

Resolved out by POL-2

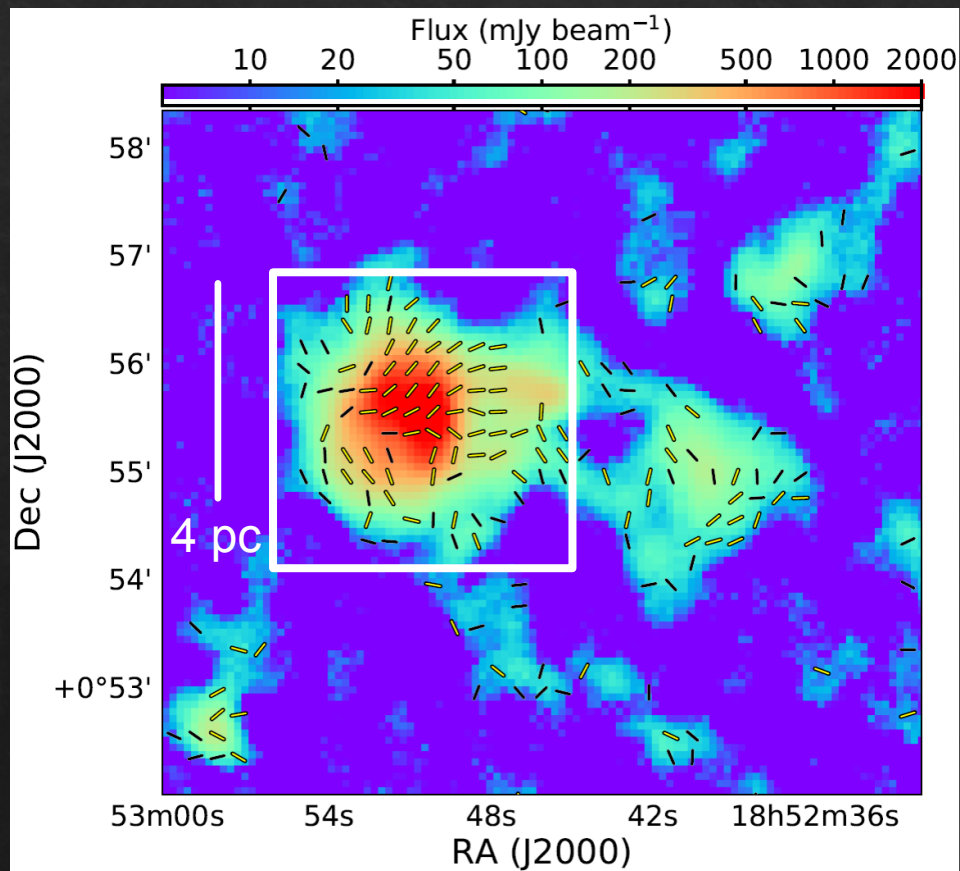
OK



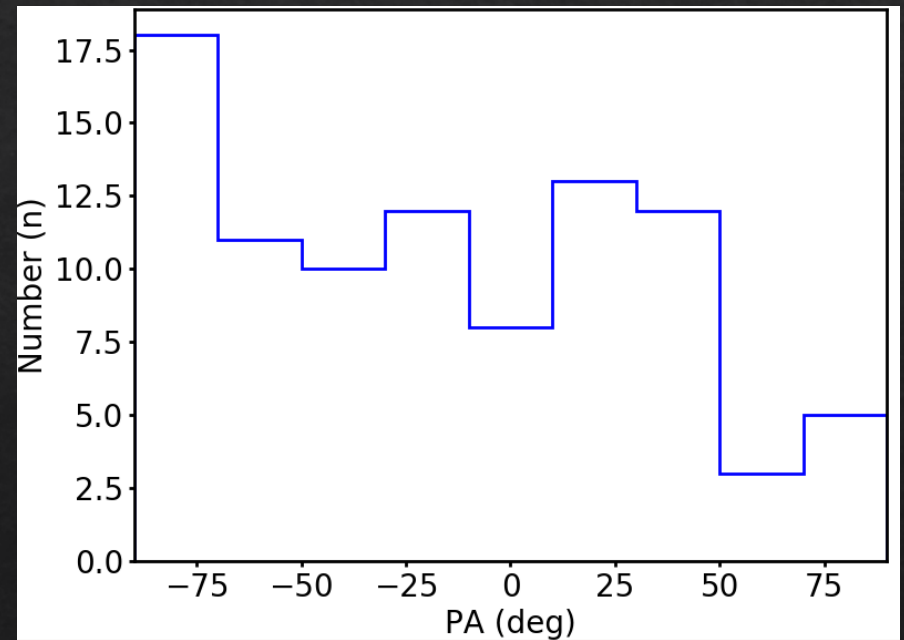


# G33.92+0.11 Polarization