Gas Kinematics within IC5146 filaments:

Does Magnetic Fields Regulate the Gas Dynamics

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Filaments, the birth sites of stars

- YSOs form from supercritical filaments (André et al. 2010, 2014).

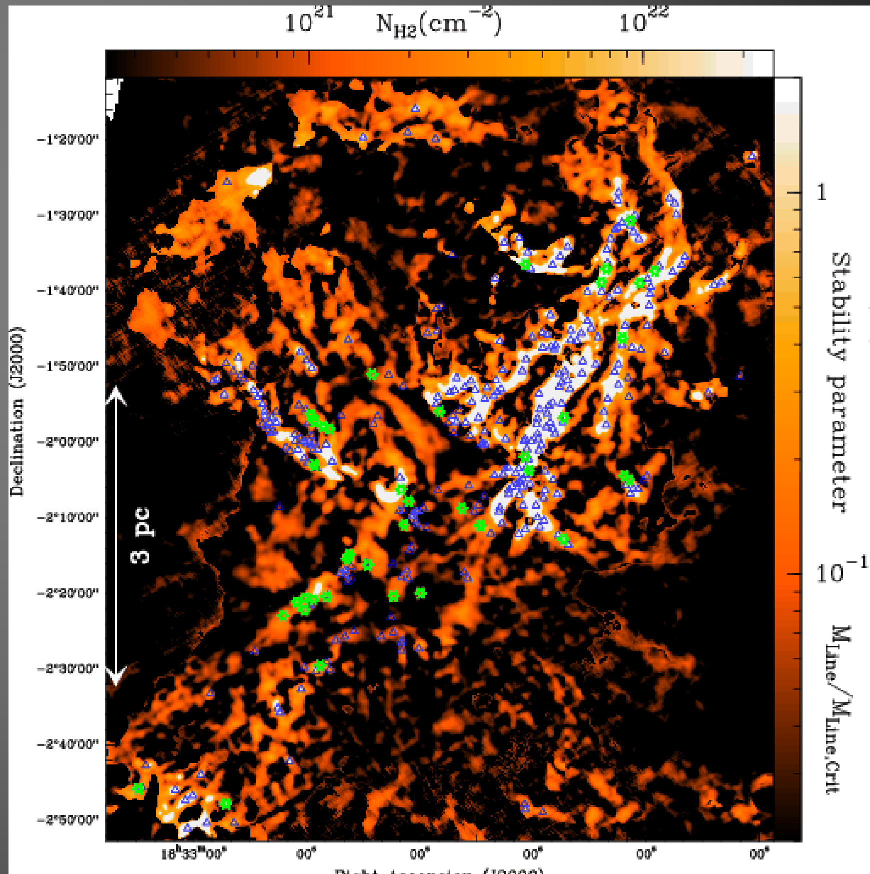
ISM

Dissipation of MHD Flows

Filaments

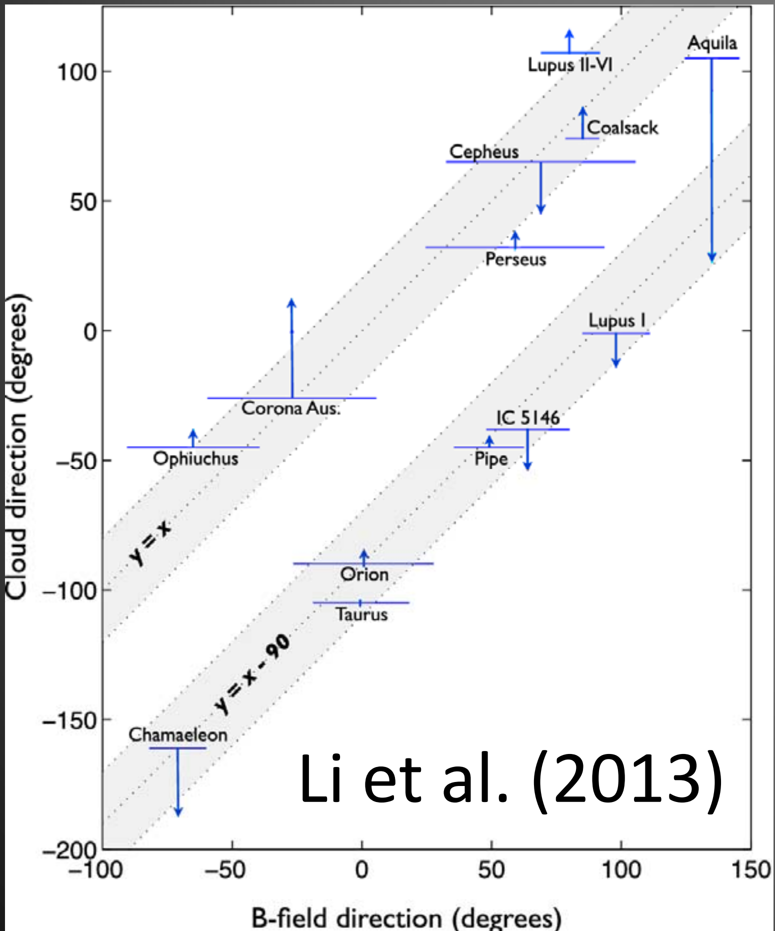
Gravitational Instability

Prestellar Cores



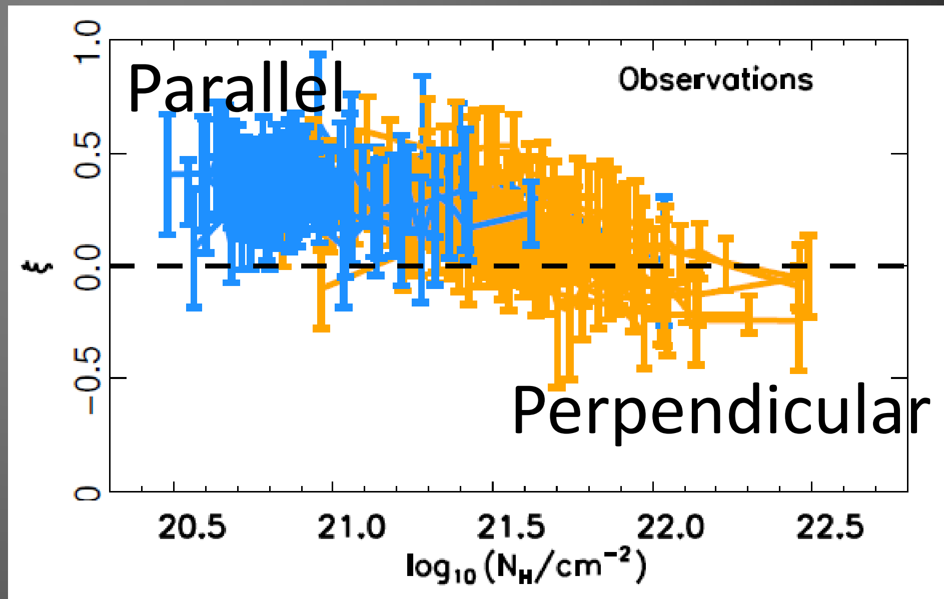
Role of B-field in Star Formation – Large scale

- Filaments are found to be aligned with B-fields, either parallel or perpendicular.



