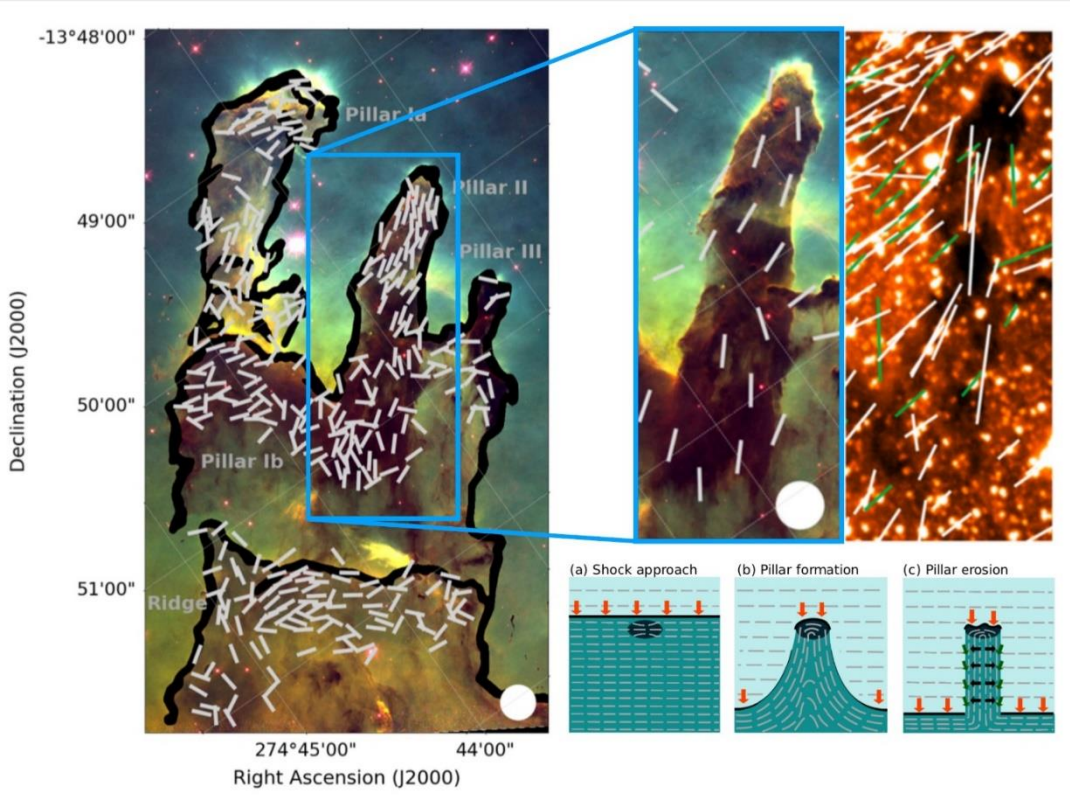
BISTRO



Pattle et al., 2018, ApJ, 860, L6

Derek Ward-Thompson

on behalf of the BISTRO Consortium

JCMT Users' Meeting, Taipei, November 6th 2019

Pierre Bastien
Mike Chen
Simon Coudé
James Di Francesco
Jason Fiege, Laura Fissell
Erica Franzmann
Doug Johnstone
Martin Houde
Kevin Lacaille
Brenda Matthews
Sarah Sadavoy
Andy Pon
Gerald Schieven
Mehrnoosh Tahani

Antonio Chrysostomou
Gary Fuller
Tim Gledhill
Jane Greaves
Matt Griffin
Jennifer Hatchell
Vera Konyves
Kate Pattle

Zhiwei Chen
Tao-Chung Ching
Eswariah Chakali
Qilao Gu
ChiYan Law
Dalei Li
Di Li
Hua-bai Li
Hong-Li Liu
Junhao Liu
Tie Liu
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Keping Qiu
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Yoshihiro Kanamori
Akimasa Kataoka
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Takayoshi Kusune
Jungmi Kwon
Masafumi Matsumura
Tetsuya Nagata
Fumitaka Nakamura
Hiroyuki Nakanishi
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Takashi Onaka ,Tae-Soo Pyo
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Hiroko Shinnaga, Yoshito Shimajiri, Motohide Tamura
Kohji Tomisaka,Yusuke Tsukamoto,Tetsuya Zenko

Ngoyen Bich Ngoc
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Do-Young Byun
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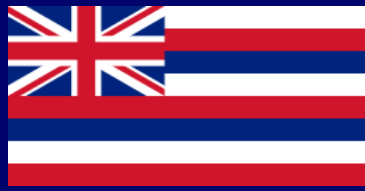
Minho Choi
Yunhee Choi
Eun Jung Chung
Ilseung Han
Thiem Hoang
Jihye Hwang
Il-Gyo Jeong
Ji-hyun Kang
Miju Kang
Sung-ju Kang
Jongsoo Kim
Kee-Tae Kim
Kyoung Hee Kim
Mi-Ryang Kim
Shinyoung Kim
Woojin Kwon
Chang Won Lee
Hyeseung Lee
Jeong-Eun Lee
Sang-Sung Lee
Young-Hee Lee
Tie Liu, Aran Lyo
Gemsook Park
Hyunju Yoo

Vivien Chen
Wen Ping Chen
Lapo Fanciullo
Ciska Kemper
Patrick Koch
Shih-Ping Lai
Sheng-Yuan Liu
Ramprasad Rao
Ya-Wen Tang
Jia-Wei Wang
Hsi-Wei Yen



David Berry
Per Friberg
Sarah Graves
Steve Mairs
Harriet Parsons
Mark Rawlings

Commercial Break

‘The role of magnetic fields in the formation of stars’

https://www.frontiersin.org/research-topics/7375/the-role-of-magnetic-fields-in-the-formation-of-stars

Editors: D Ward-Thompson, C F McKee, R S Furuya, Y Tsukamoto

Articles:

Magnetic fields and Protostellar discs – Wurster & Lu
Magnetic fields, the SFR and the IMF – Krumholz & Federrath
Interferometric observations of magnetic fields – Hull & Zhang
Magnetic fields and molecular cloud evolution – Hennebelle & Inutsuka
Submillimetre observations of magnetic fields – Pattle & Fissell
Numerical methods and simulations – Teyssier & Commercon
Magnetic fields and outflows – Pudritz & Ray
Zeeman observations of star formation – Crutcher & Kemball

frontiers Research Topics

Frontiers in Space Science
Topic: 7375

BISTRO: Overview

- Aims to map star-forming regions in polarised light at 450 & 850 microns
- Awarded 448 hours of Bands 1 & 2 observing time in 32 fields
- 129 members (~20% here) across 7 partner regions & EAO, plus 10 associates
- P.I.s: Derek Ward-Thompson (UK & Ireland), Keping Qiu (China), Tetsuo Hasegawa (Japan), Woojin Kwon (Korea), Shih-Ping Lai (Taiwan), Pierre Bastien (Canada), Diep Ngoc (Vietnam)
- DR team incudes at least ~3 members from each partner region
- We aim to map the high-column-density regions of many star-forming regions

BISTRO-1: 224 hours (B2)

MAIN GOALS:

- To map the magnetic field within low-mass cores and filaments, on scales of ~1000 AU
- To determine magnetic field strengths and morphologies in 13 nearby molecular clouds
- To 'complete' the JCMT Gould Belt Survey

CURRENT STATUS:

- All observing complete – 100% of programme observed !!! Thank you EAO ☺
- 6 x 1G papers published: 8 more in prep
- 2 x 2G papers published plus one 'spin-out' review paper
- All data reduction complete

BISTRO-2: 224 hours (B1&2)

MAIN GOALS:

- To map the magnetic field within both low-mass and higher mass regions (sample 'mass axis' of star formation models) – 16 more fields to 2.5 kpc
- Also include 450 micron observations in selected fields (preliminary studies of wavelength dependence of magnetic fields)

CURRENT STATUS:

- Observing ongoing – ~80% of programme observed – thanks again EAO ☺
- 1 x pre-1G paper published: 7 more in prep
- 5 x 2G papers in prep
- Data reduction ongoing – new data reduction strategy for faint regions and for 450-micron data

BISTRO-3: 224 hours (???)

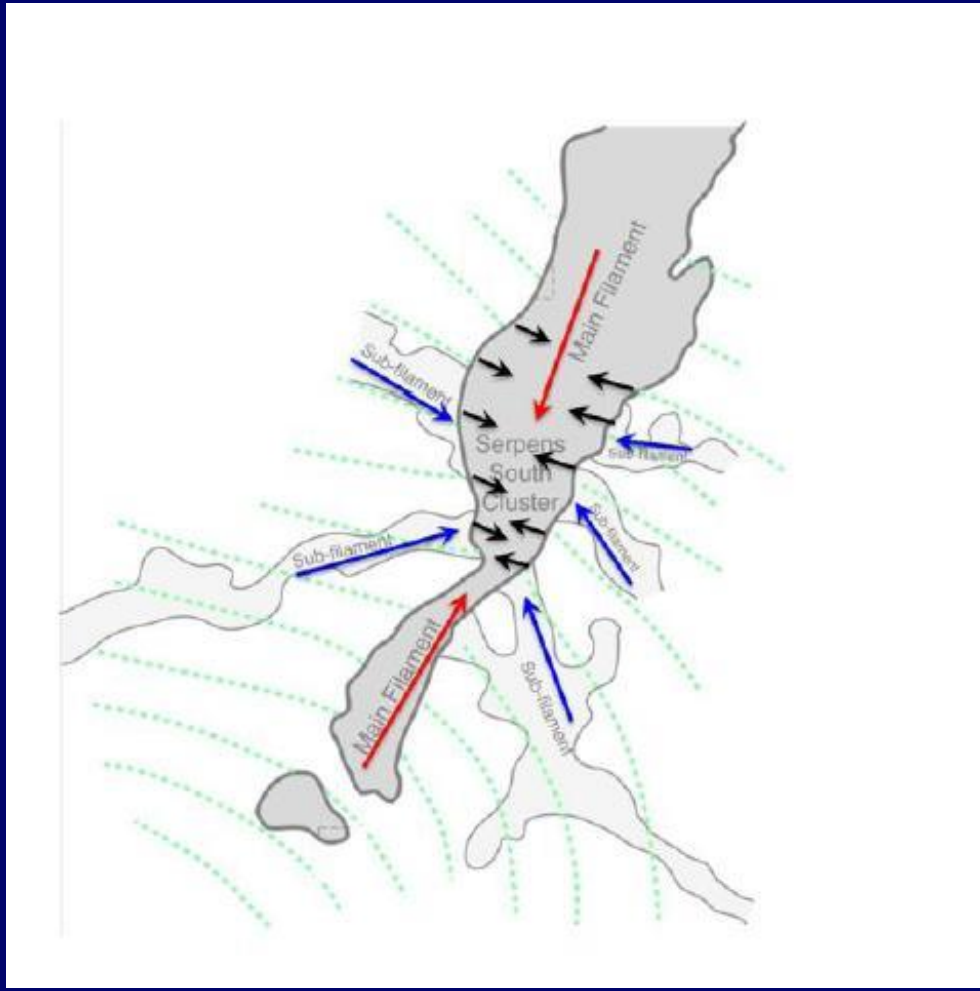
MAIN GOALS:

- To map the magnetic field within much higher mass regions (sample ‘resolution axis’ of star formation models) – 16 more fields out to GC
- To map regions at different evolutionary status including much younger and fainter regions (sample ‘evolutionary axis’ of models)
- Also include 450 micron observations in selected fields (extended studies of wavelength dependence of fields)

CURRENT STATUS:

