SELF SIMILAR MAGNETIC MORPHOLOGICS IN A MASSIVE STAR FORMING REGION

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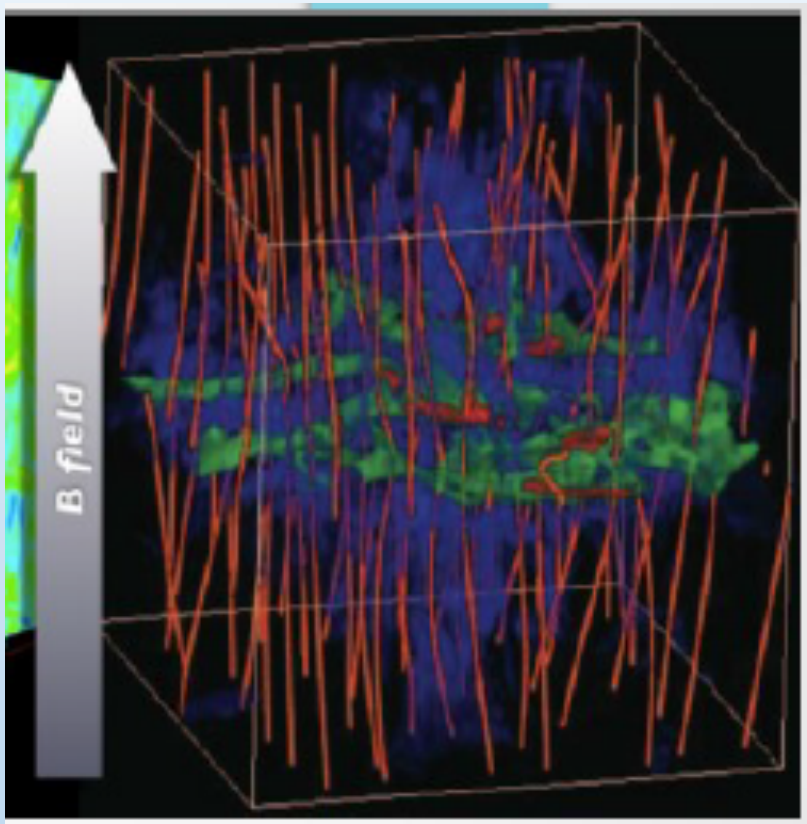
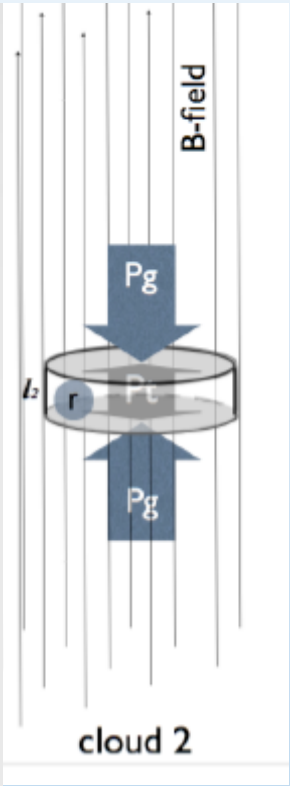
BIMODEL FILAMENT ORIENTATION WITH PRESENCE OF GRAVITY