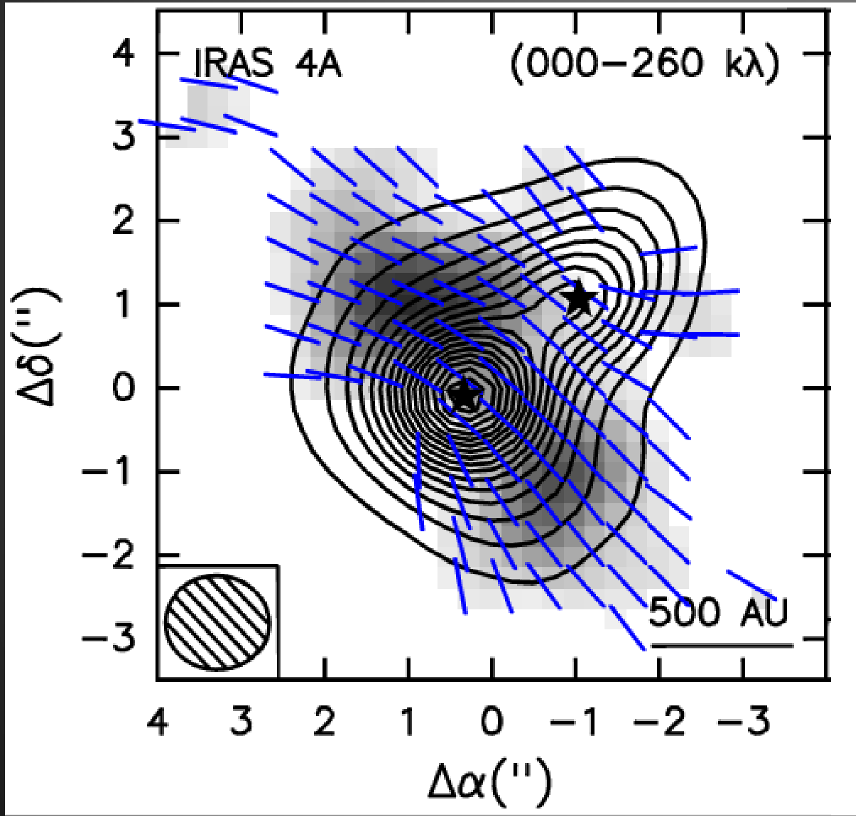
Li et al. (2013)

Planck Collaboration (2015)



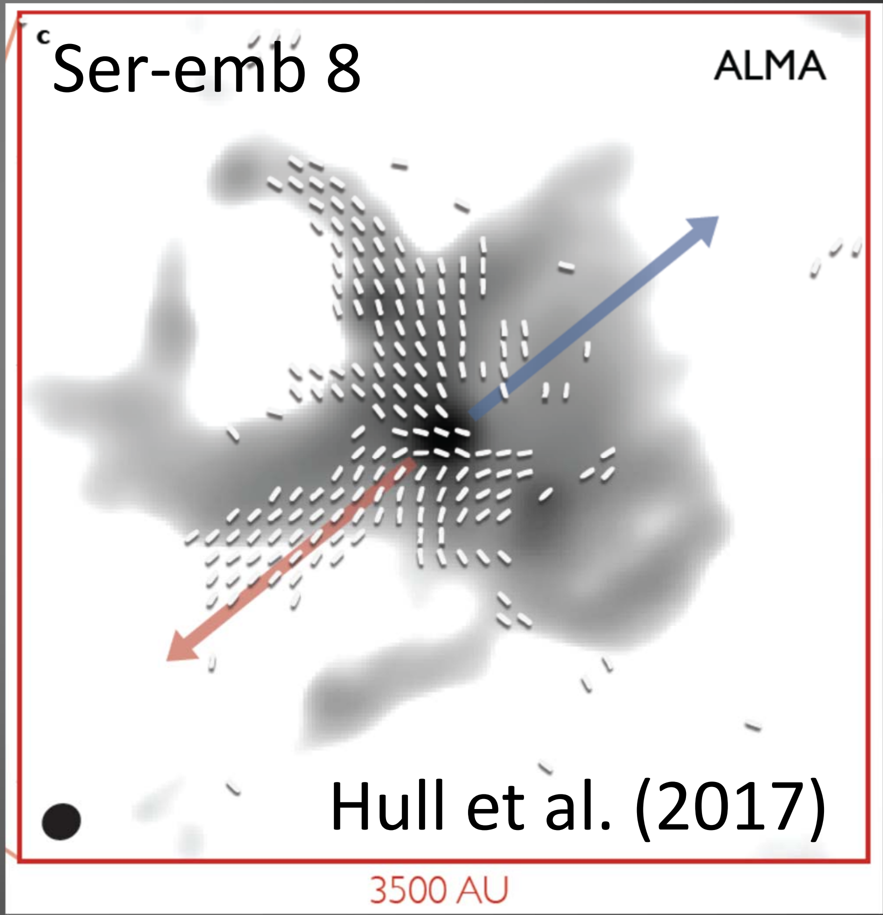
Role of B-field in Star Formation – Small scale