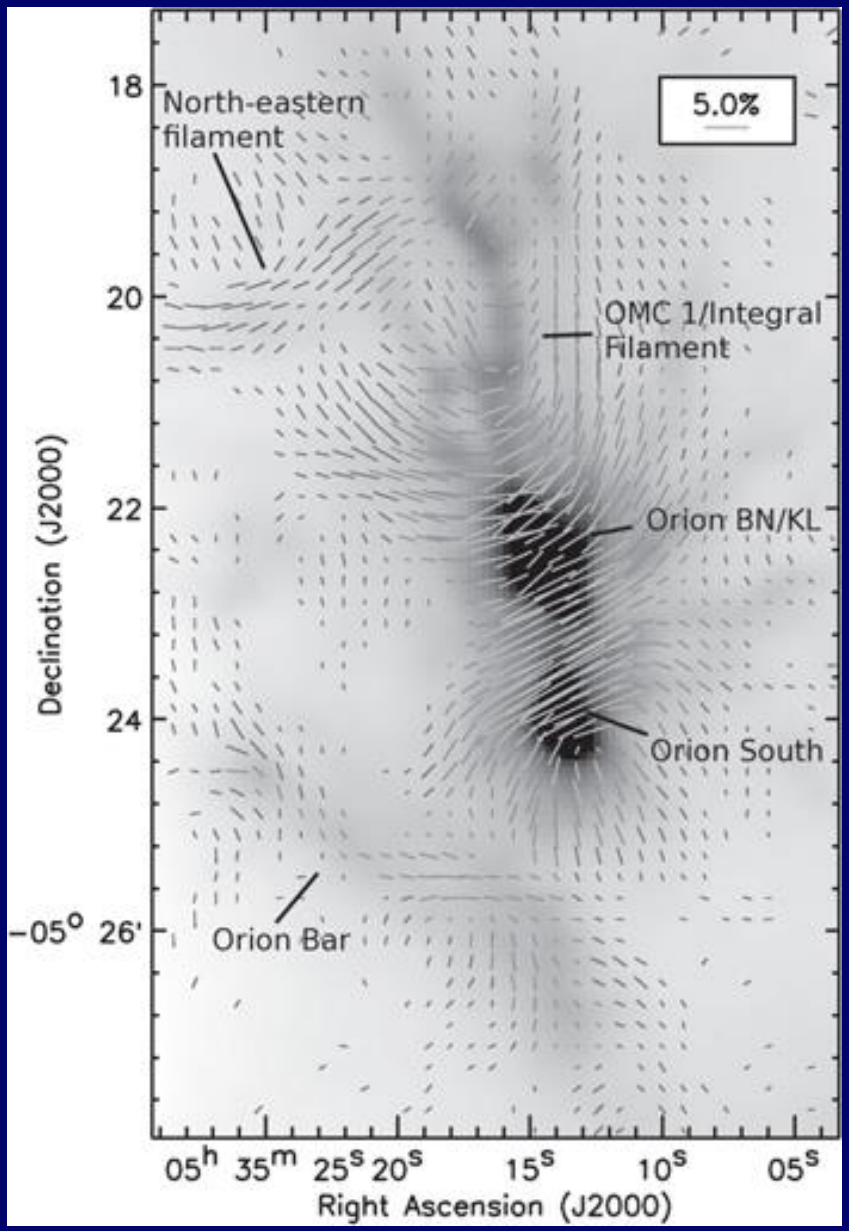
- Application submitted…

The model



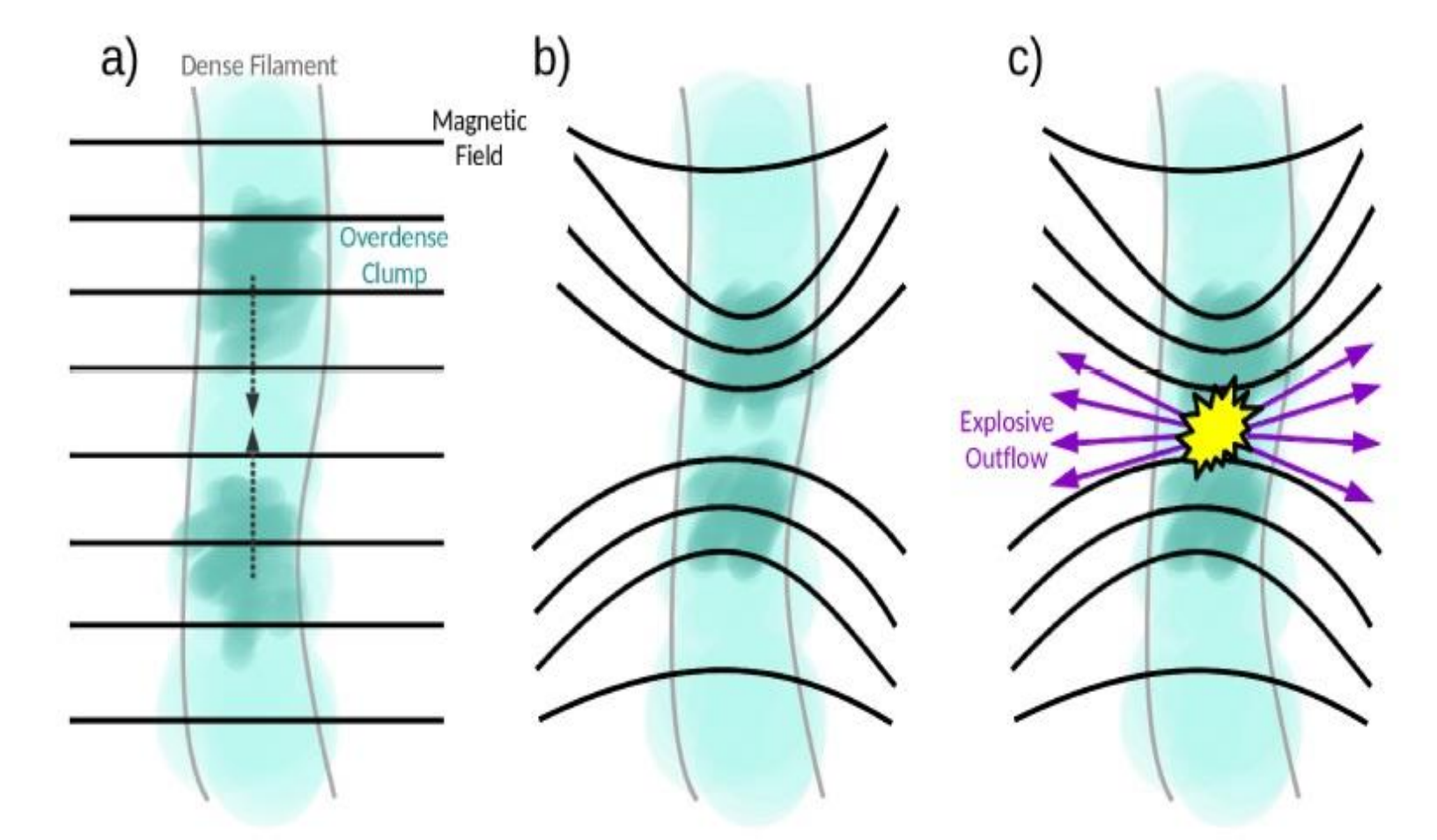
Andre et al., 2014, PPVI, pp.27-51

Orion A



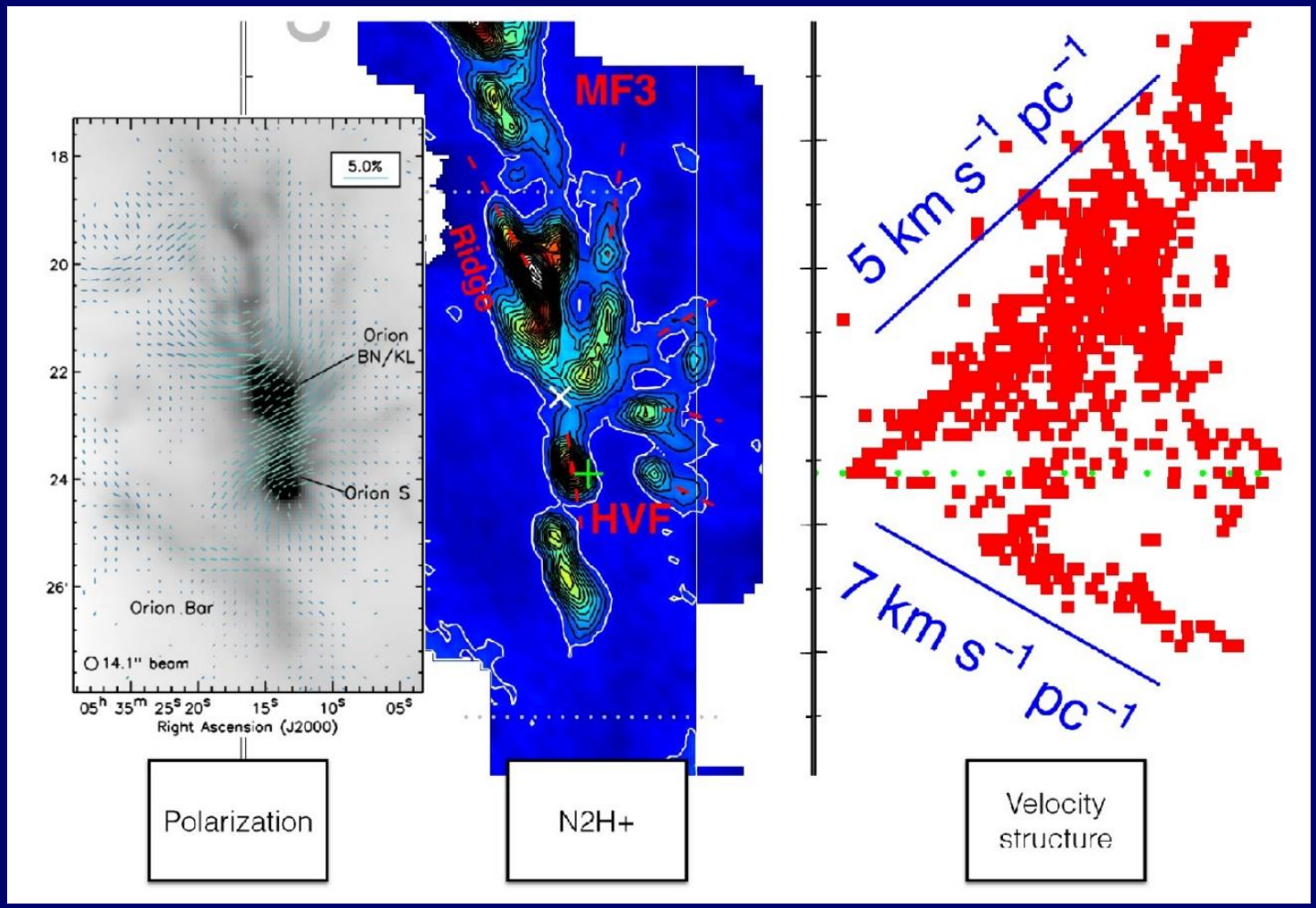
Ward-Thompson et al 2017
ApJ 842, 66

A magnetic ‘spring’