Perpendicular

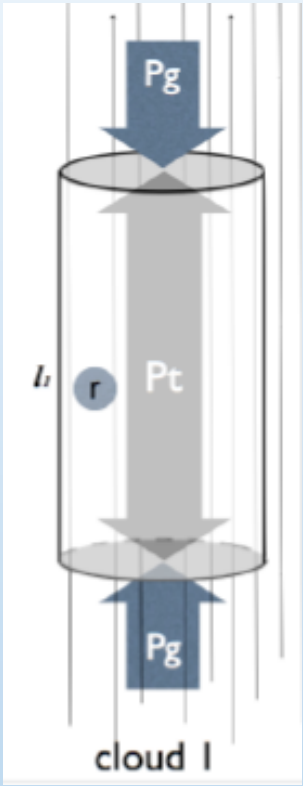


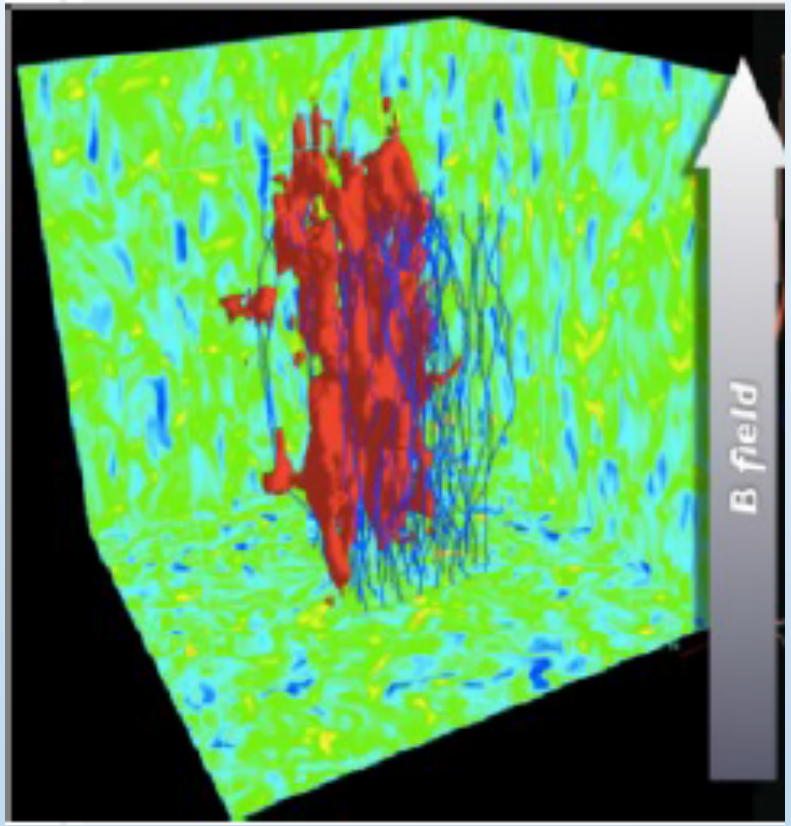
Nakaruma & Li (2008)



Li et.al. (2013)