Hourglass B-field

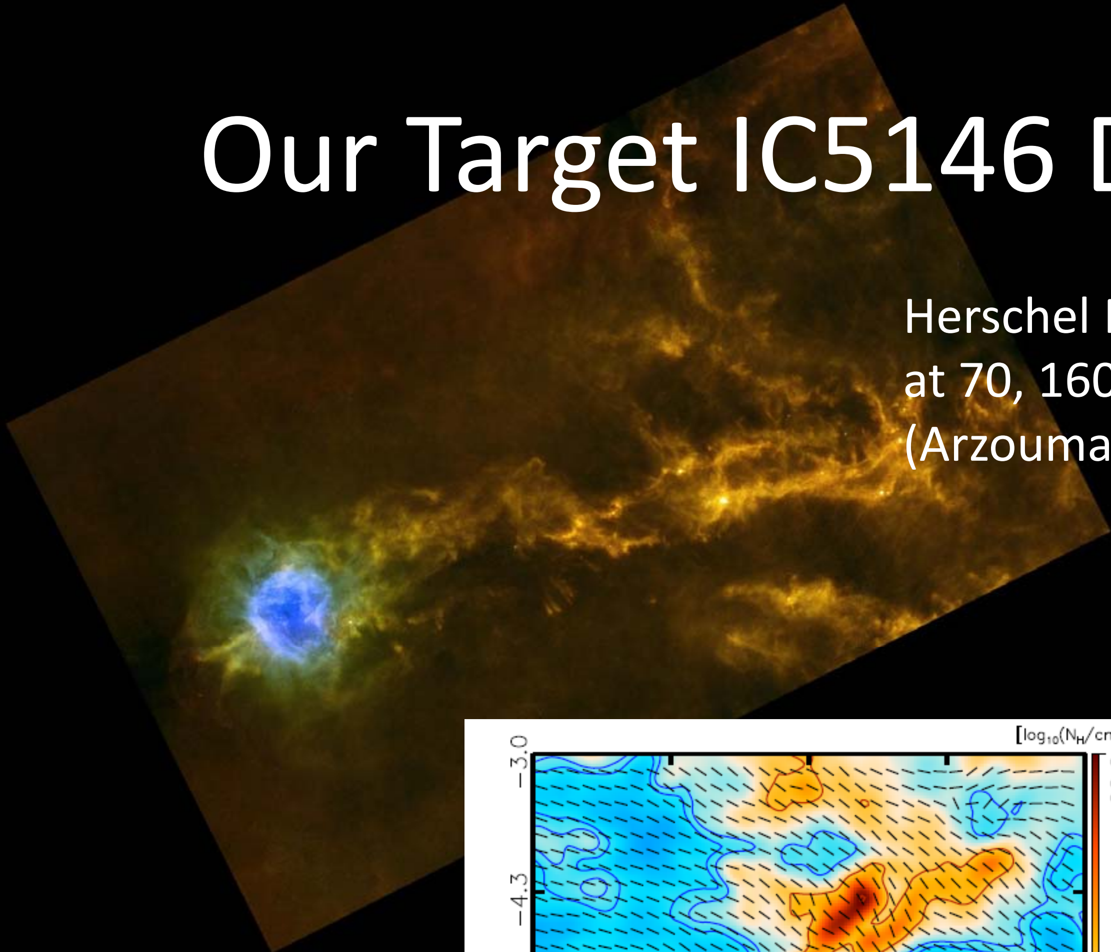


Frau et al. (2011)