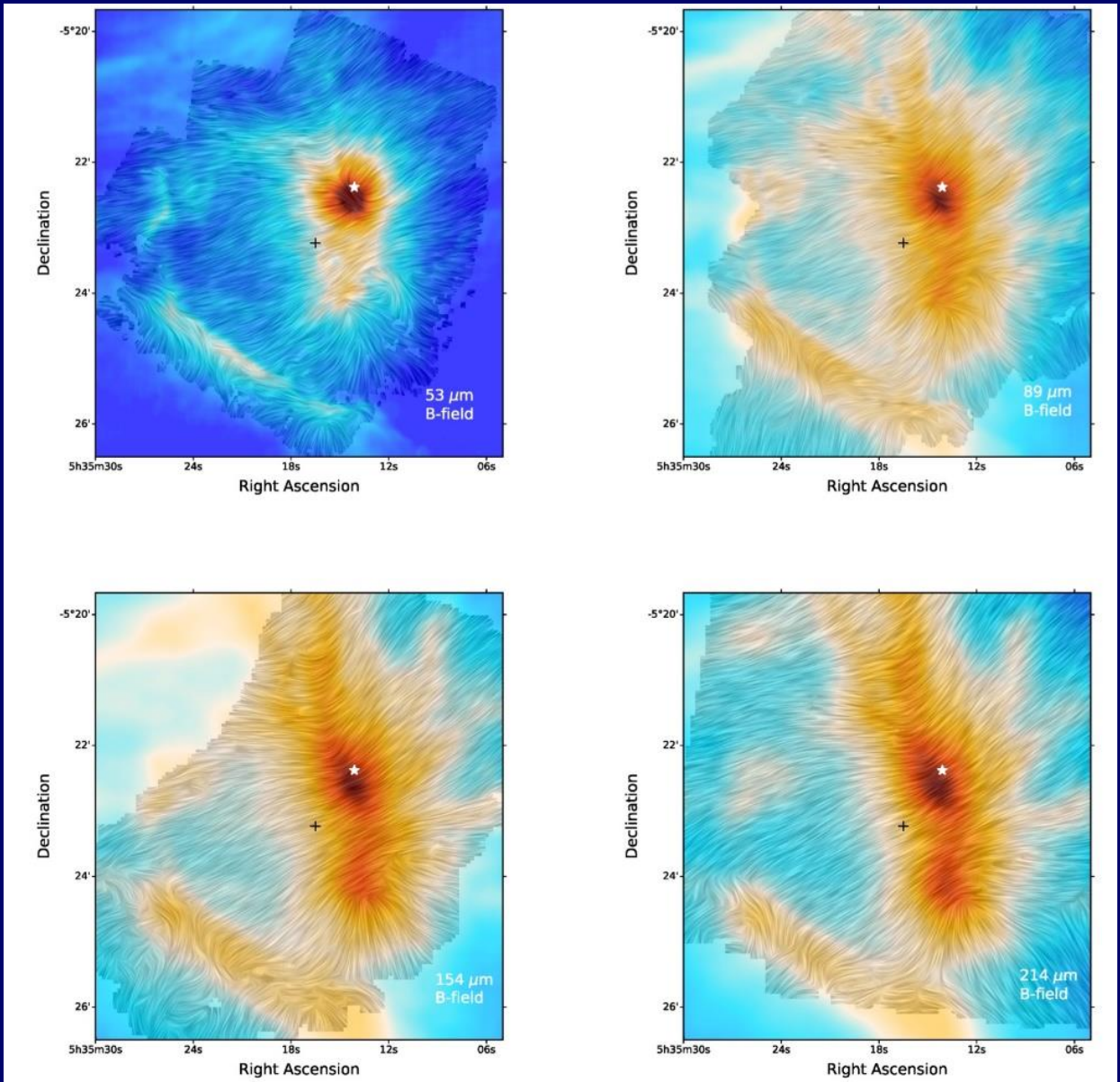
Pattle et al 2017, ApJ, 846, 122

Observed velocities



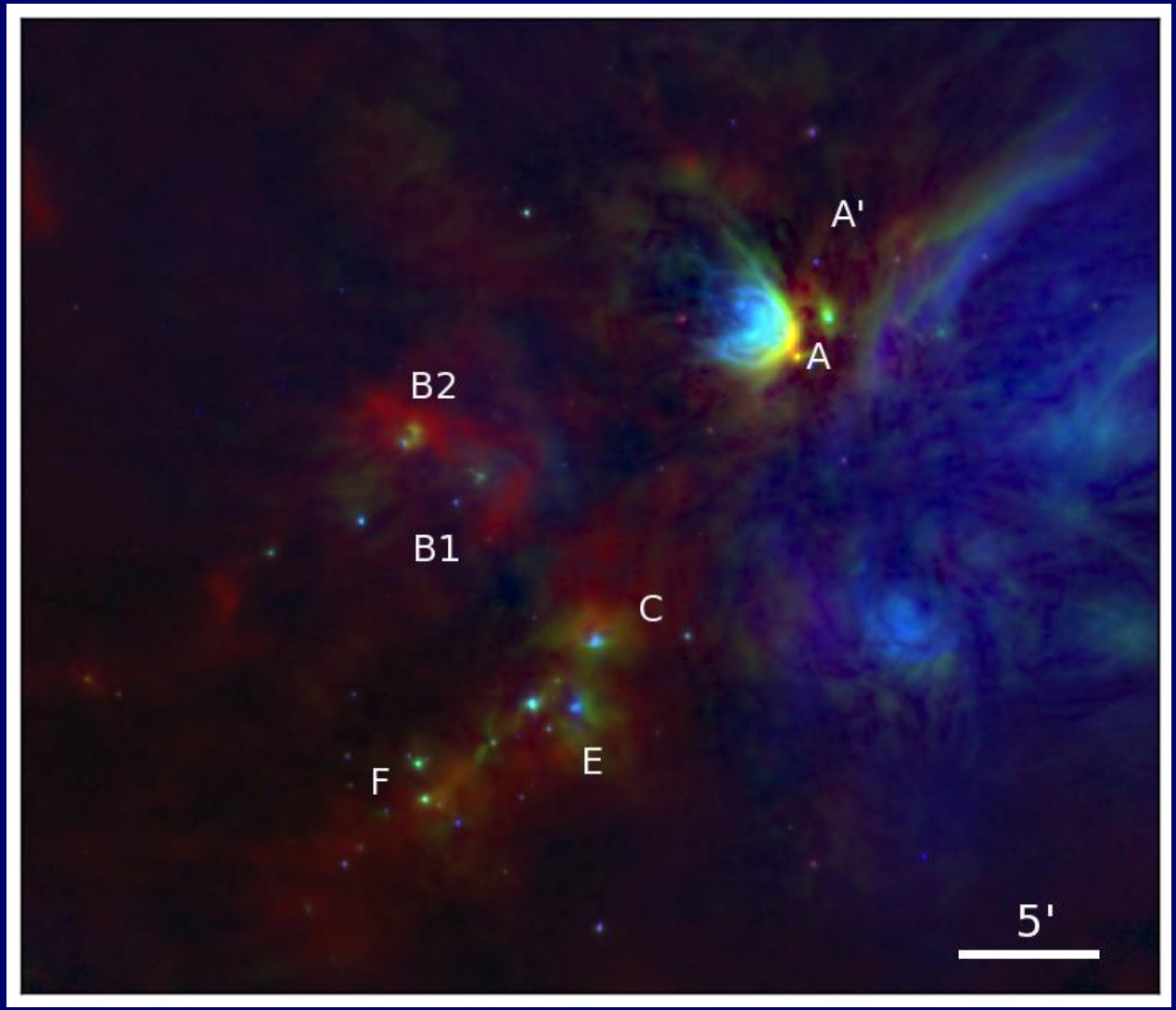
Hacar 2018 (priv comm); Hacar et al 2017 A&A 602, L2