Parallel

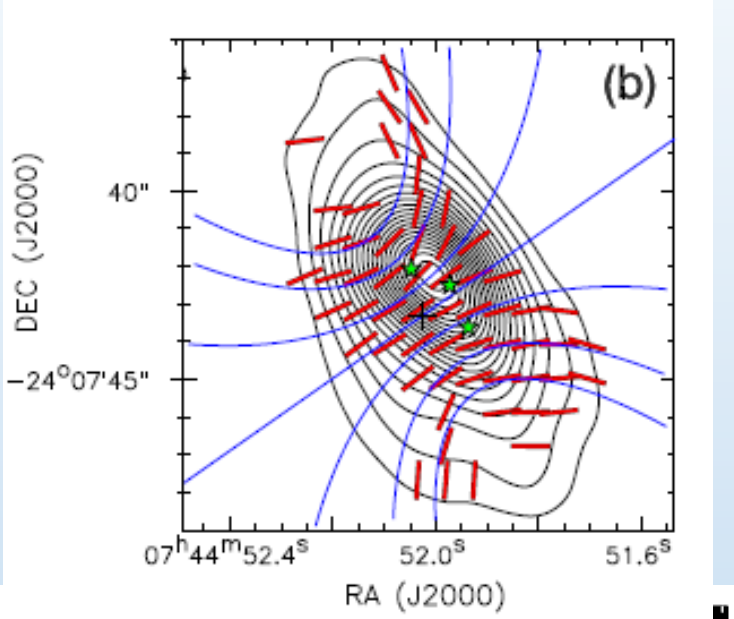


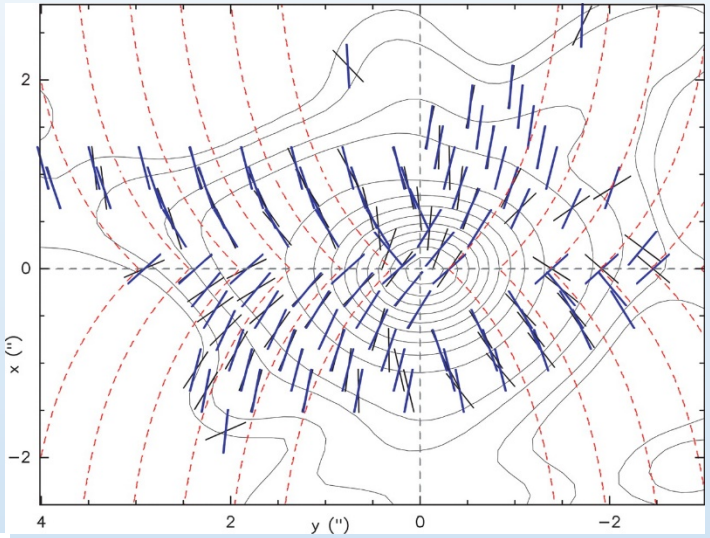


Stone et al. (1998)

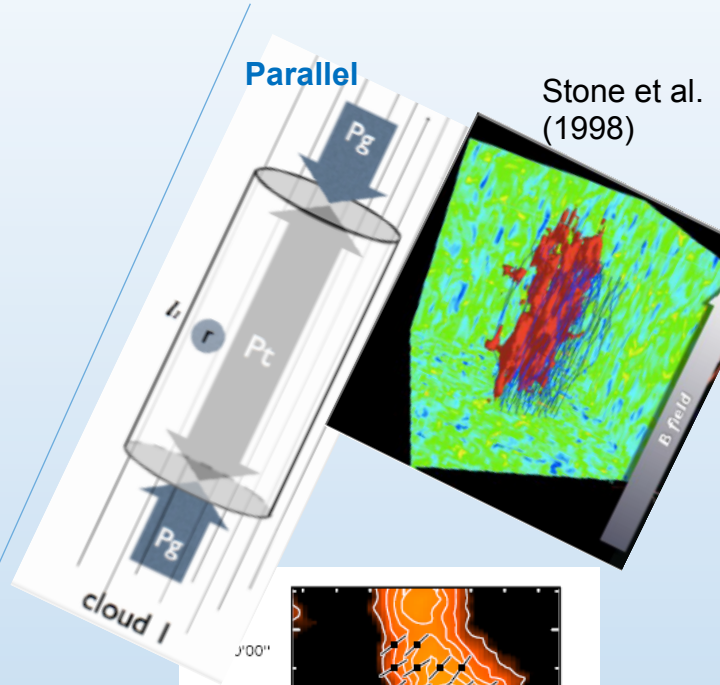
MAGNETIC FIELDS OFTEN **BIPOLAR** IN INTERSTELLAR CLOUDS

G240.31+0.07
@ Qiu et al. (2014)