Randomly aligned B-field

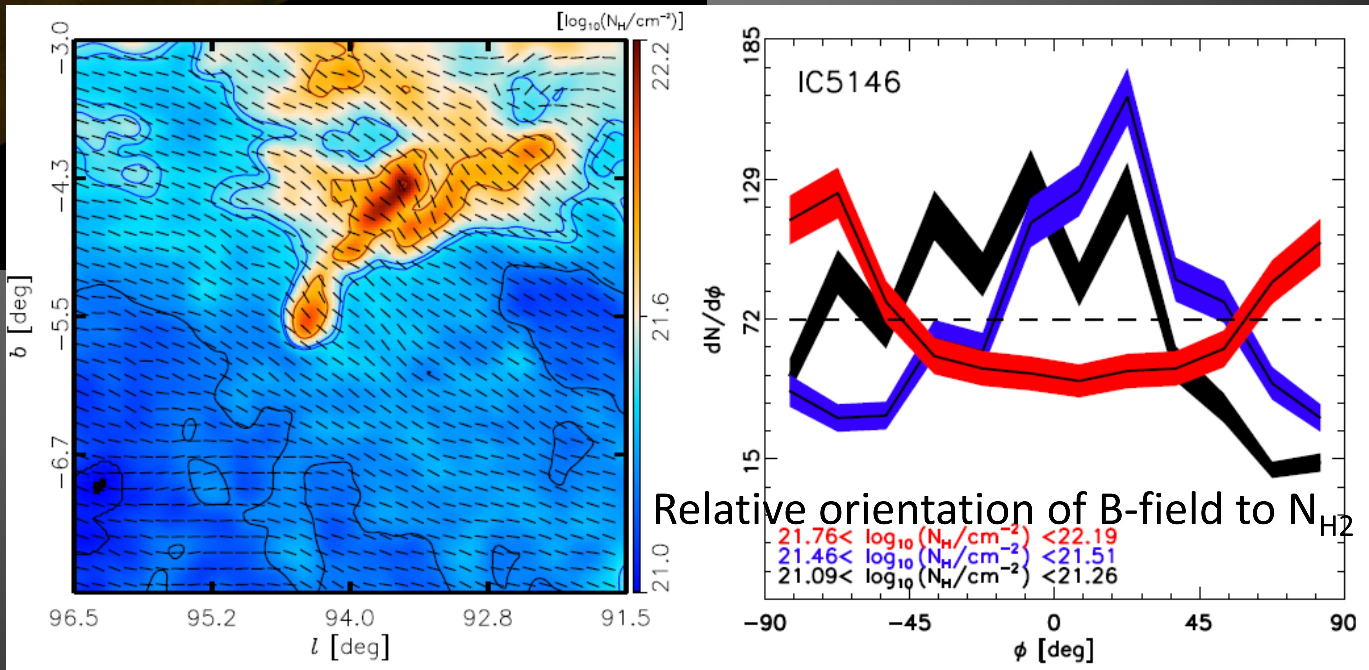


Our Target IC5146 Dark Cloud



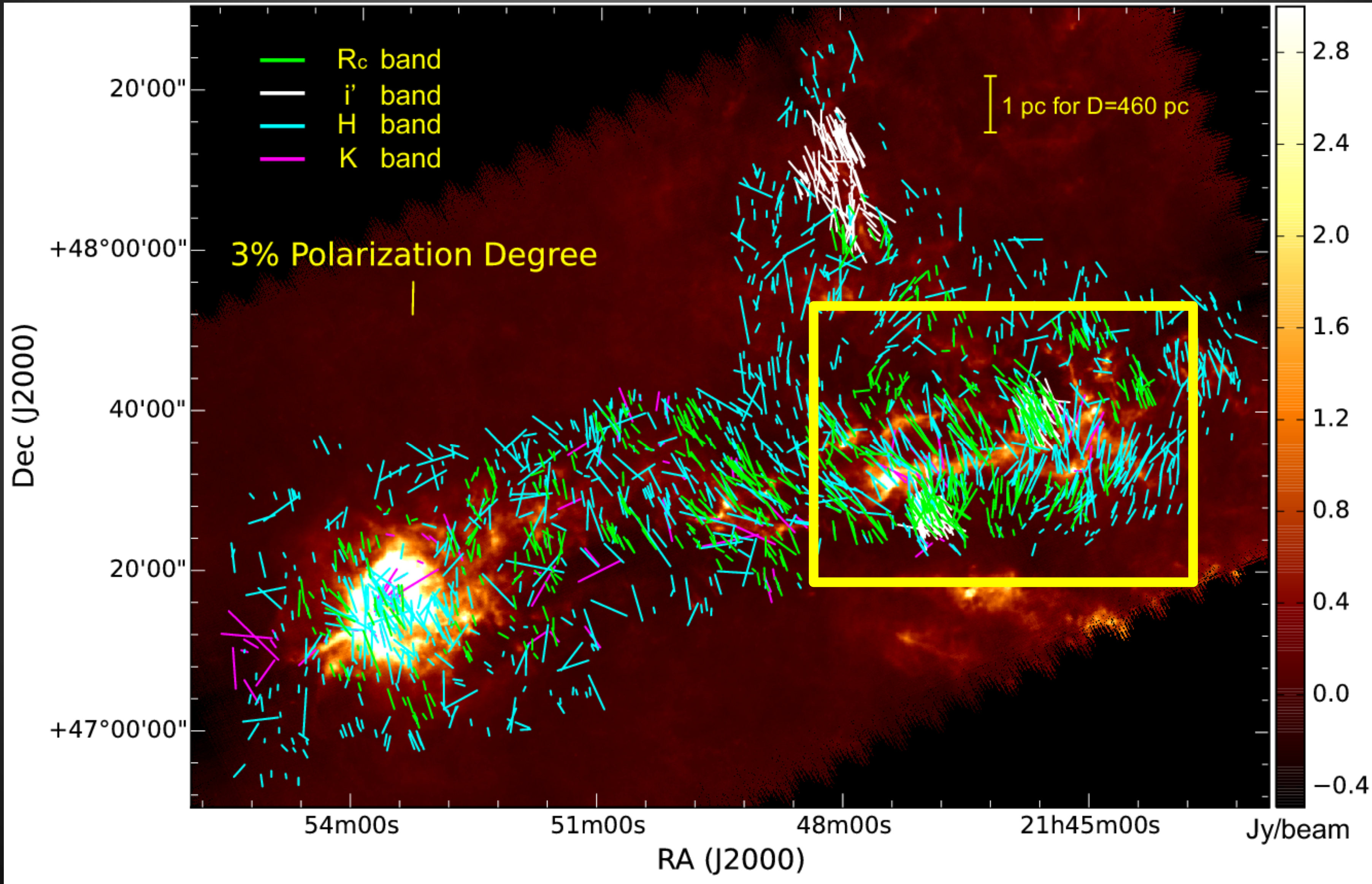
Herschel PACS/SPIRE data
at 70, 160, 250, 350 and 500 μm
(Arzoumanian et al. 2011)

Planck Collaboration (2015)



Relative orientation of B-field to N_{H2}

Stellar Polarization Map

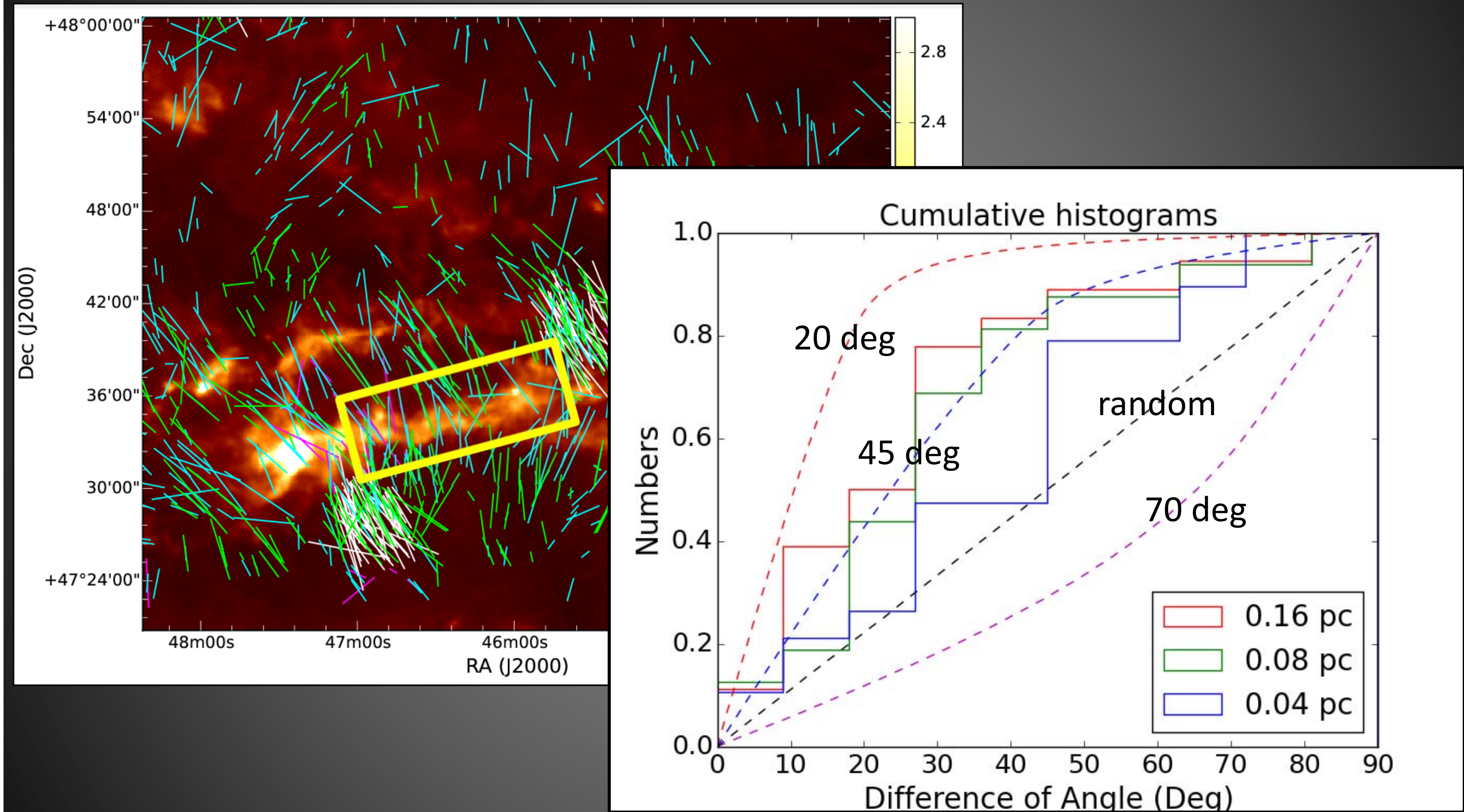


Alignment between B-field and Intensity Gradient in Multi-scale

- Polarization-Intensity gradient relation technique (Koch el al. 2012)
- δ= Relative orientation between B-field and intensity gradient
- δ -> 0 : Gas motion is freezing along B-field
- δ -> 90 : B-field is bent by other forces