Orion A with SOFIA



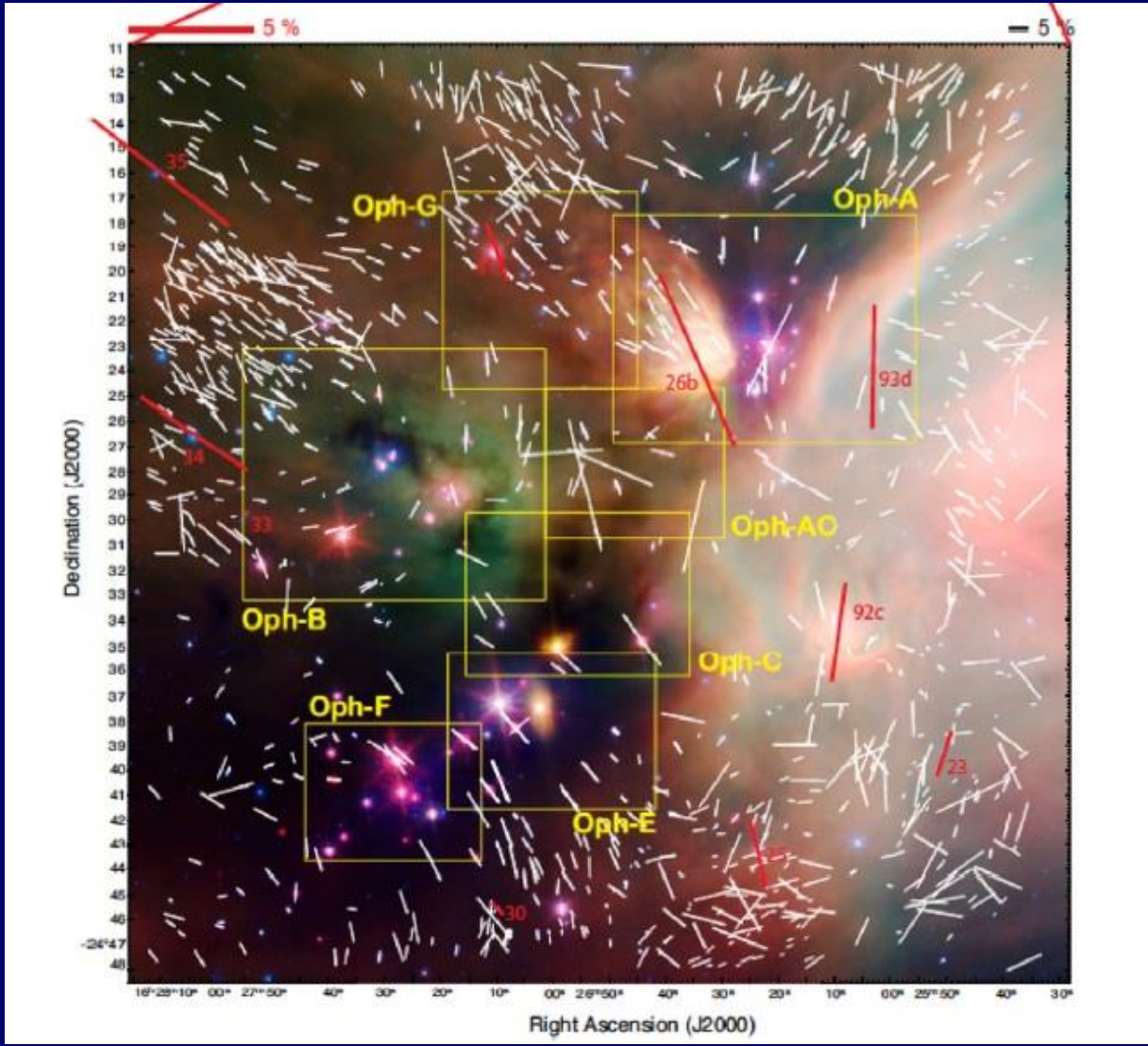
Chuss et al., 2019, ApJ, 872, 187

Ophiuchus – L1688



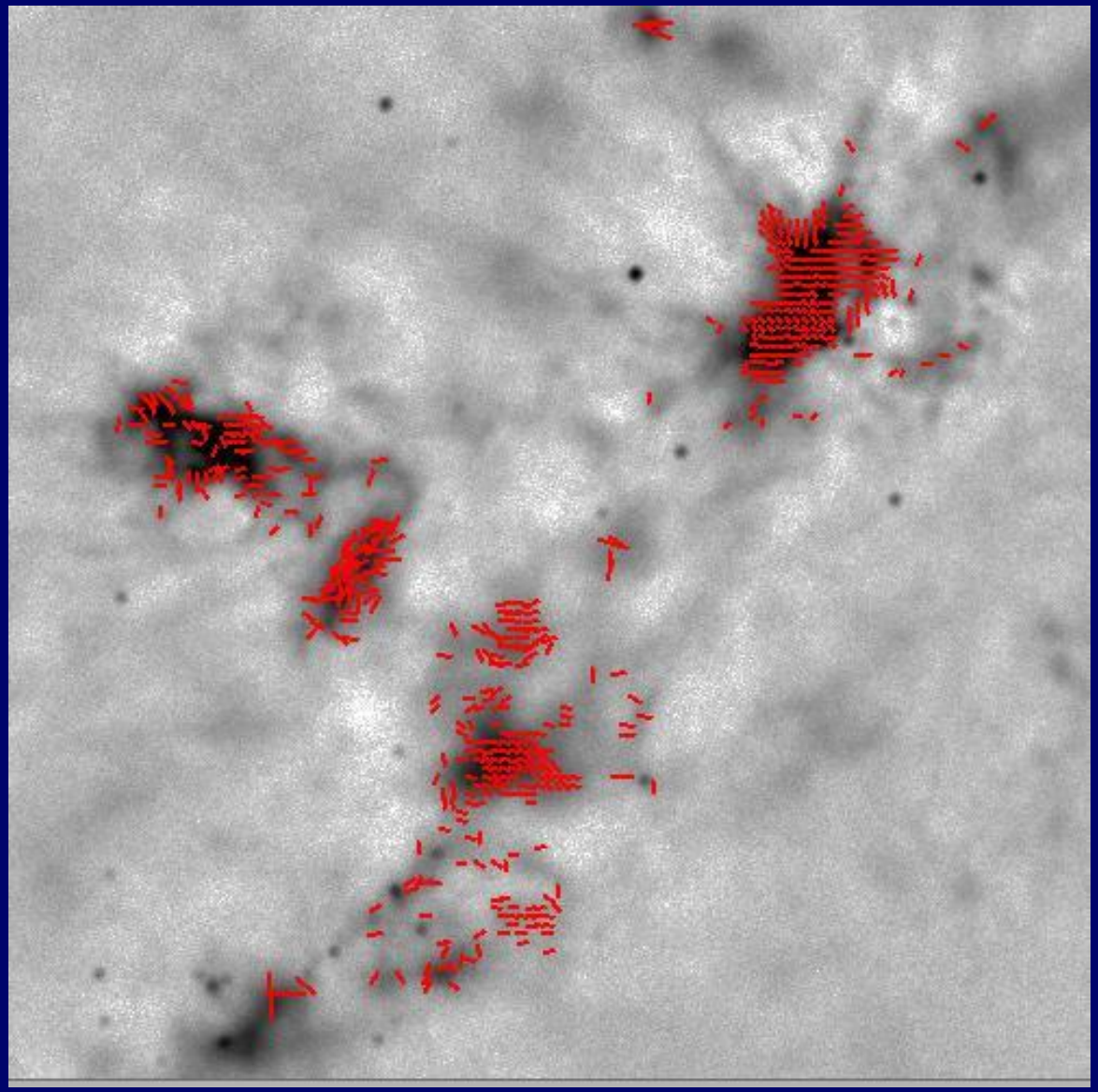
Pattle et al. 2015, MNRAS, 450, 1094

NIR Polarisation



Kwon et al 2015, ApJS, 220, 17

Ophiuchus – L1688

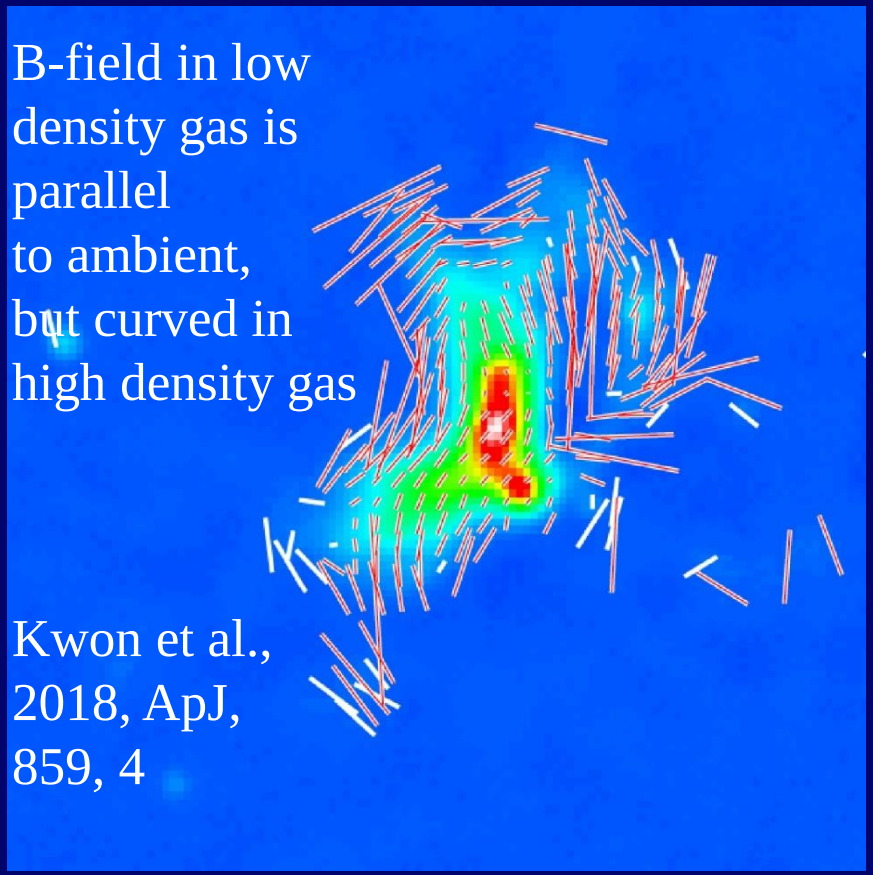


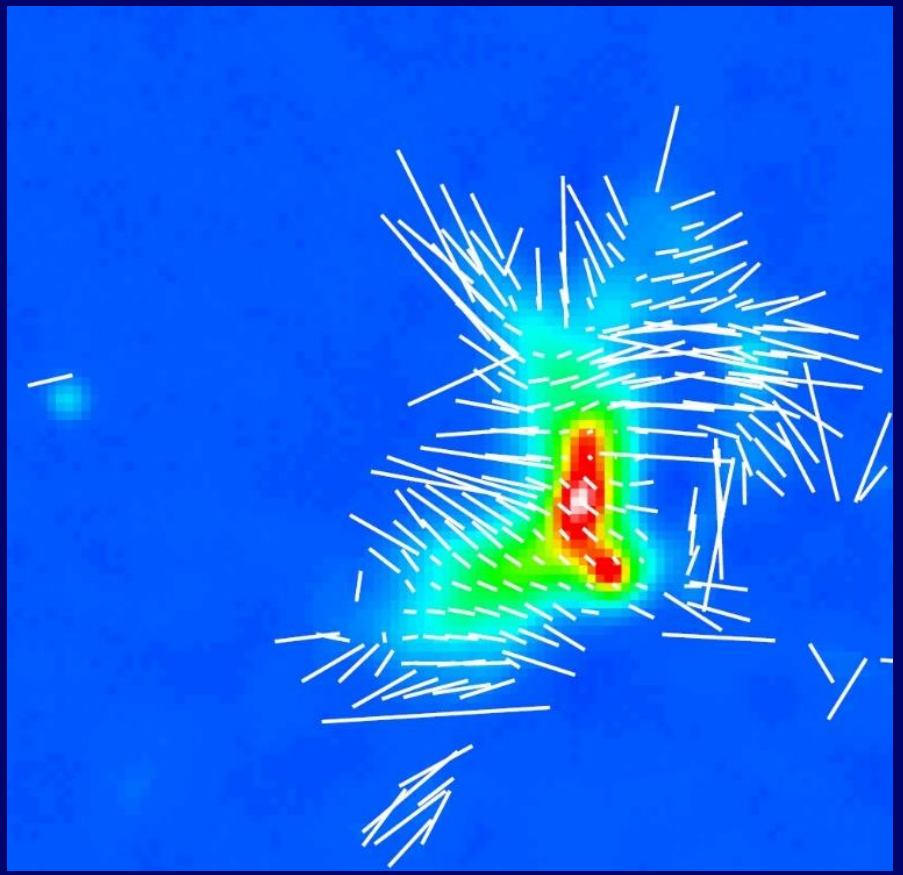
Field seen in NIR (ambient) lies at ~50 degrees

Pattle et al 2019, ApJ 880, 27

Oph A

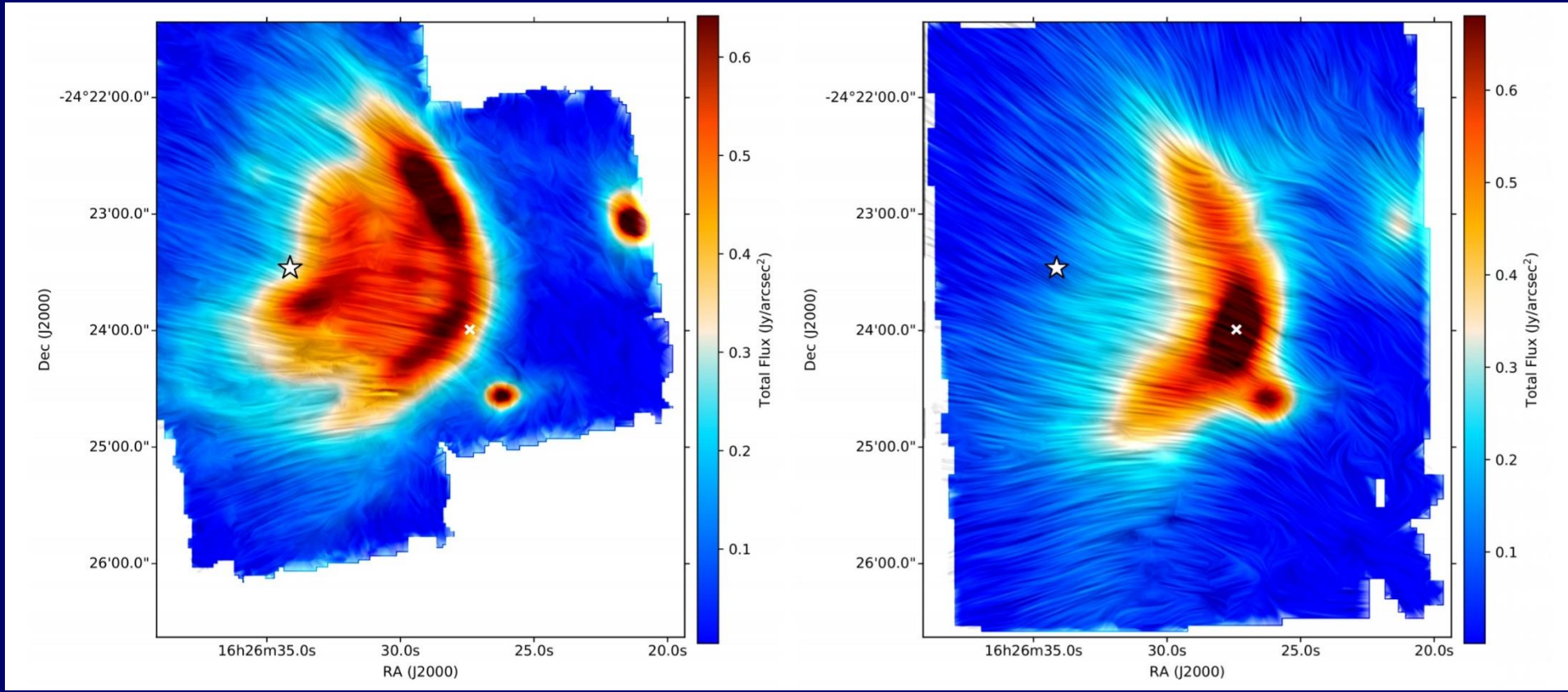
B-field in low density gas is parallel to ambient, but curved in high density gas