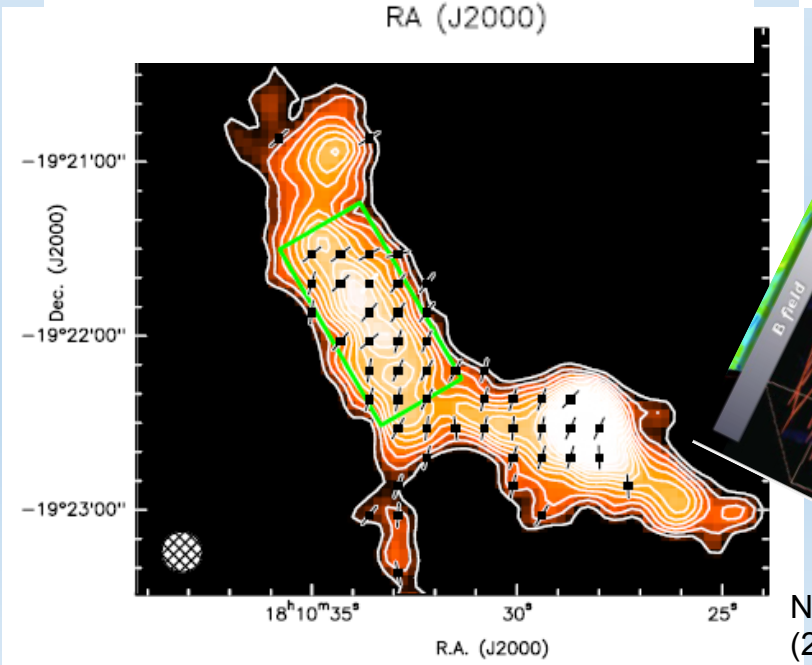




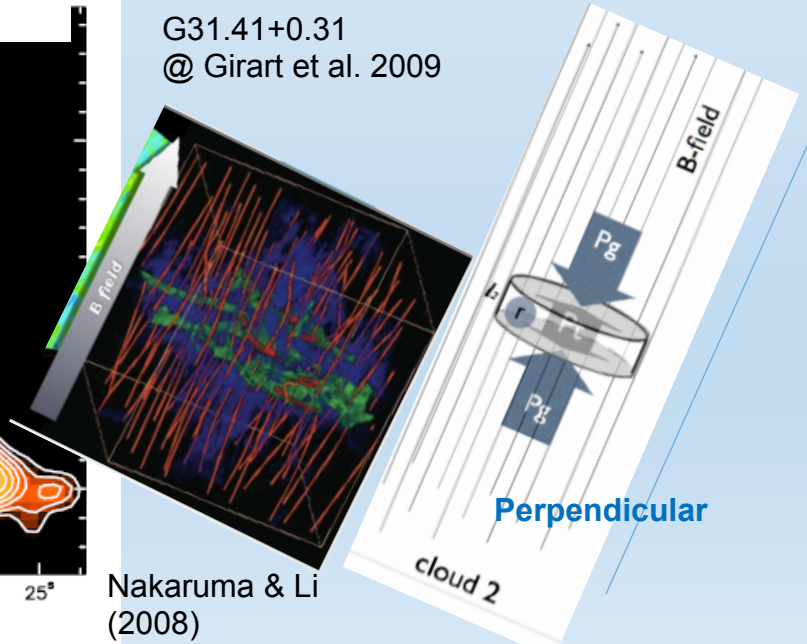
G31.41+0.31
@ Girart et al. 2009



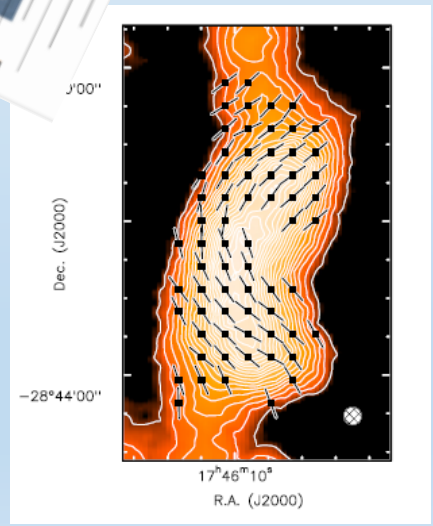
Stone et al. (1998)



G11.11−0.12
@ Pillai et al. (2015)