- Intensity Gradient:
  - Herschel 250 micron data
  - Binned to 0.04 – 0.16 pc scale

Polarization-Intensity Gradient Relation in Main Filament

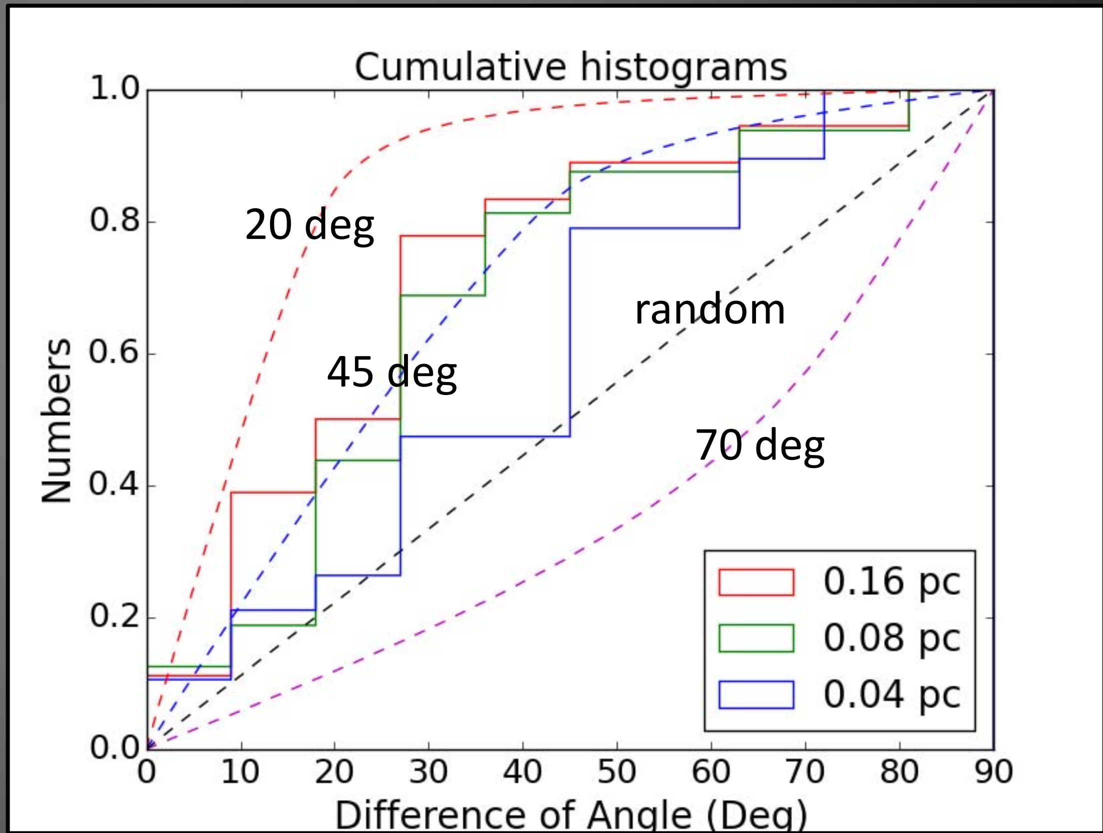


Polarization-Intensity Gradient Relation in Main Filament

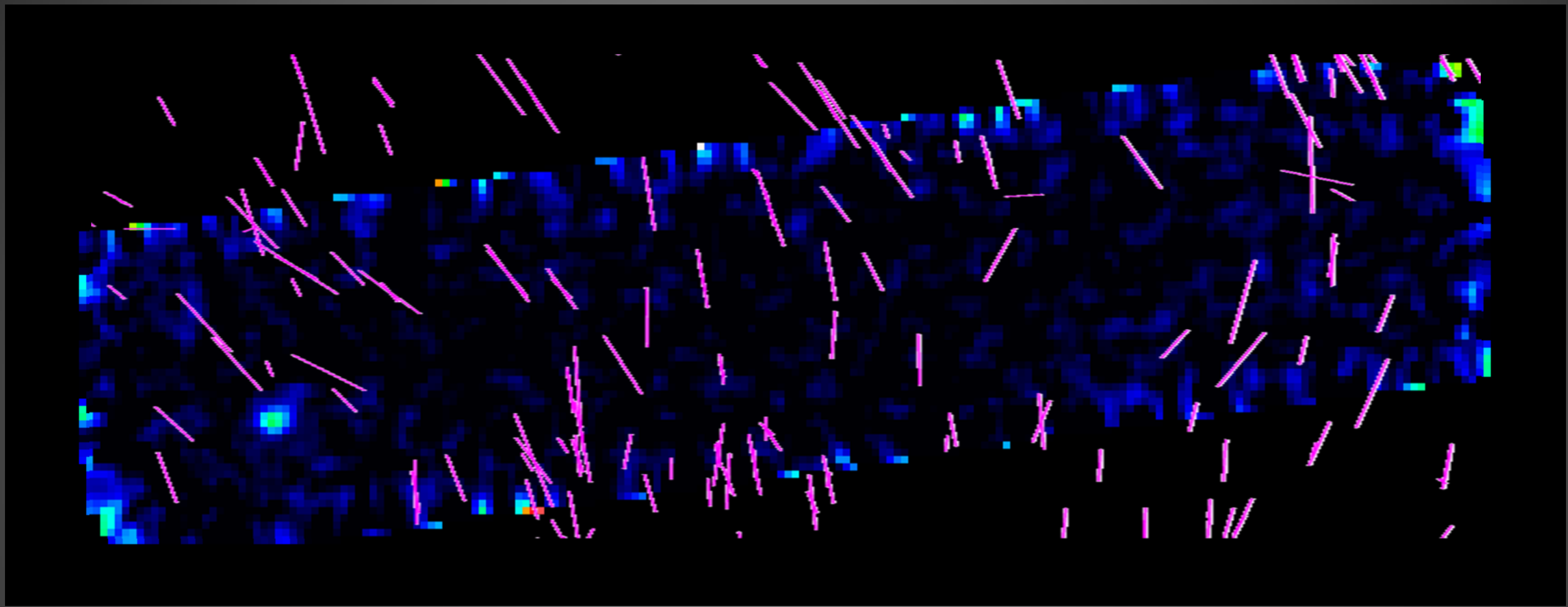
0.4 pc : PLANCK beam size

0.1 pc : Filament width

0.04 pc : Herschel beam size



Gas Kinematics in Main Filament



- JCMT 13CO 3-2 (Graham 2008)
- In few pc scale, gas flows from the center of filament toward the two ends, almost perpendicular to B-field.