Kwon et al., 2018, ApJ, 859, 4

SOFIA

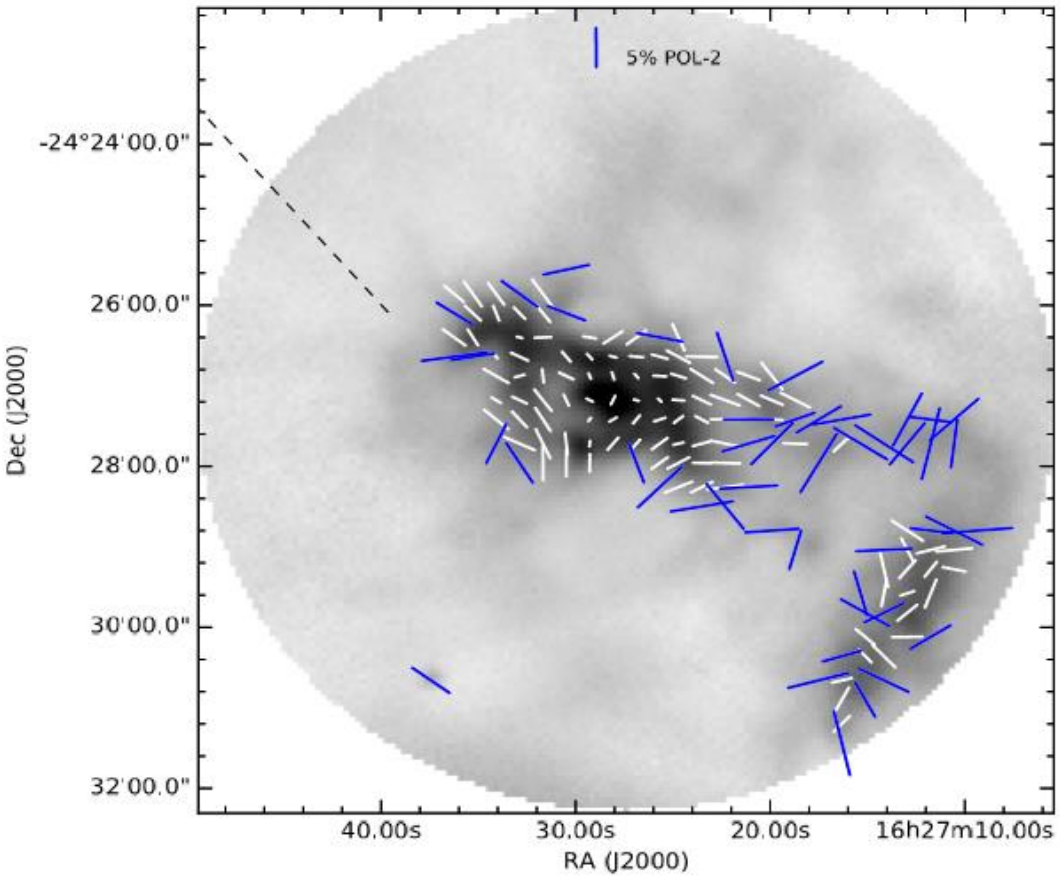


Santos et al., 2019, ApJ, 882, 113

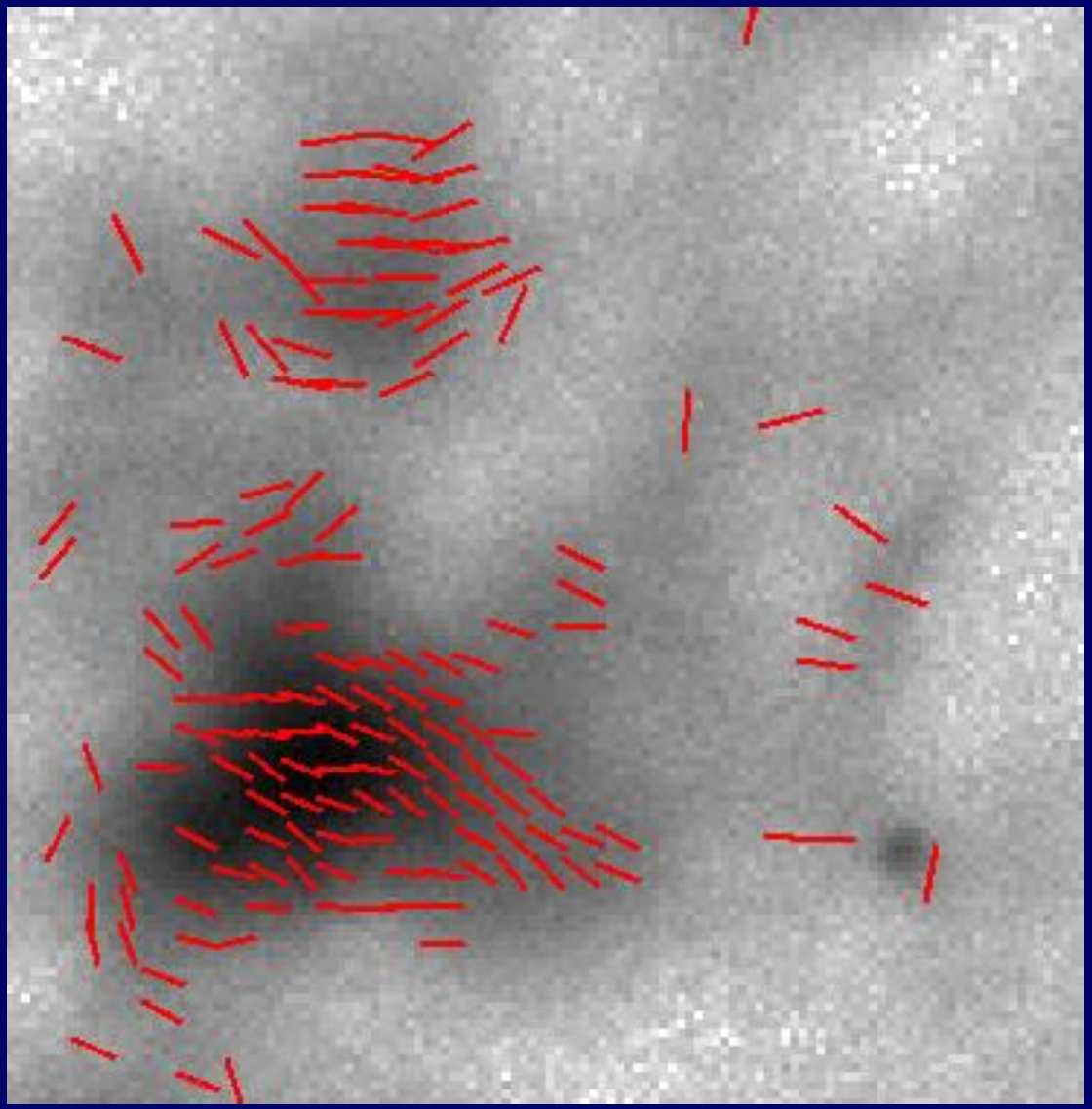
Oph B

Field more disordered, but parallel to ambient in east, orthogonal in west

Soam et al., 2018, ApJ, 861, 65



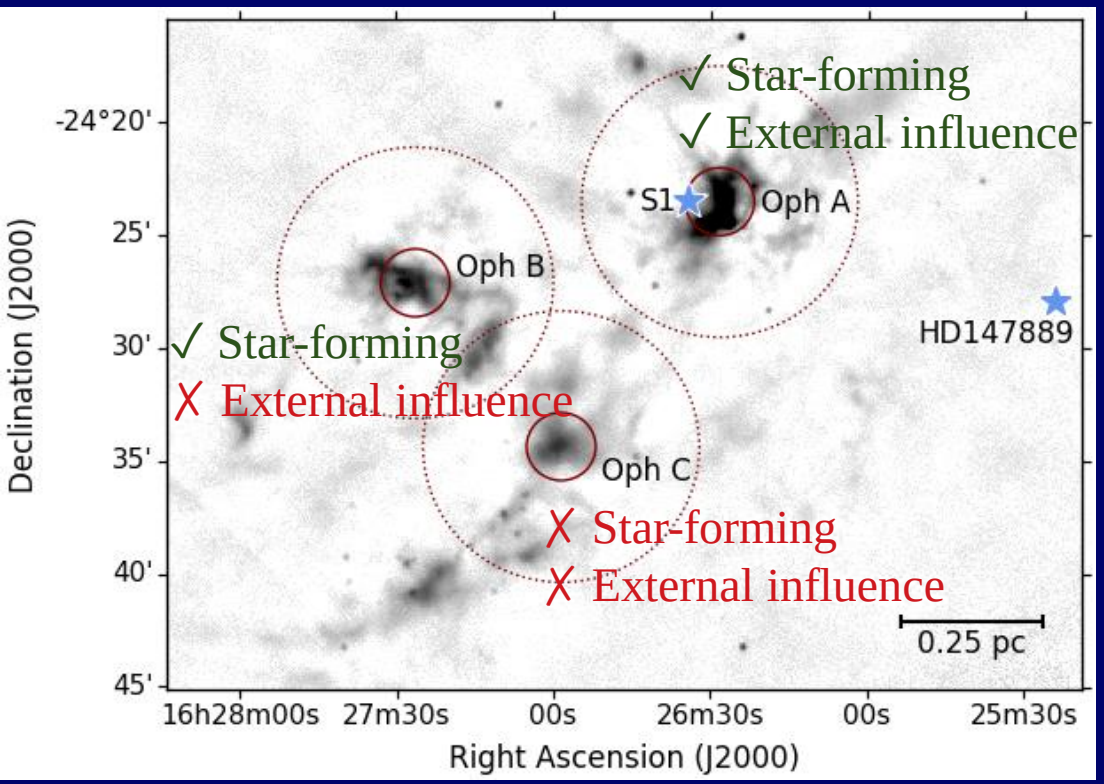
Oph C

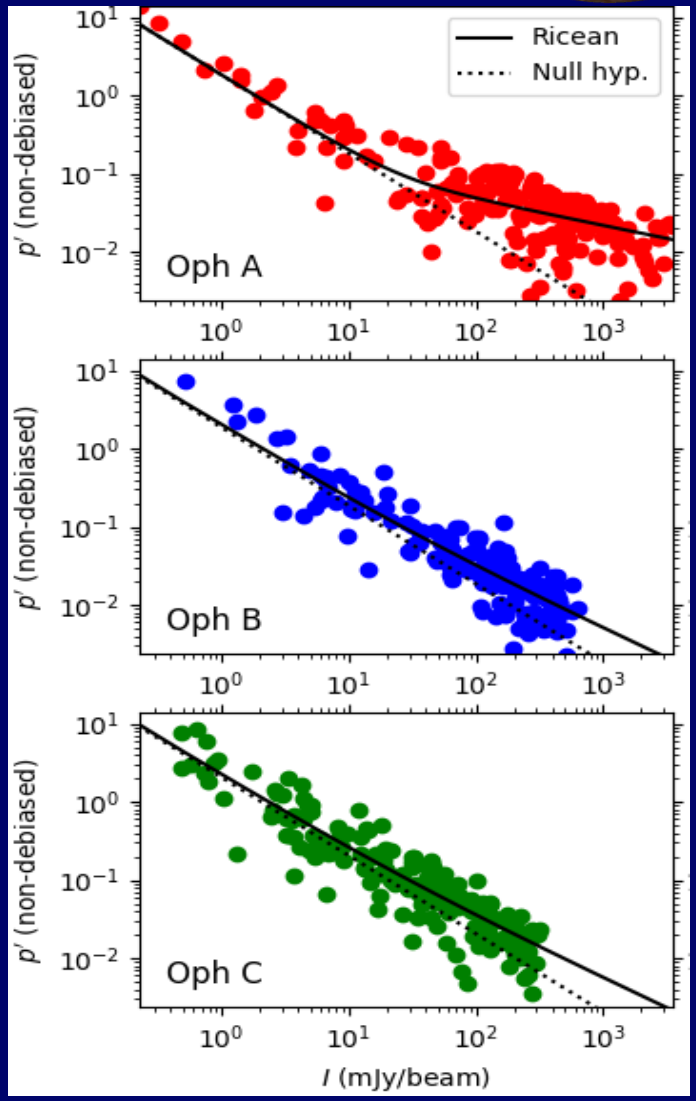


Field parallel to ambient in south, rotated in north

Liu et al., 2019, ApJ 877, 43

Ricean Statistics





Pattle et al. 2019, ApJ 880 27

Serpens Main

Vectors show field (blue>3σ red>2σ)