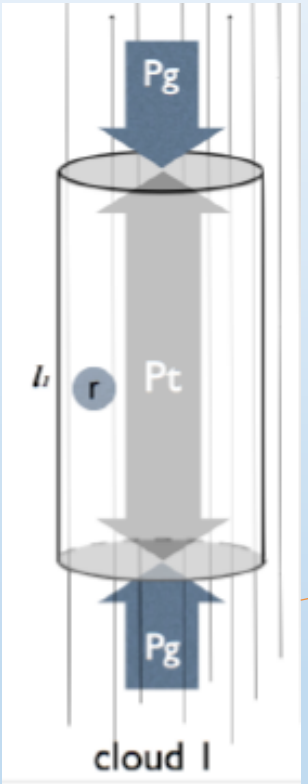


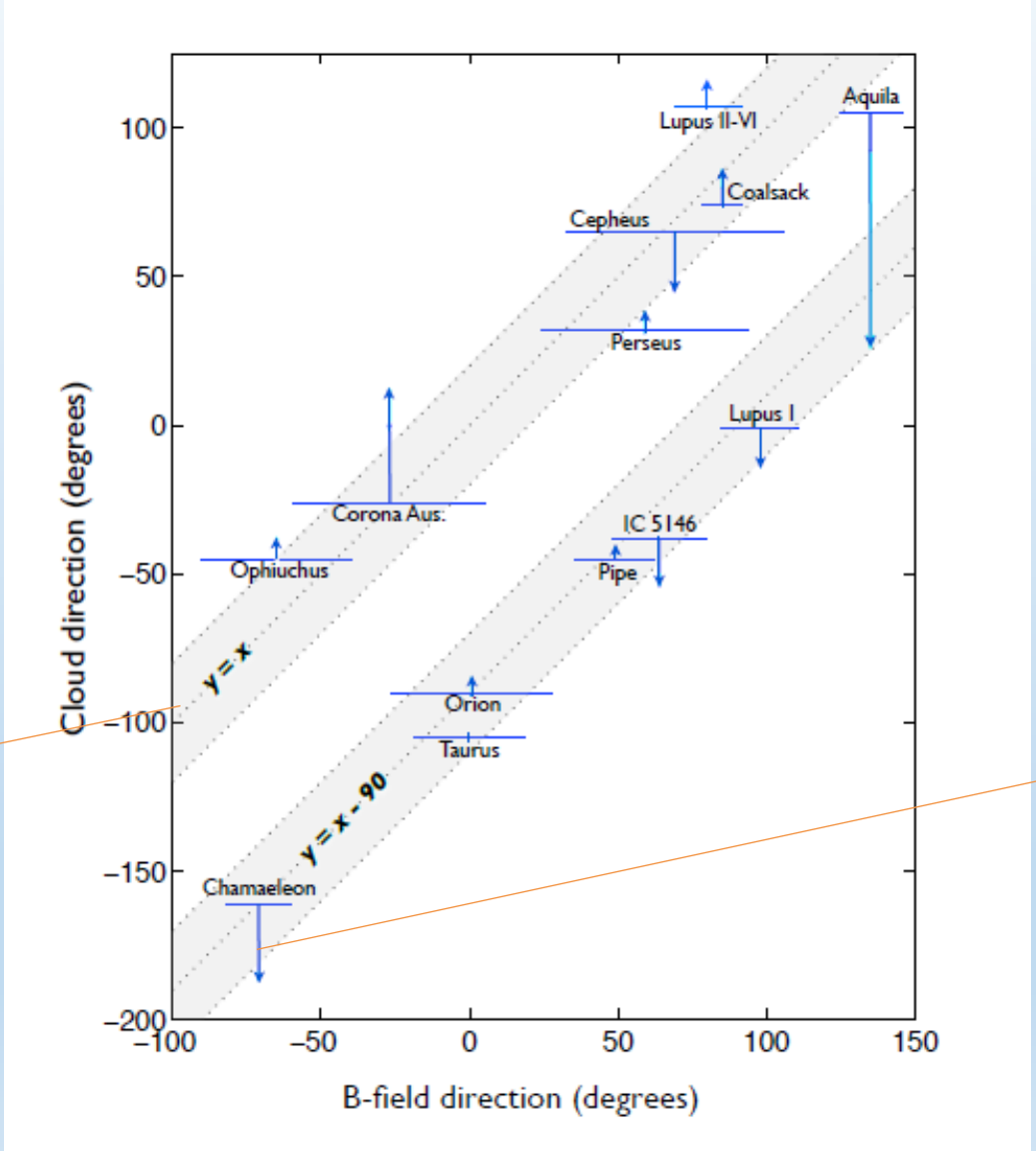
Nakaruma & Li (2008)

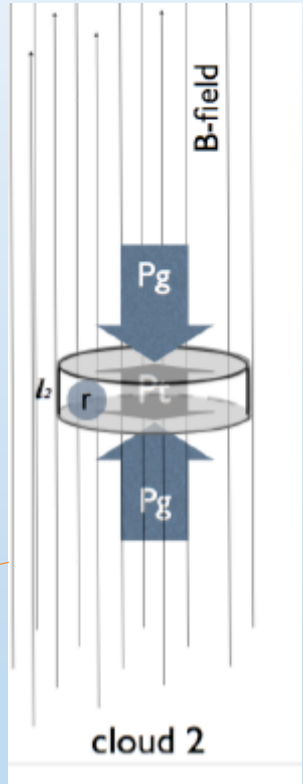


G0.253+0.016
@ Pillai et al. (2015)