Map

◇ POL-2 850  $\mu\text{m}$  B-field orientation



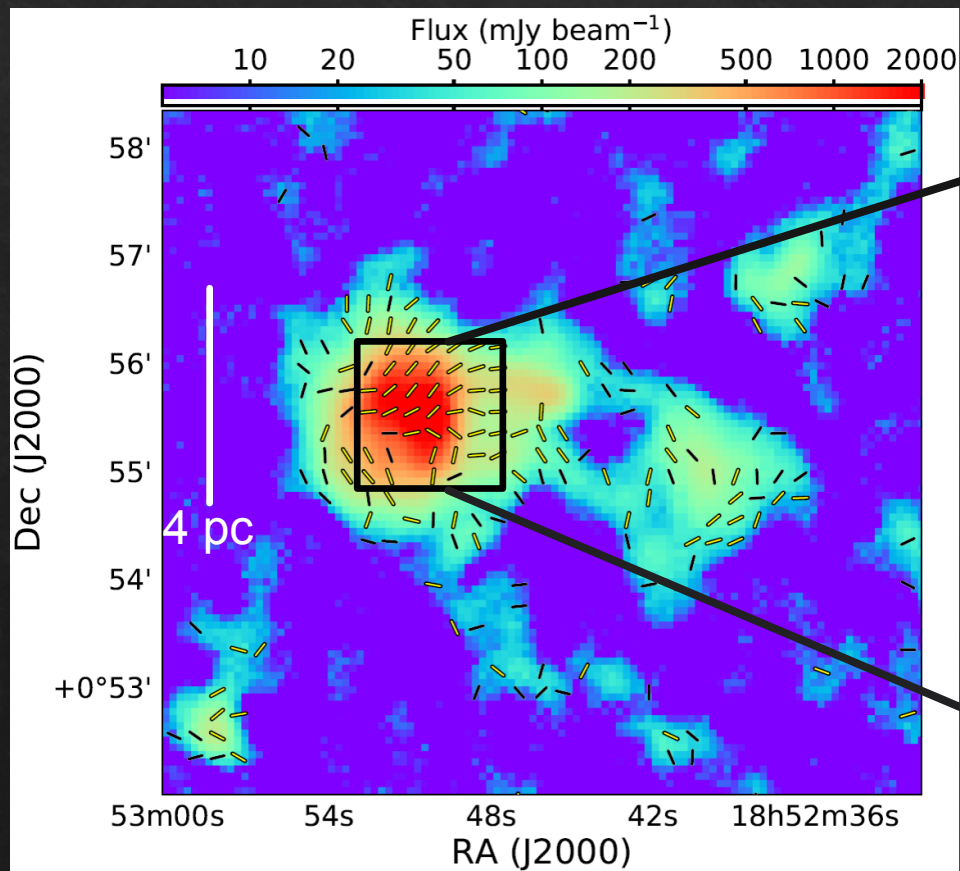
◇ Histogram of B-field PA