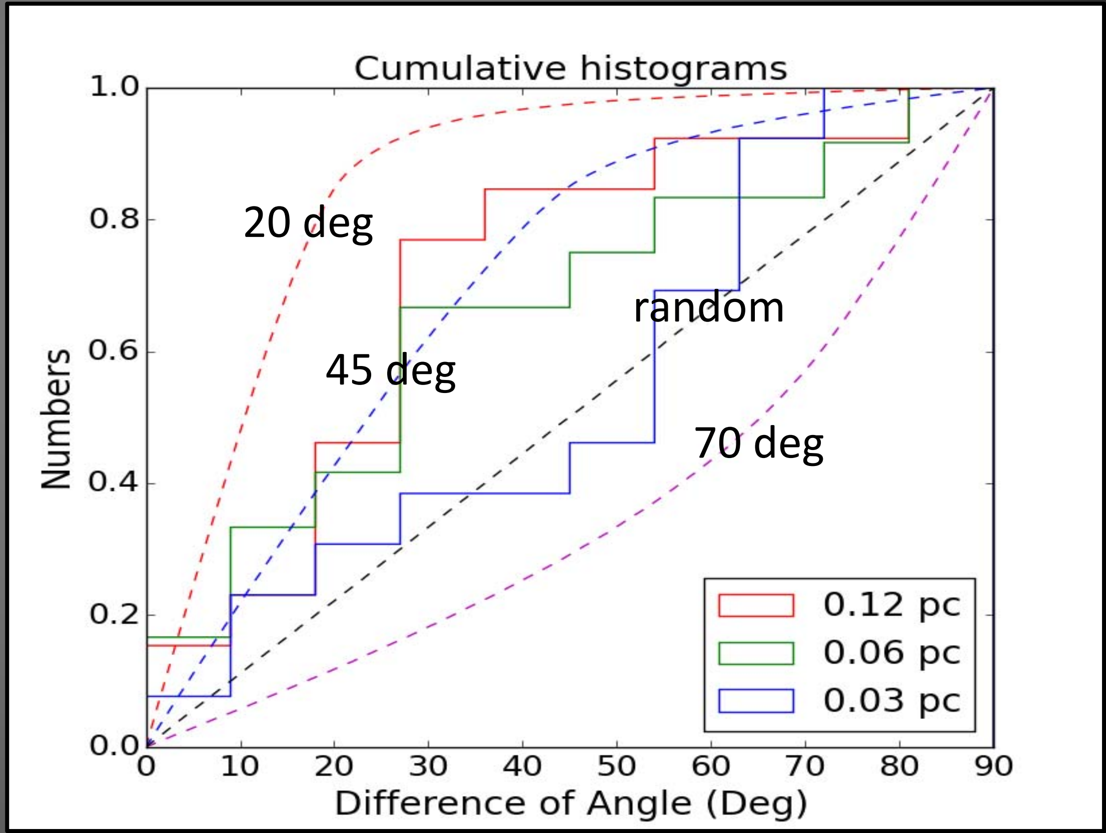
Polarization-Velocity Gradient Relation in Main Filament

- Velocity Gradient from JCMT 13CO (3-2) line
- ~0.1 pc scale velocity gradient: Radial contraction?