BIPOLAR: EVEN COULDS IN GLOUD BELT







Li et.al. (2013)

Questions:

Strong initial field, supporting the cloud at ~100pc level, e.g. Shu, Adams, Lizano, Li, …

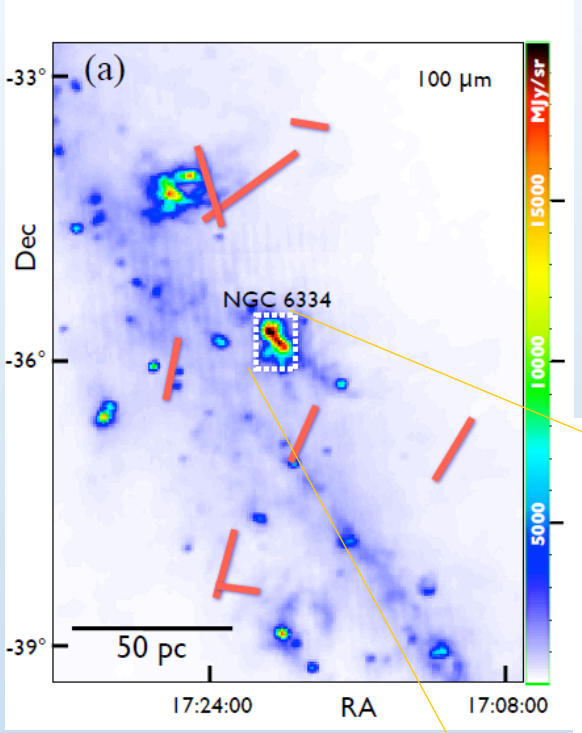
Turbulence fragmentation + Dynamo. e.g. Padoan, Nordlund, Federrath,

1. Magnetic fields *inherited from the inter cloud medium* or *governed by cloud turbulence*?
2. **Role of magnetic fields** in clouds from 100pc to 0.1pc?
3. Relation between fields in cores and the surrounding medium?
4. Cloud Fragmentation and HMSF theory *DRIVEN BY magnetic field*?

CANDITATE: NGC6334

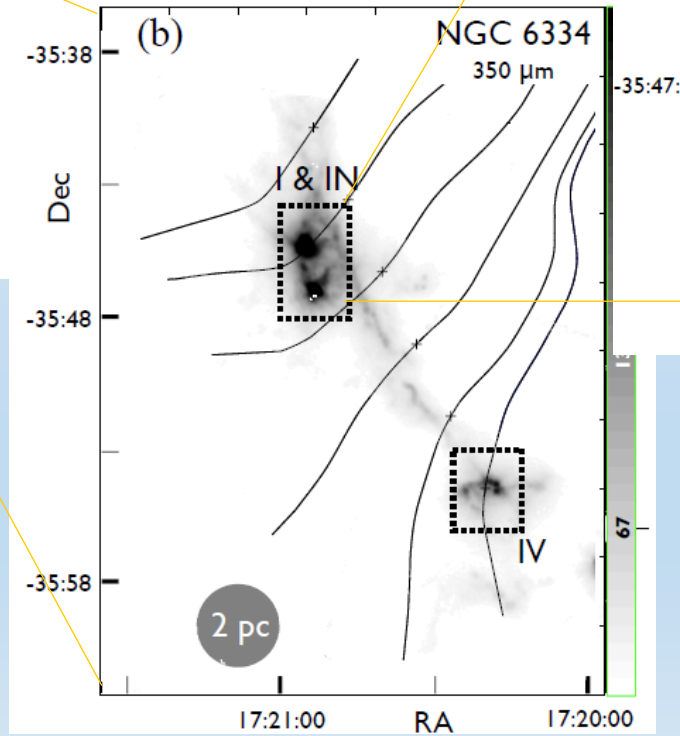
- One of the closest clouds that
a. Close enough (1.7kpc) to allow observer to observe star-light polarization
b. Have massive star forming site