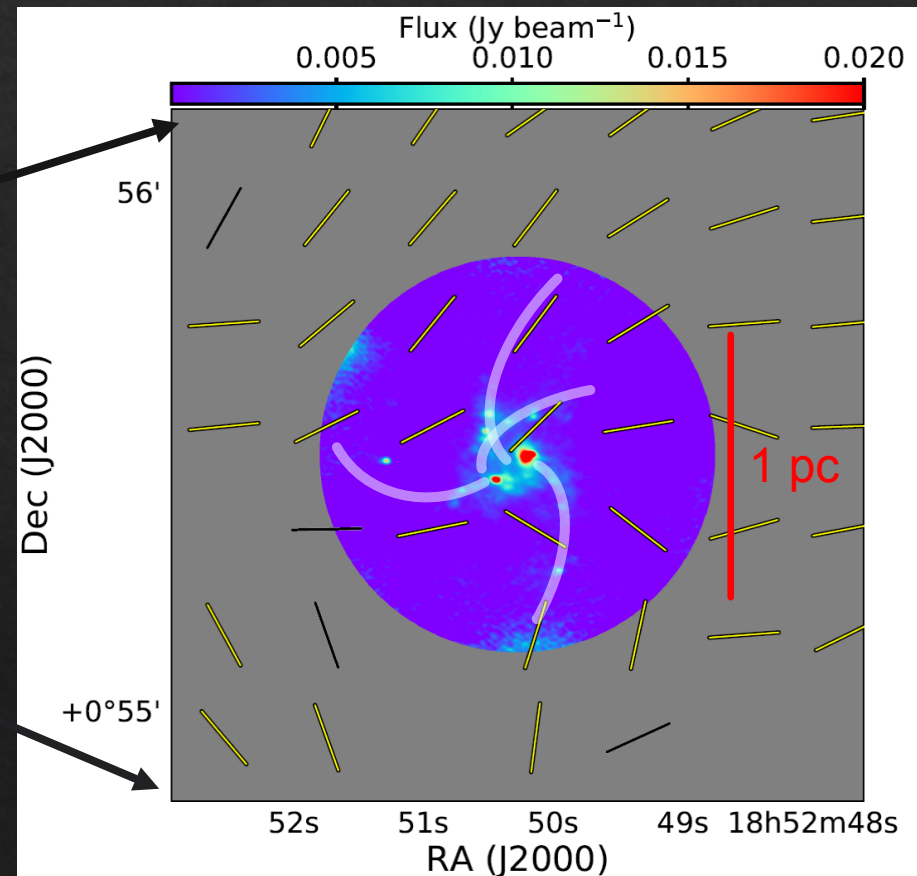


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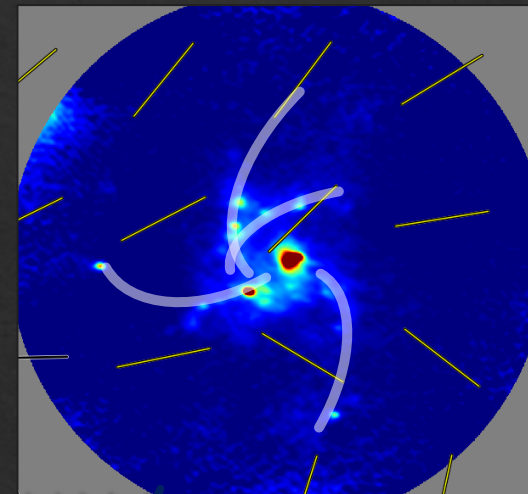