0.4 pc : PLANCK beam size

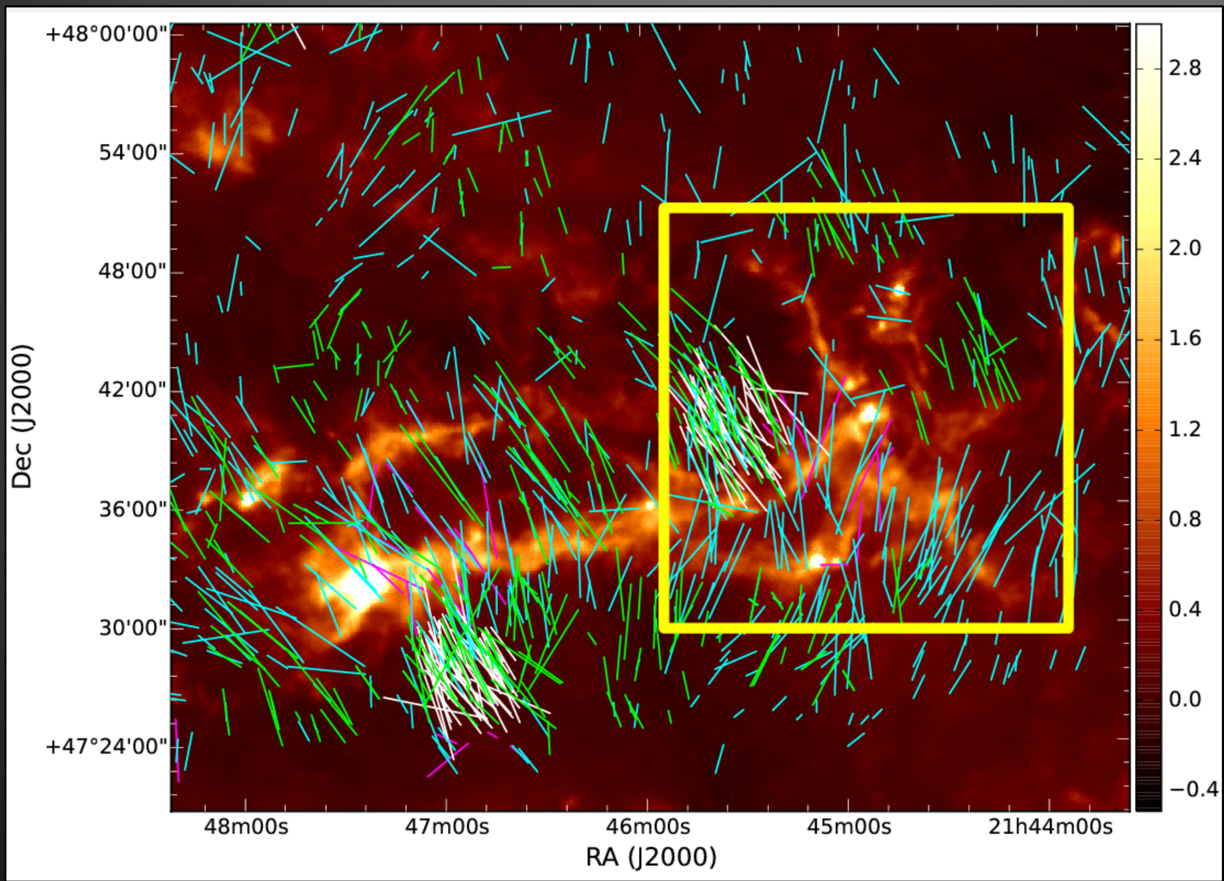
0.1 pc : Filament width

0.03 pc : JCMT beam size



Polarization-Intensity Gradient Relation in Hub-Filament System

- Hub-Filament System: Central dense hub surrounded with converging filament

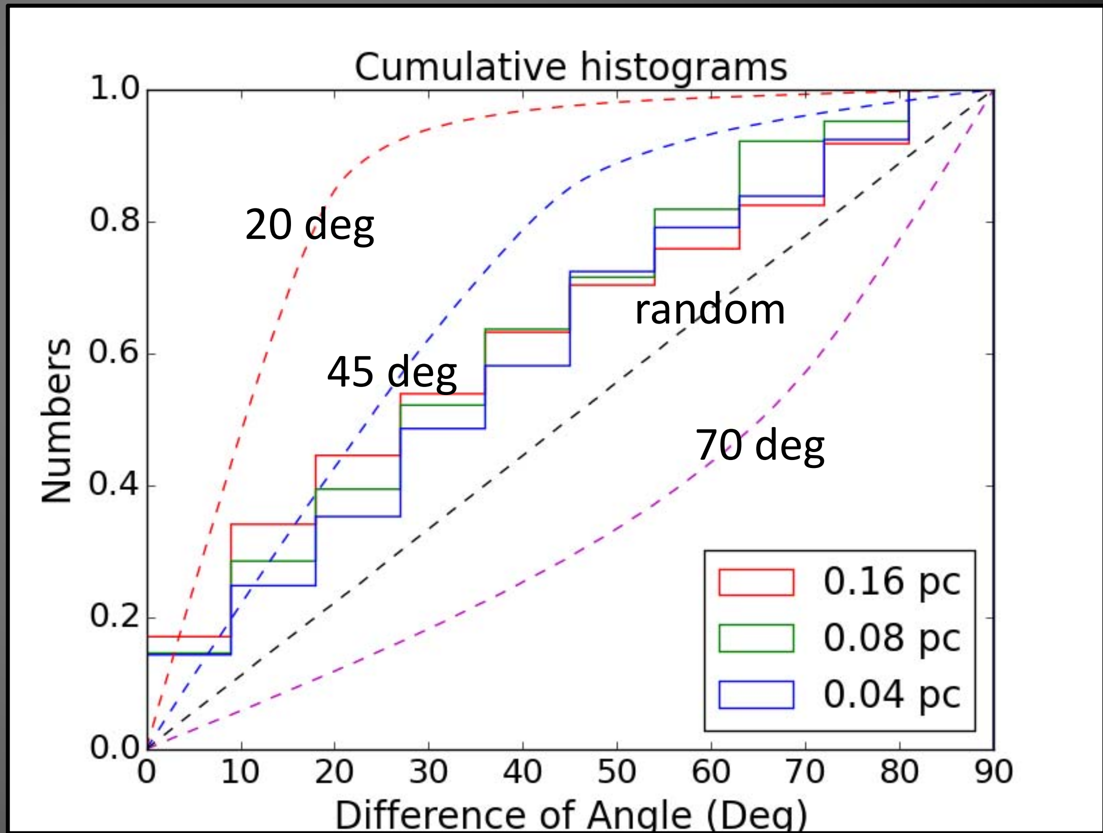


Polarization-Intensity Gradient Relation in Hub-Filament System

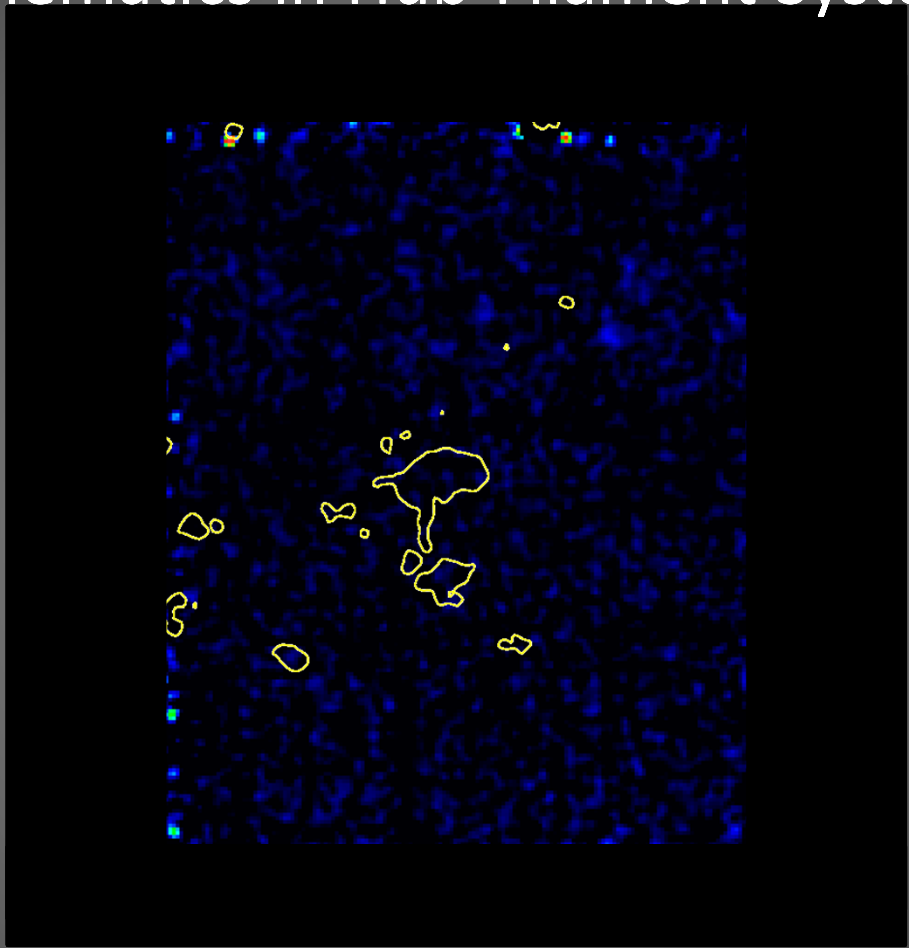
0.4 pc : PLANCK beam size

0.1 pc : Filament width

0.04 pc : Herschel beam size

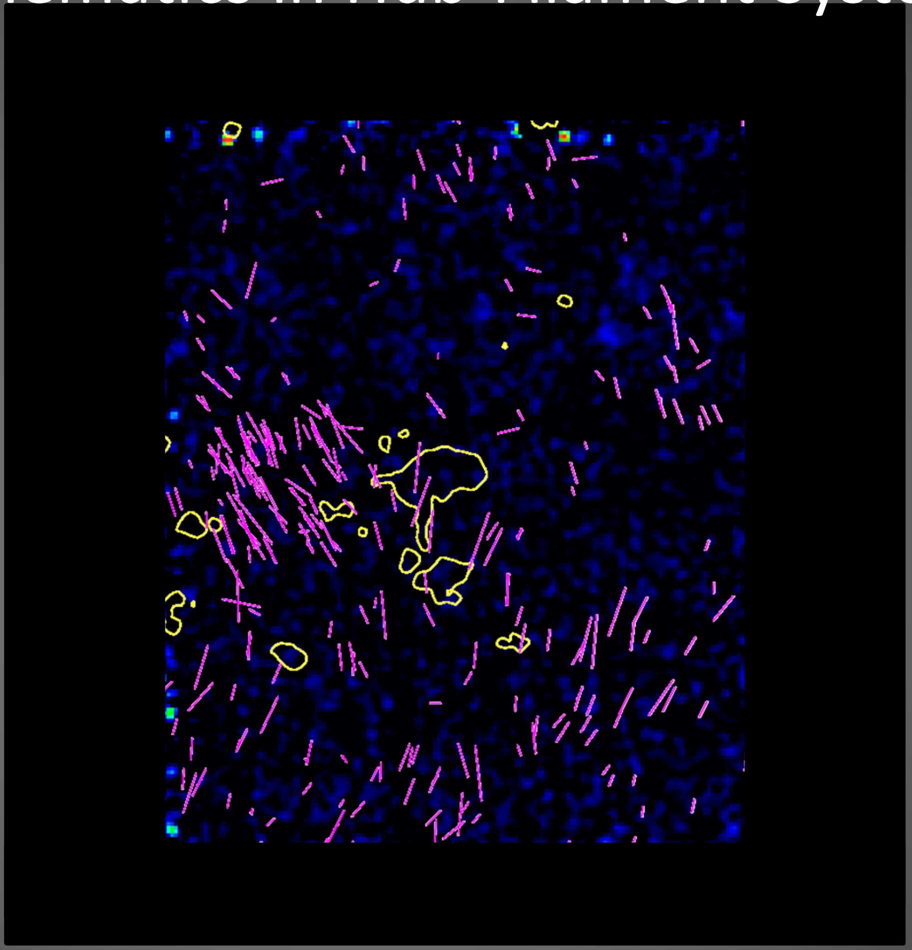


Gas Kinematics in Hub-Filament System



- JCMT ^{13}CO 3-2
- Gas flows from surrounding filaments toward the central hub and nearby cores (yellow contour, ^{13}CO 3-2 intensity peak).

Gas Kinematics in Hub-Filament System



- JCMT ^{13}CO 3-2