Field perp to filaments

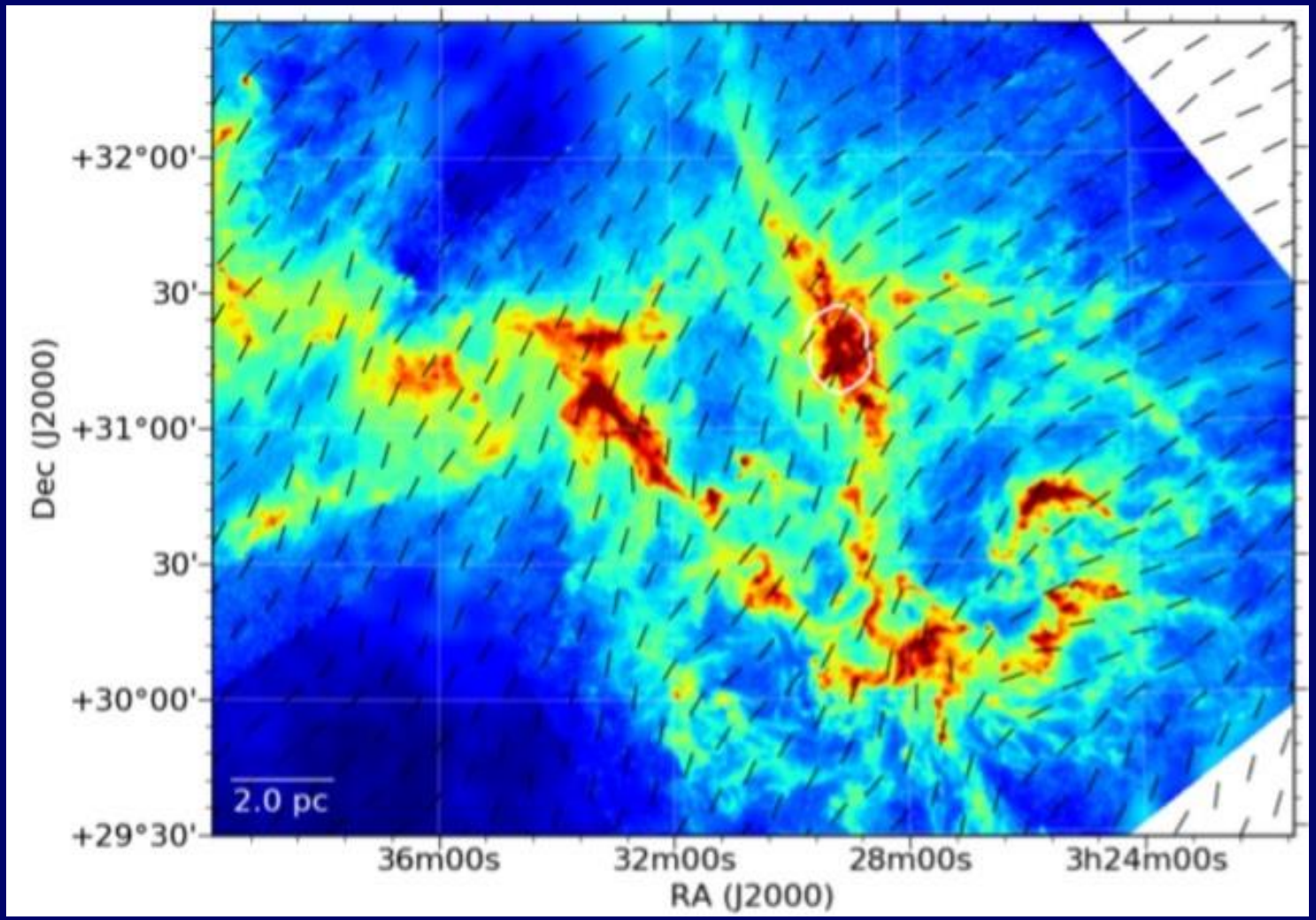
%age pol. reduces in high density regions

IMAGE REDACTED

W Kwon et al., 2019 in prep

N2H+ CARMA image from Lee, Kwon et al., 2014

NGC1333 Planck



Planck Collaboration (2016) on Herschel tau

NGC1333 BISTRO

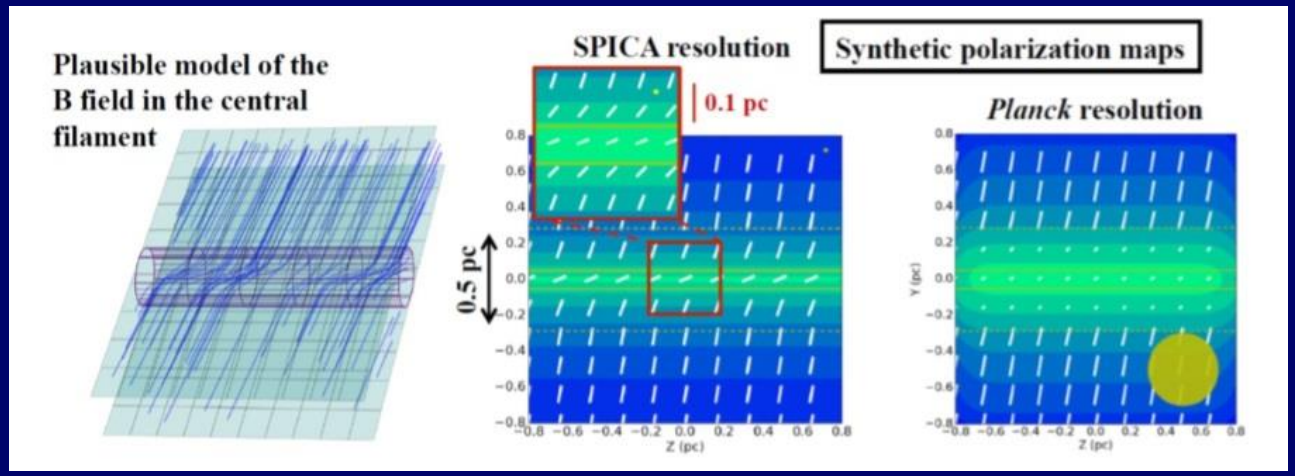
Doi et al., (2019) in prep.

IMAGE REDACTED

NGC1333 Filaments

Doi et al.,
2019,
in prep.

IMAGE REDACTED



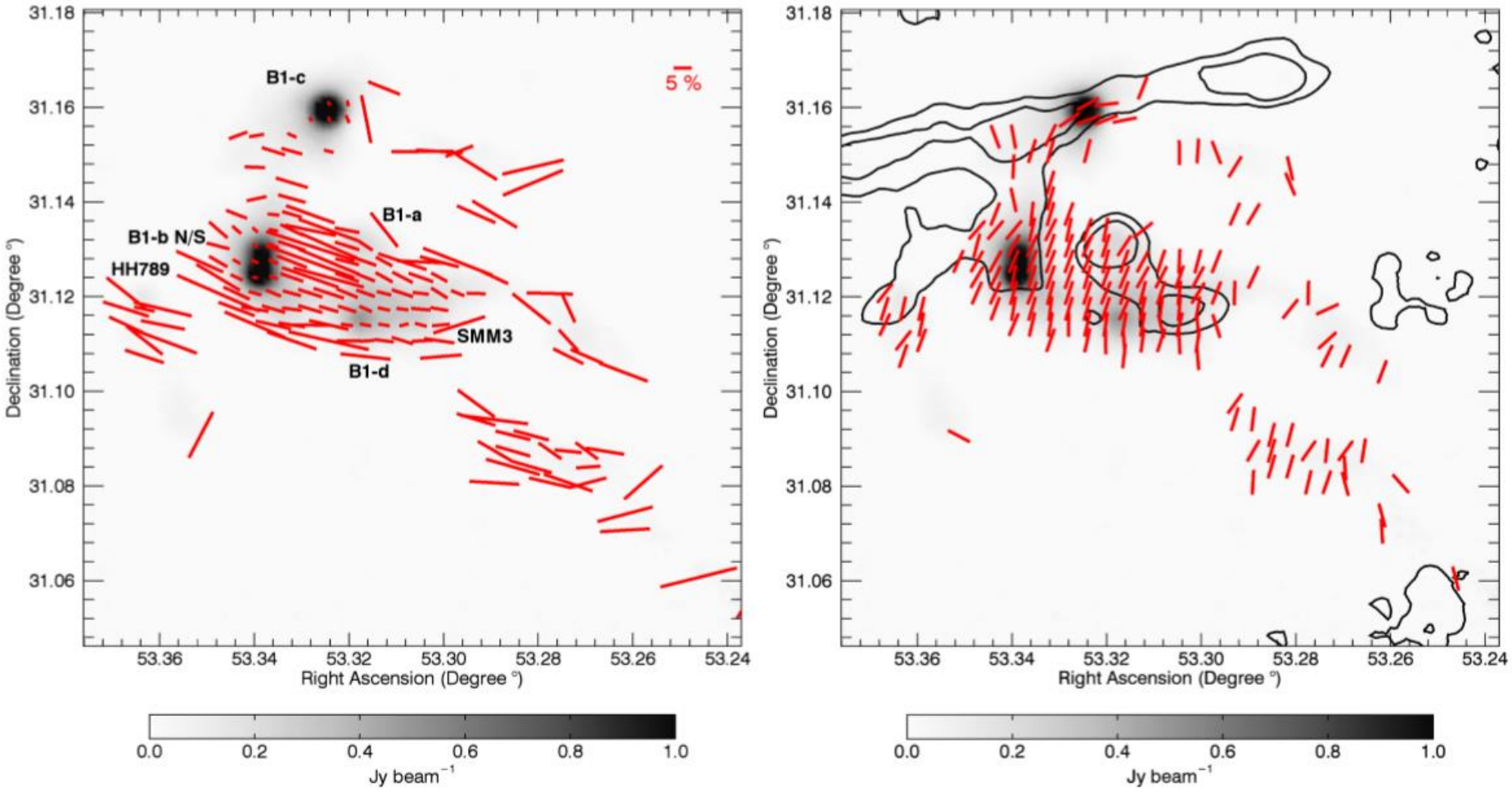
Andre et al., 2019, PASA 36, 29

NGC1333 Protostars

IMAGE REDACTED

BISTRO B-fields
(Doi et al 2019 in prep)
vs
CARMA B-fields
(Hull et al 2014, ApJS 213,13)

Perseus B1



Coudé et al, 2019, ApJ, 877, 88

B-field ~ 120+/-60uG

L1689B

Faintest object so far observed.