◇ ALMA Band 6 continuum



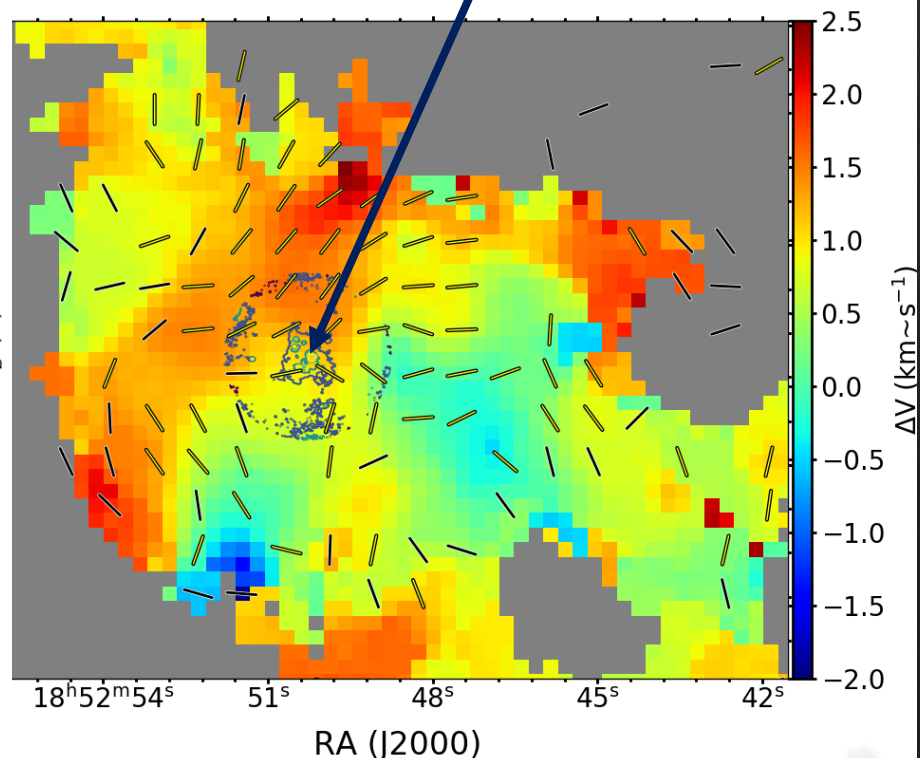
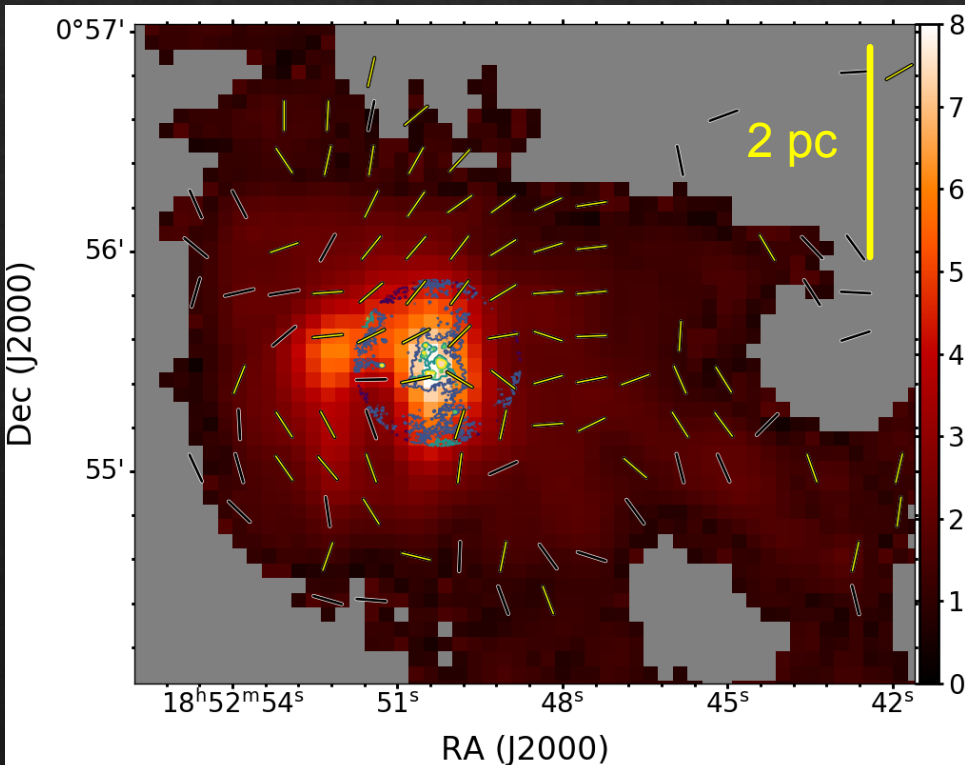
# IRAM 30m C<sup>18</sup>O (2-1)

- ◇ Major structure extracted using dendrogram
- ◇ The sub-pc accretion streams extend to pc-scale