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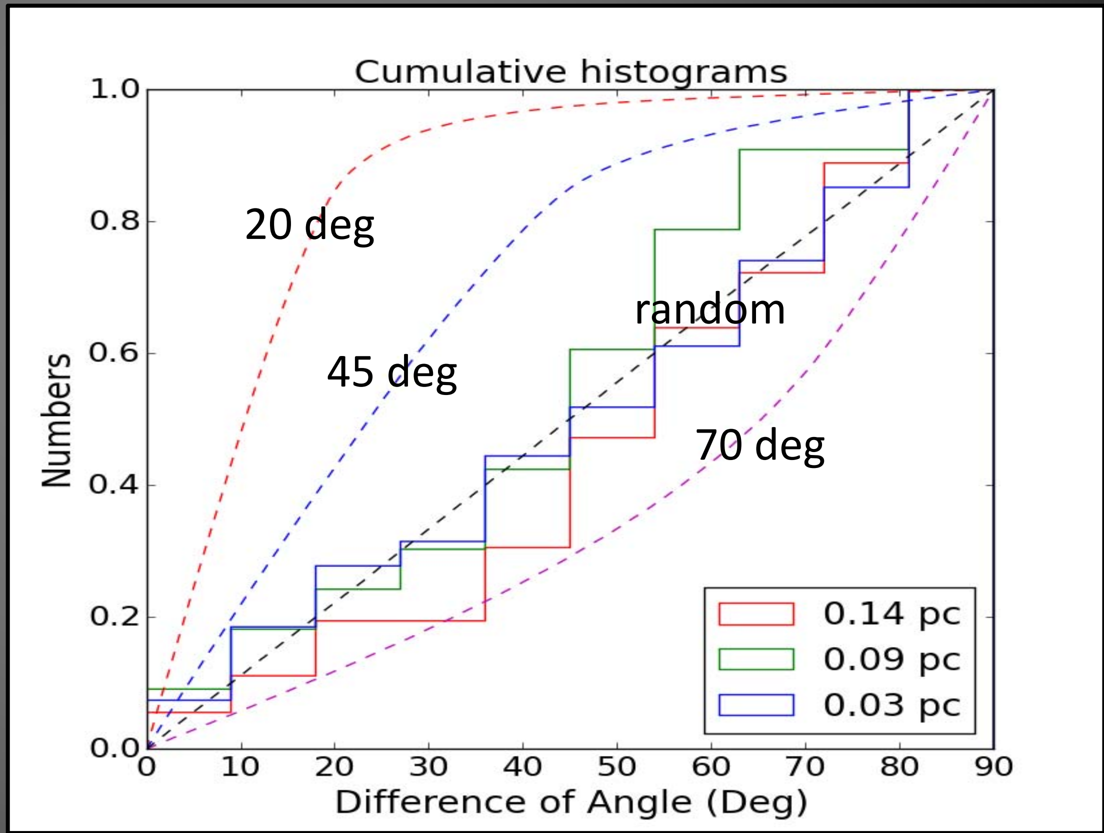
Polarization-Velocity Gradient Relation in Hub-Filament Systema

- Velocity Gradient from JCMT 13CO (3-2) line
- Randomly aligned

0.4 pc : PLANCK beam size

0.1 pc : Filament width

0.03 pc : JCMT beam size



Summary

- B-field plays different role in Main Filament and Hub-Filament system.

- In Main Filament:
  - Large scale longitudinal fragmentation, perpendicular to B-field, can be seen, but with lower velocity gradient.
  - B-field is likely guiding the radial contraction in 0.08-0.16 pc scale
  - B-field is misaligned to both density and velocity gradient at ~0.03 pc scale.

- In Hub-Filament System:
  - B-field is misaligned to both density and velocity gradient in ~0.03 – 0.16 pc scale.