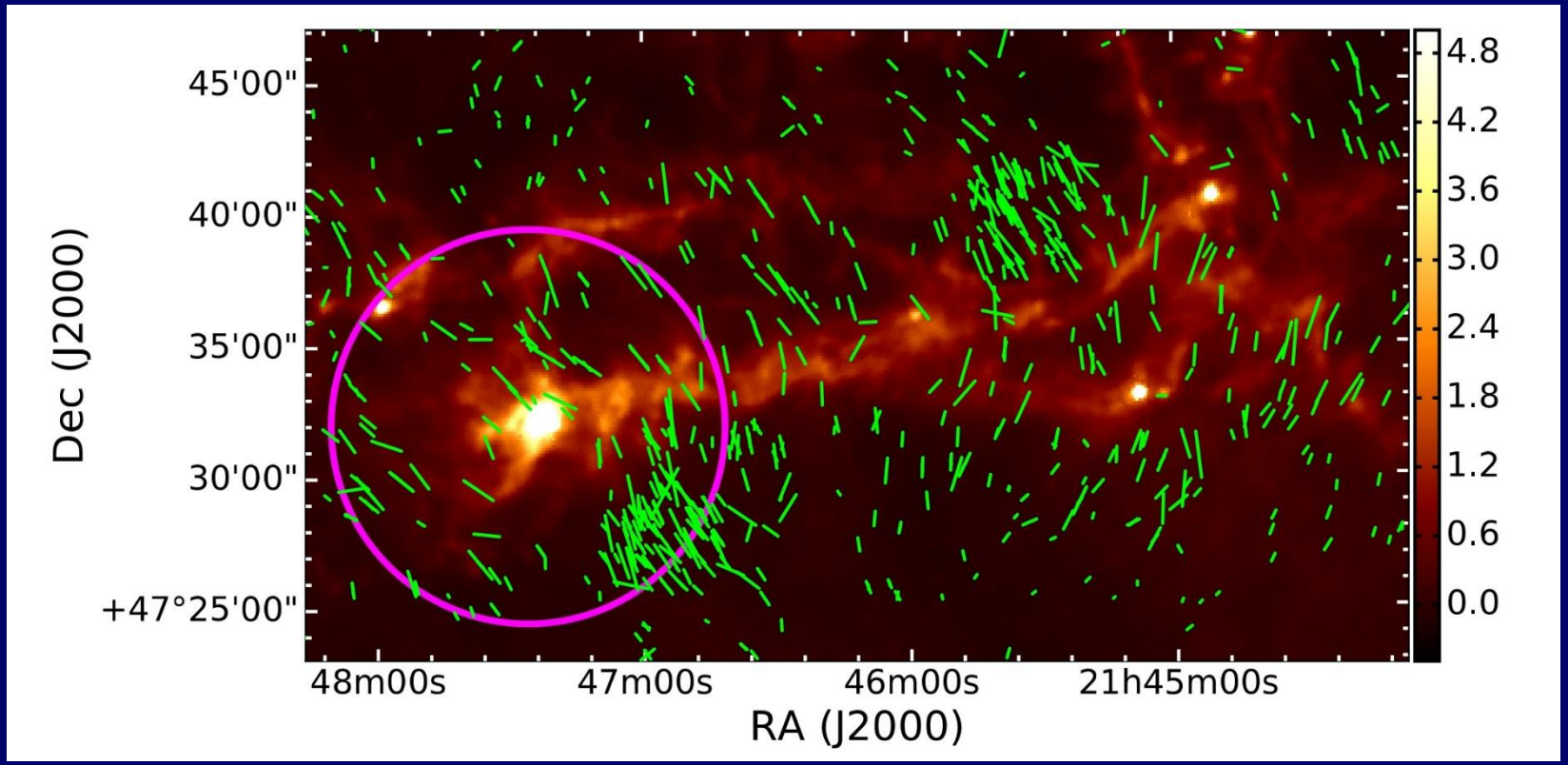
Field roughly north-south, rotates in centre.

Perp. to core/filament.

Ward-Thompson et al., 2019, in prep

IMAGE REDACTED

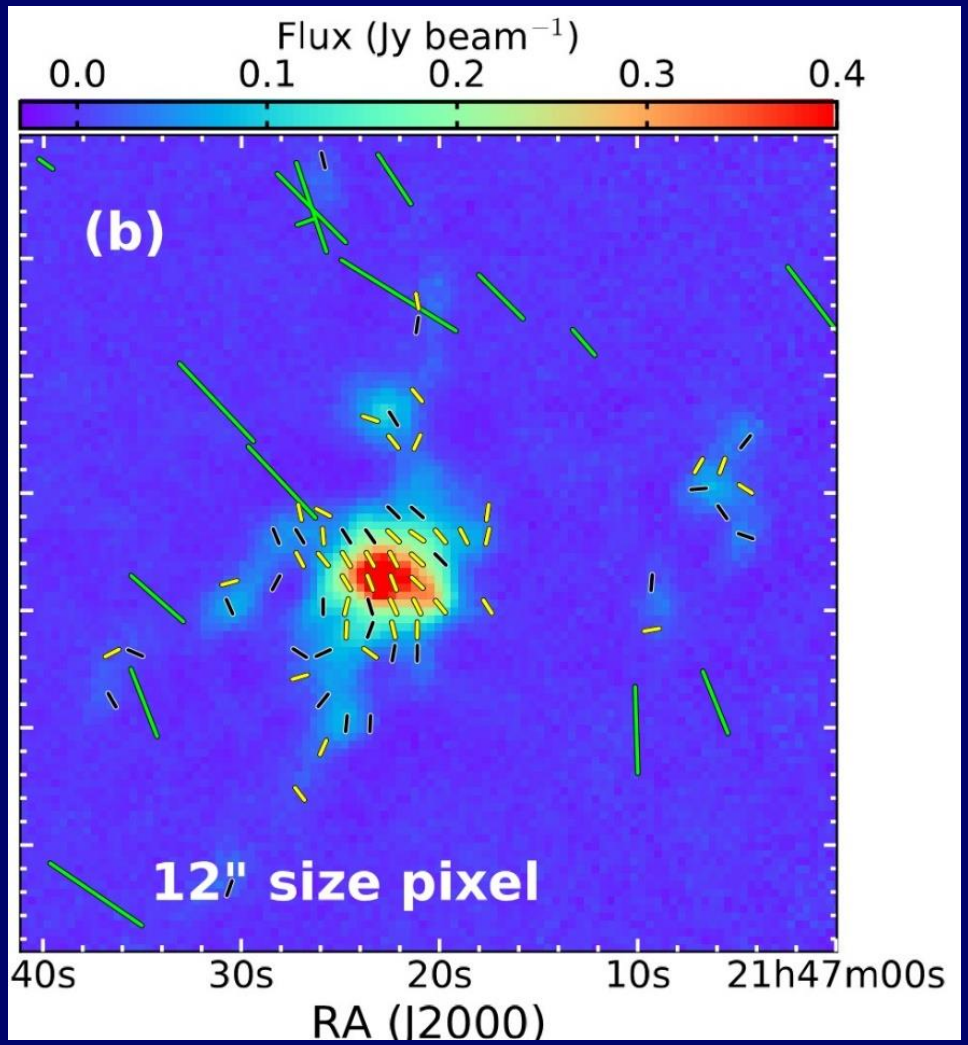
IC5146 – Another filament



IR poln. – Wang et al., 2019, ApJ, 876, 42

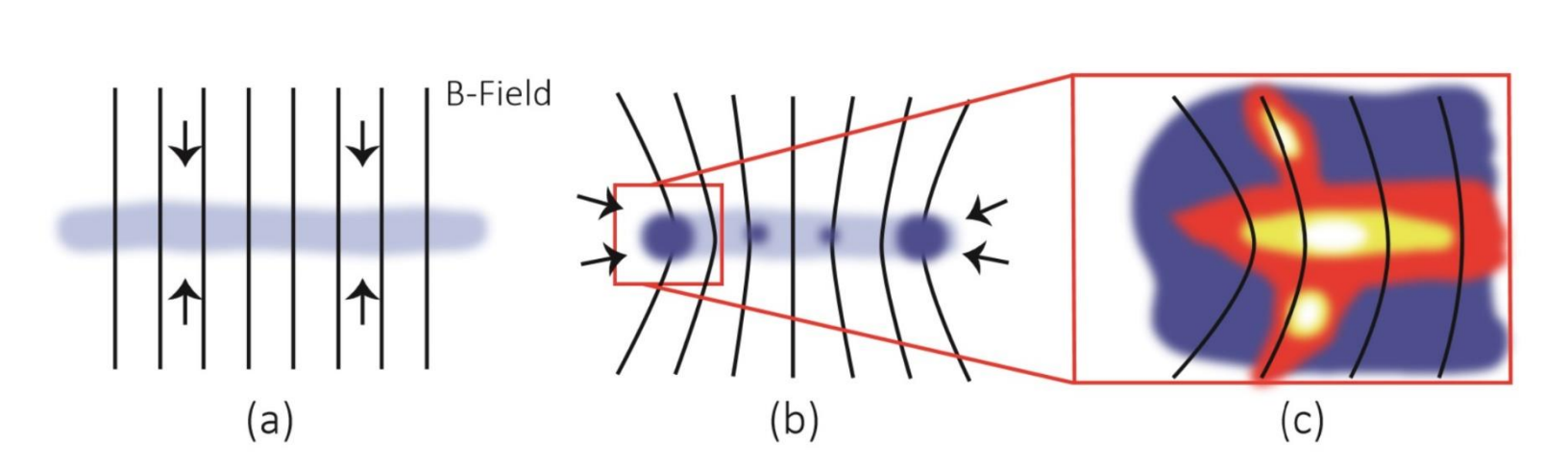
IC5146 – Hub

A hint of a turn in centre of Hub



Wang et al., 2019, ApJ, 876, 42

Cartoon of IC 5146

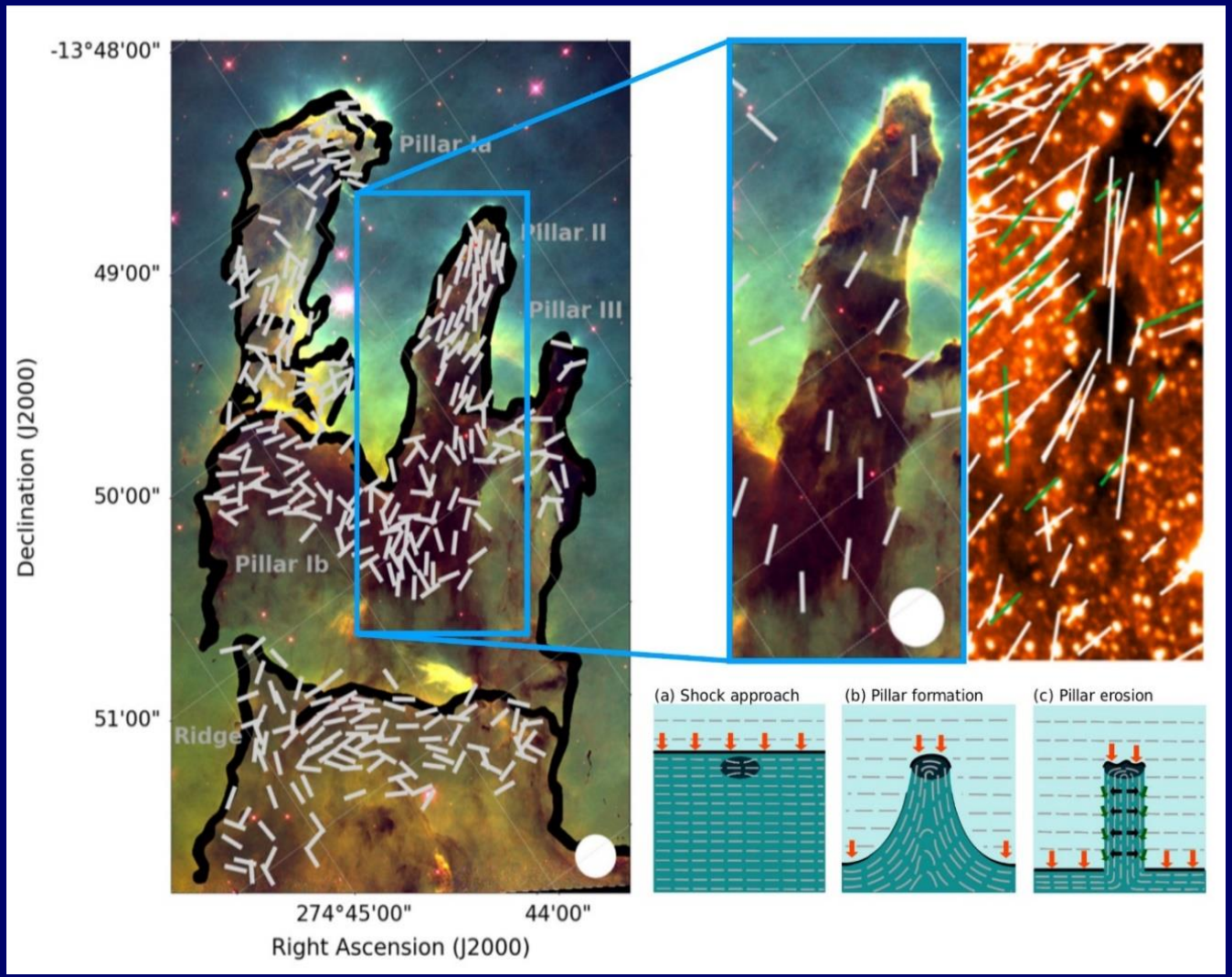


Is IC 5146 like the Orion filament? (Wang et al., 2019, ApJ, 876, 42)