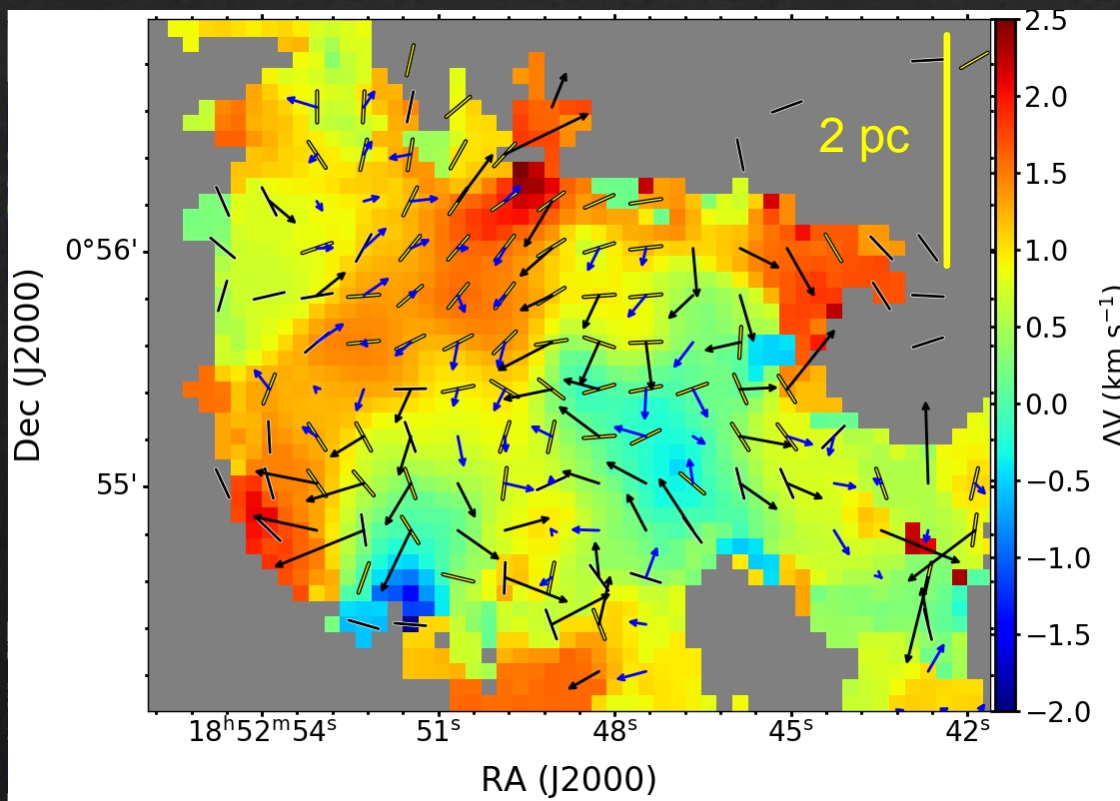
Gaussian Amplitude

Centroid Velocity

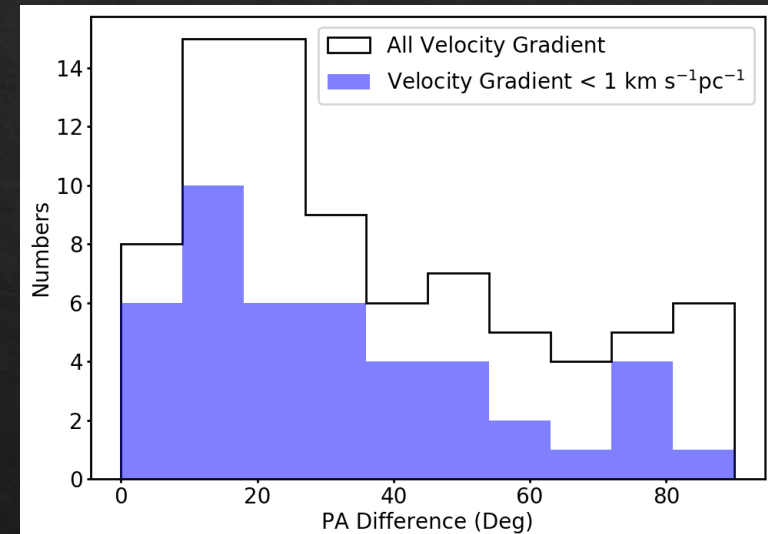


# C<sup>18</sup>O (2-1) LOS Velocity Gradient

- ◇ Velocity gradient calculated from centroid velocities
- ◇ Pixels with great VG possibly be biased by separate velocity components



