Magnetic Fields within Hub-Filament Systems

Jia-Wei Wang

Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan (ASIAA)

Collaborators:
Shih-Ping Lai (NTHU), Hauyu Baobab Liu (ASIAA), Patrick Koch (ASIAA), 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

Orion A
(Ward-Thompson et al. 2017)

Perseus B1
(Coudé et al. 2019)

Oph A
(Kwon et al. 2018)
The IC5146 Hub-Filament System

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

JCMT POL-2 850 μm polarization (Wang et al. 2019)
The IC5146 Hub-Filament System

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

- Mean: $-27^\circ \pm 27^\circ$
- $\|$ : $-73^\circ$
- $\perp$ : $17^\circ$
- Mean: $28^\circ \pm 21^\circ$
- Mean: $37^\circ \pm 15^\circ$
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)

at sub-pc-scale
Filament fragmentation
Van Loo et al. (2014)

Seifried et al. (2015)
Another Story: G33.92+0.11

- Massive (~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

34' x 7'

Resolved out by POL-2

OK

ALMA DCN 3-2 map

Liu et al. (2015)
G33.92+0.11 Polarization Map

- POL-2 850 µm B-field orientation

- Histogram of B-field PA
G33.92+0.11 Polarization Map

- POL-2 850 µm B-field orientation
- ALMA Band 6 continuum
IRAM 30m C^{18}O (2-1)

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

Gaussian Amplitude

Centroid Velocity
C$^{18}$O (2-1) LOS Velocity Gradient

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

Relative angle between B-field and VG
C$^{18}$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
Comparison

- **IC5146**
  - pc-scale: pinched uniform B-field
  - B-field \(\perp\) Filament
  - B-field \(\perp\) VG
  - sub-pc-scale: 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??
  - 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