Pillars of creation

B-fields in the ‘Pillars of Creation’ of M16

Pattle et al., 2018, ApJL, 860, L6



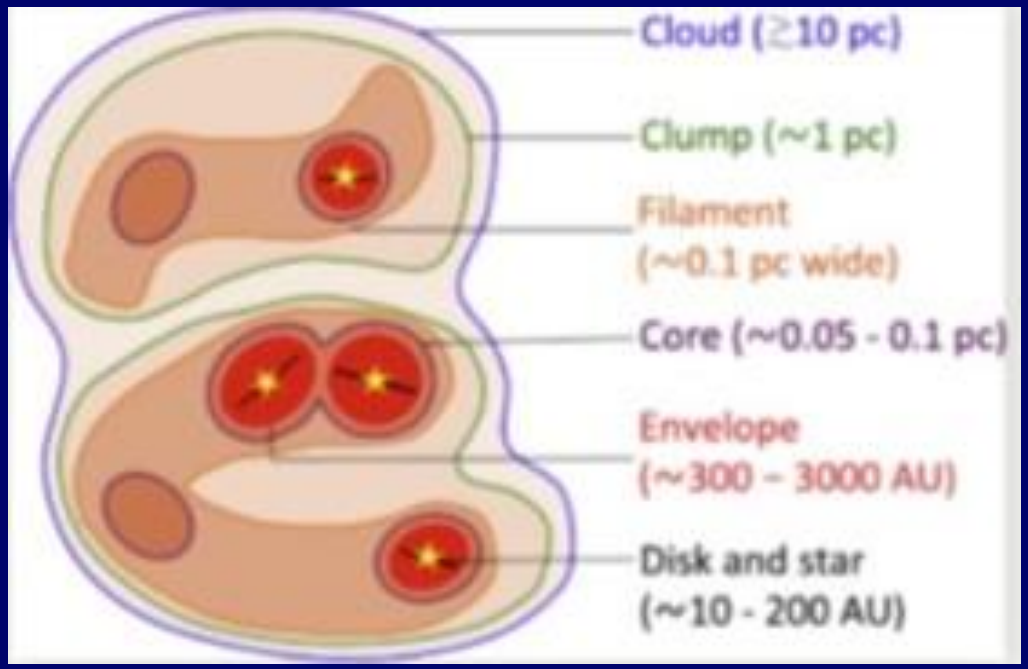
Orion B: NGC 2071

IMAGE REDACTED

Grey scale is 850 μm continuum emission.
B-field vectors at P/δP > 3
Lyo et al., in prep

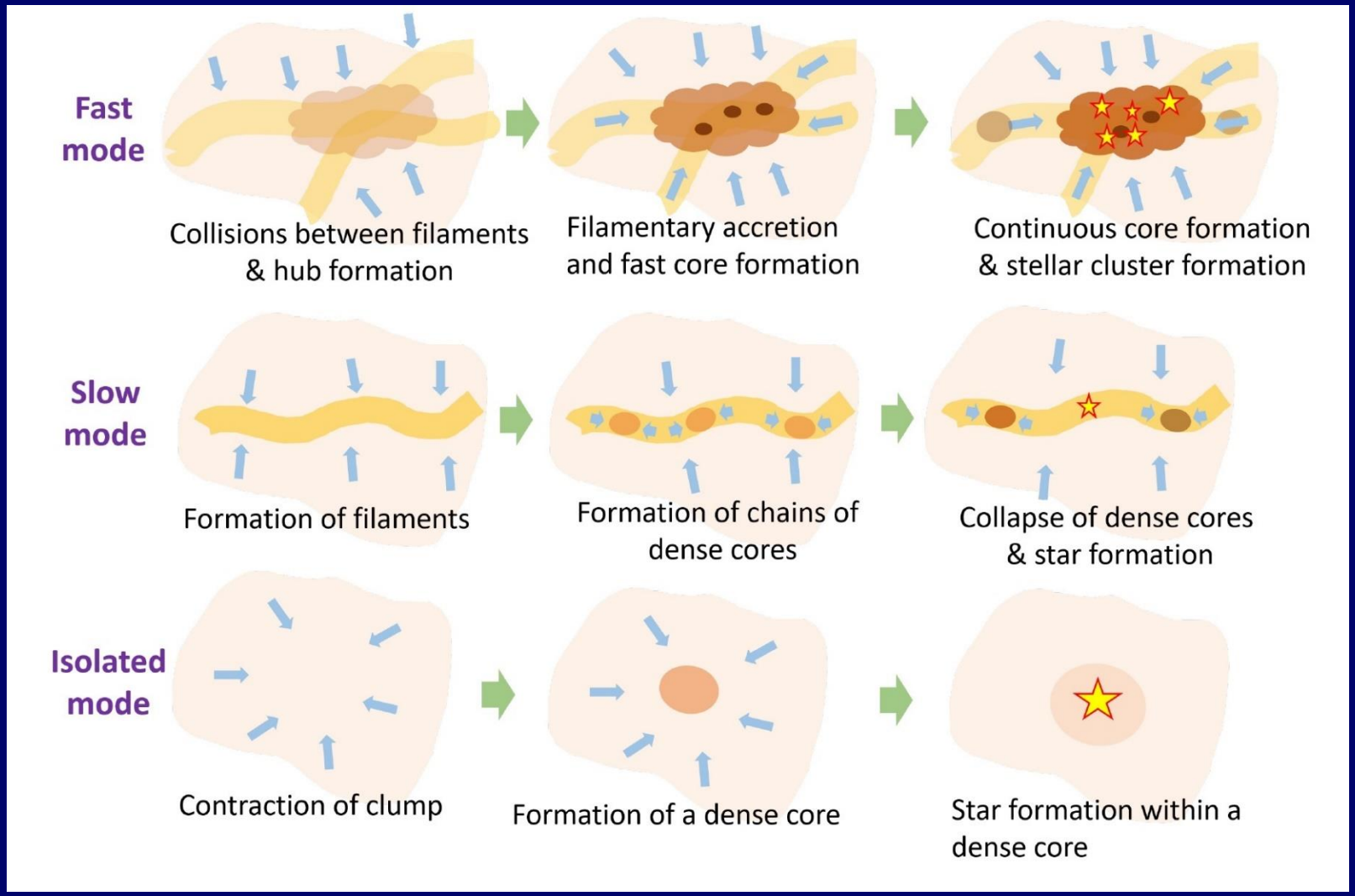
B-field vectors at P/δP > 4
blue- and red-contours
represent blue- and red-shifted
^{12}CO(3-2) emission

New models



Pokhrel et al., 2019, ApJ, 853, 5

Generalised models



Seo et al., 2019, ApJ, 871, 134

BISTRO PUBLICATIONS – 1G

1G Paper Status on BISTRO-1

Ward-Thompson et al., 2017, ApJ, 842, 66 – Survey paper, Orion A

J. Kwon et al., 2018, ApJ, 859, 4 – First look at Oph A

Soam et al., 2018, ApJ, 861, 65 – First look at Oph B

Wang et al., 2019, ApJ, 876, 42 – First look at IC5146

Liu et al., 2019, ApJ, 877, 43 – First look at Oph C

Coudé et al., 2019, ApJ, 877, 88 – First look at B1

Tang et al., in prep., – First look at Serpens Main NW

W. Kwon et al., in prep., – First look at Serpens Main SE

Ward-Thompson et al., in prep., – First look at L1689B

Chakali et al., in prep., – First look at Taurus

Lyo et al., in prep., – First look at Orion B

Coude et al., in prep., – First look at NGC 1333N

Doi et al., in prep., – First look at NGC 1333S

Ngoc et al., in prep., - First look at Auriga

1G Paper Status on BISTRO-2

Pattle et al., 2018, ApJL, 860, L6 – M16, Pillars of Creation

Hwang et al., in prep., – Mon R2

Konyves et al., in prep., – Rosette Nebula

Ching et al., in prep., – DR21

Arzoumanian et al., in prep., – NGC 6334

Duan et al., in prep., – DR15

Tahani et al., in prep., – NGC 2264

Pattle et al., in prep., – M16

BISTRO Publications – 2G

2G Paper Status

Pattle et al., 2017, ApJ 846, 122 – DCF analysis in Orion A

Pattle et al., 2019, ApJ 880, 27 – Polarisation fraction analysis in Oph A/B/C

Pattle et al., in prep., – Magnetic stability of cores in Ophiuchus

Fanciullo et al., in prep., – Wavelength dependence of polarisation in Orion A

Yen et al., in prep., – Alignment of B-fields and bipolar outflows

Chakali et al., in prep., – B-fields and velocity gradients in filaments

Hwang et al., in prep., – 450/850 comparison paper

BISTRO Spin-out Review Paper

Pattle & Fissel, 2019, FrASS 6 15 – Review of science of BISTRO in context

SCUBA-2 GBLS Papers:

Ward-Thompson et al., 2007, PASP, 119, 855 – Survey description

Hatchell et al., 2013, MNRAS, 429, L10 – Perseus, NGC1333

Sadavoy et al., 2013, ApJ, 767, 126 – Perseus, B1

Dodds et al., 2015, MNRAS, 447, 722 – Perseus, NGC 1333, discs

Rumble et al., 2015, MNRAS, 448, 1551 – Serpens, MWC 297

Salji et al., 2015, MNRAS, 449, 1769 – Orion A North, cores

Salji et al., 2015, MNRAS, 449, 1782 – Orion A North, filaments

Buckle et al., 2015, MNRAS, 449, 2472 – Taurus, L1495

Pattle et al., 2015, MNRAS, 450, 1094 – Ophiuchus

Mairs et al., 2015, MNRAS, 454, 2557 – Data reduction comparison

Kirk et al., 2016, ApJ, 817, 167 – Orion B, cores

Kirk et al., 2016, ApJ, 821, 98 – Orion B, clustering

Coudé et al., 2016, MNRAS, 457, 2139 – Orion A North

Chen et al., 2016, ApJ, 826, 95 – Perseus, grain growth

Rumble et al., 2016, MNRAS, 460, 4150 – Serpens, W40

Mairs et al., 2016, MNRAS, 461, 4022 – Orion A South

Ward-Thompson et al., 2016, MNRAS, 463, 1008 – L1495, SCUBA2 Herschel comparison

Lane et al., 2016, ApJ, 833, 44 – Orion A, clustering

Pattle et al., 2017, MNRAS, 464, 4255 – Cepheus

Mowat et al., 2017, MNRAS, 467, 812 – Lupus I

Johnstone et al., 2017, ApJ. 836, 132 – IC5146

Broekhoven-Fiene et al., 2018, ApJ, 852, 73 – Auriga

Bresnahan et al., 2019, MNRAS, submitted – Corona Australis

HARP-B GBLS papers:

Ward-Thompson et al. 2007, PASP 119, 855
Buckle et al. 2010, MNRAS 401, 204
Davis et al. 2010, MNRAS 405, 759
Graves et al. 2010, MNRAS 409, 1412
Duarte-Cabral et al. 2010, A&A 519, A27
Buckle et al. 2012, MNRAS 422, 521
Christie et al. 2012, MNRAS 422, 968
White et al. 2015, MNRAS 447, 1996
Drabek-Maunder et al. 2016, MNRAS 457, L84