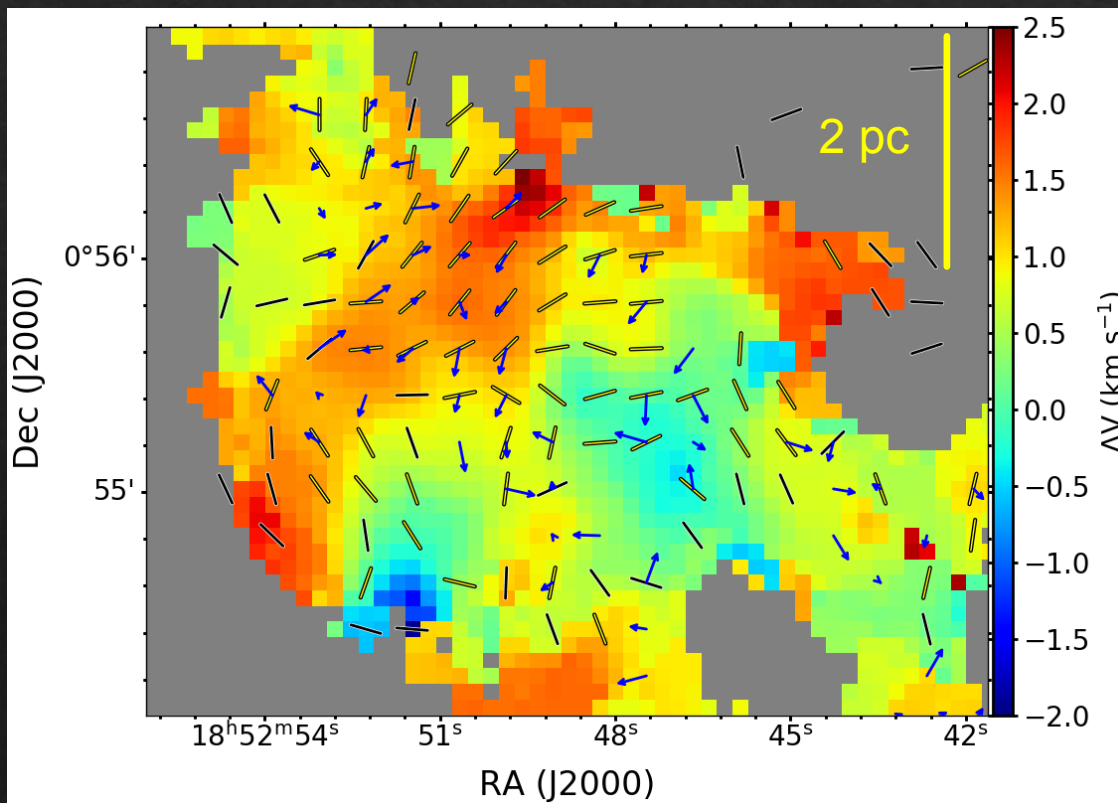
Relative angle between B-field and VG



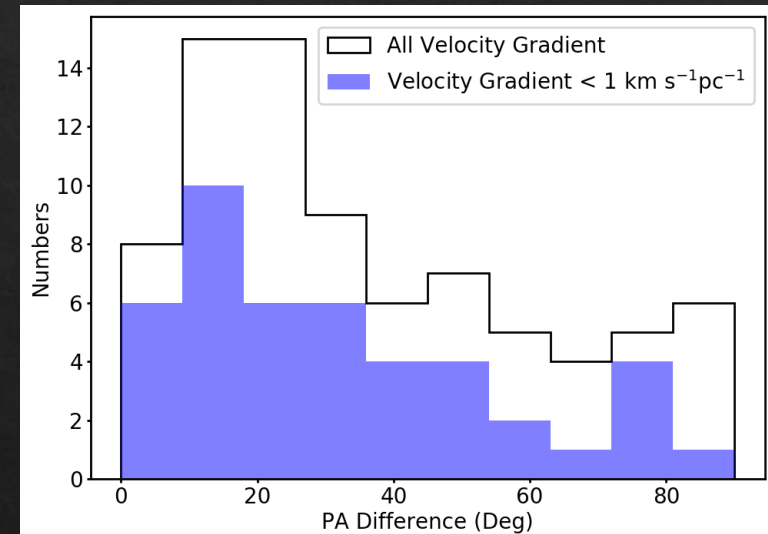


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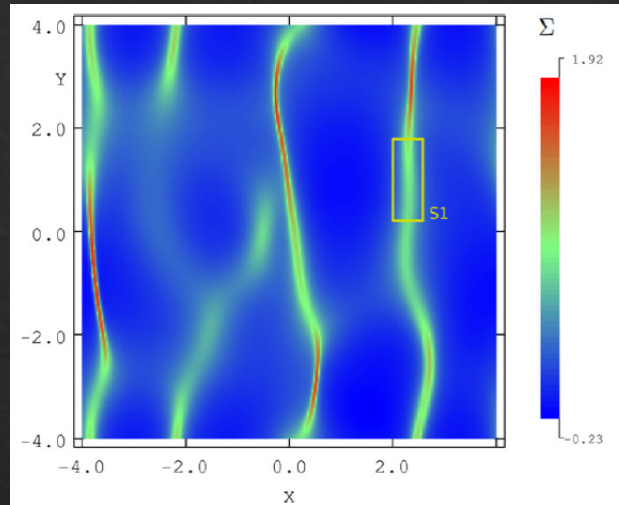
# Comparison

	pc-scale	sub-pc-scale
◇ IC5146	pinched uniform B-field B-field $\perp$ Filament B-field $\perp$ VG	pinched uniform B-field B-field $\parallel$ Filament B-field $\parallel$ VG
◇ G33.92+0.11	spiral-like B-field B-field $\parallel$ Filament B-field $\parallel$ VG	waiting for ALMA data..

# Two Evolutionary Paths?

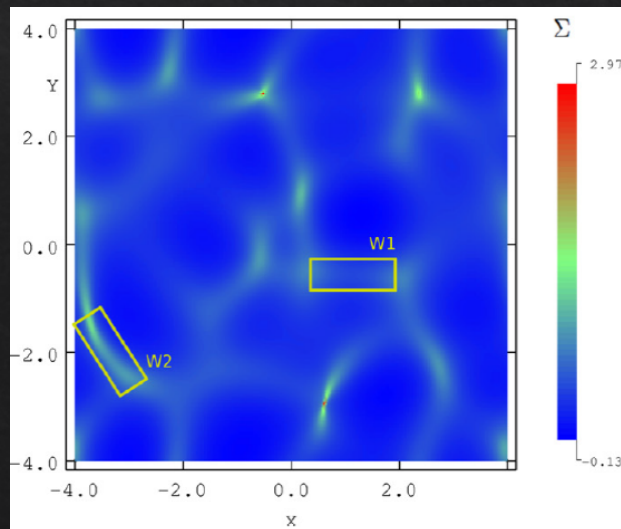
◇ IC5146

Strong B-field Case??  
Van Loo et al. (2014)

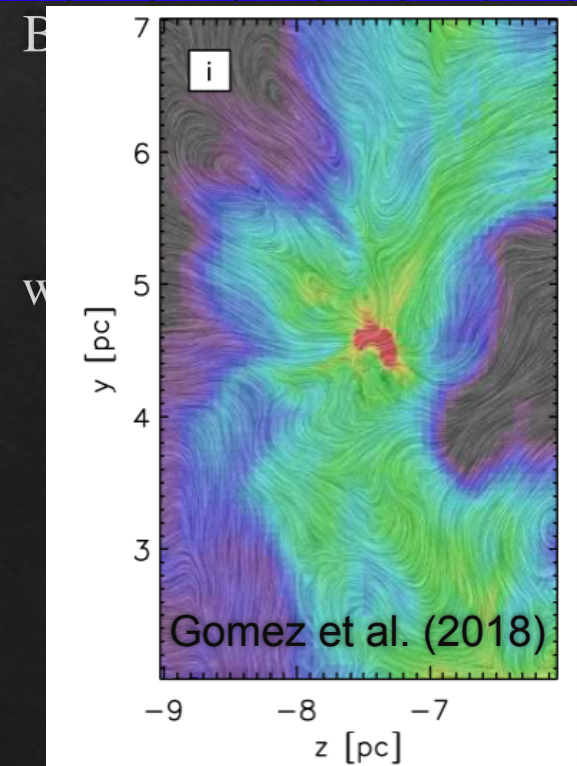
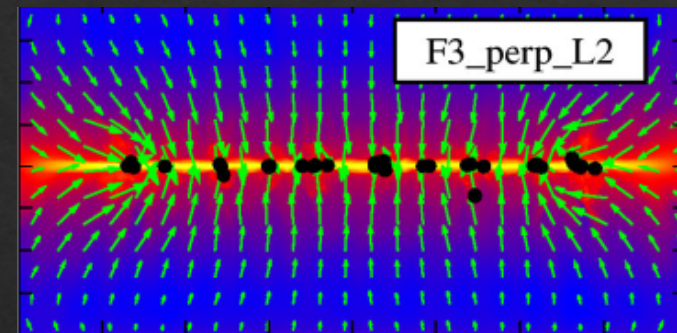


◇ G33.92+0.11

Weak B-field Case??



Seifried et al. (2015)



Gomez et al. (2018)



# Follow-up Questions...

If these two evolutionary paths exist:

- ◇ What is the key physical parameter causing these two paths?
- ◇ Which one is more common?
- ◇ What are their time scale? star formation efficiency?
- ◇ How they affect the following cluster/star/disk formation?

To answer these questions, more samples are needed:

- ◇ Observations to similar targets
- ◇ BISTRO 2, 3