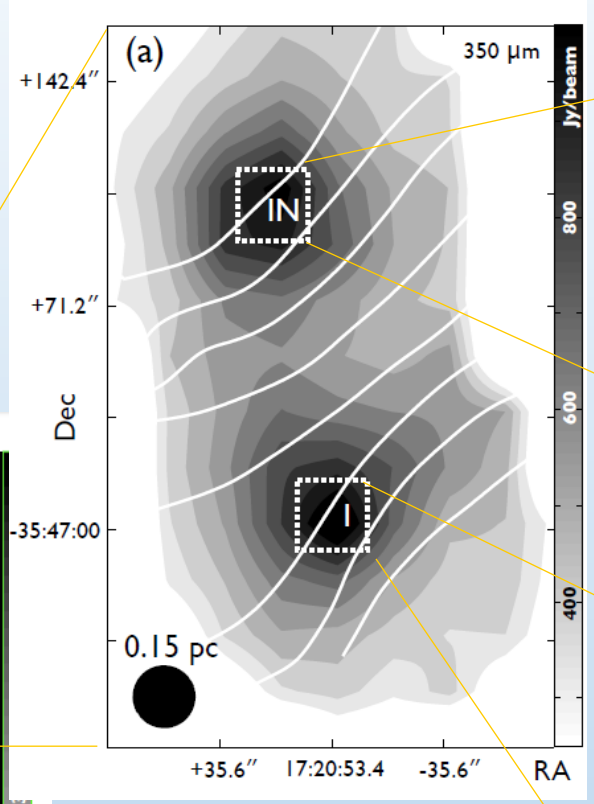
A *FIRST* MULTISCALE STUDY OF HIERACHIAL MAGNETIC FIELDS IN NGC6334



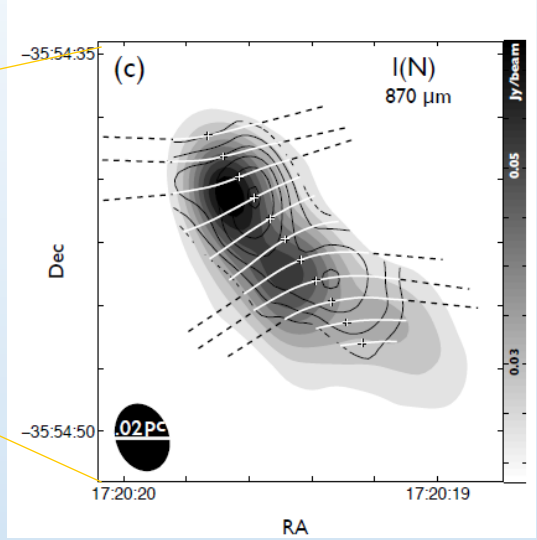
Optical, 50pc

~10pc

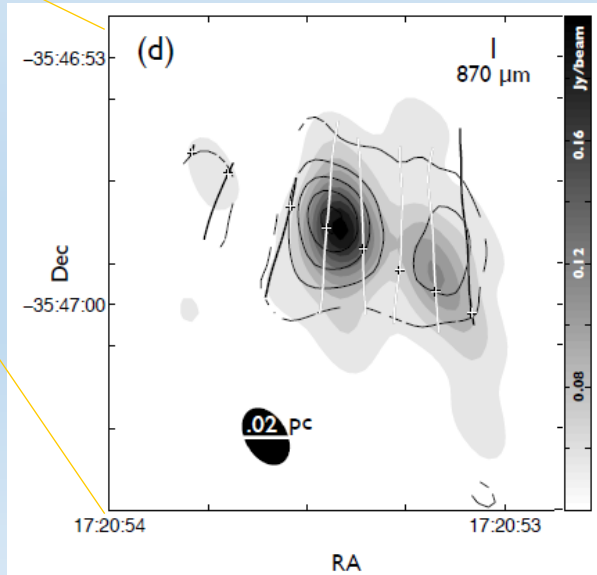




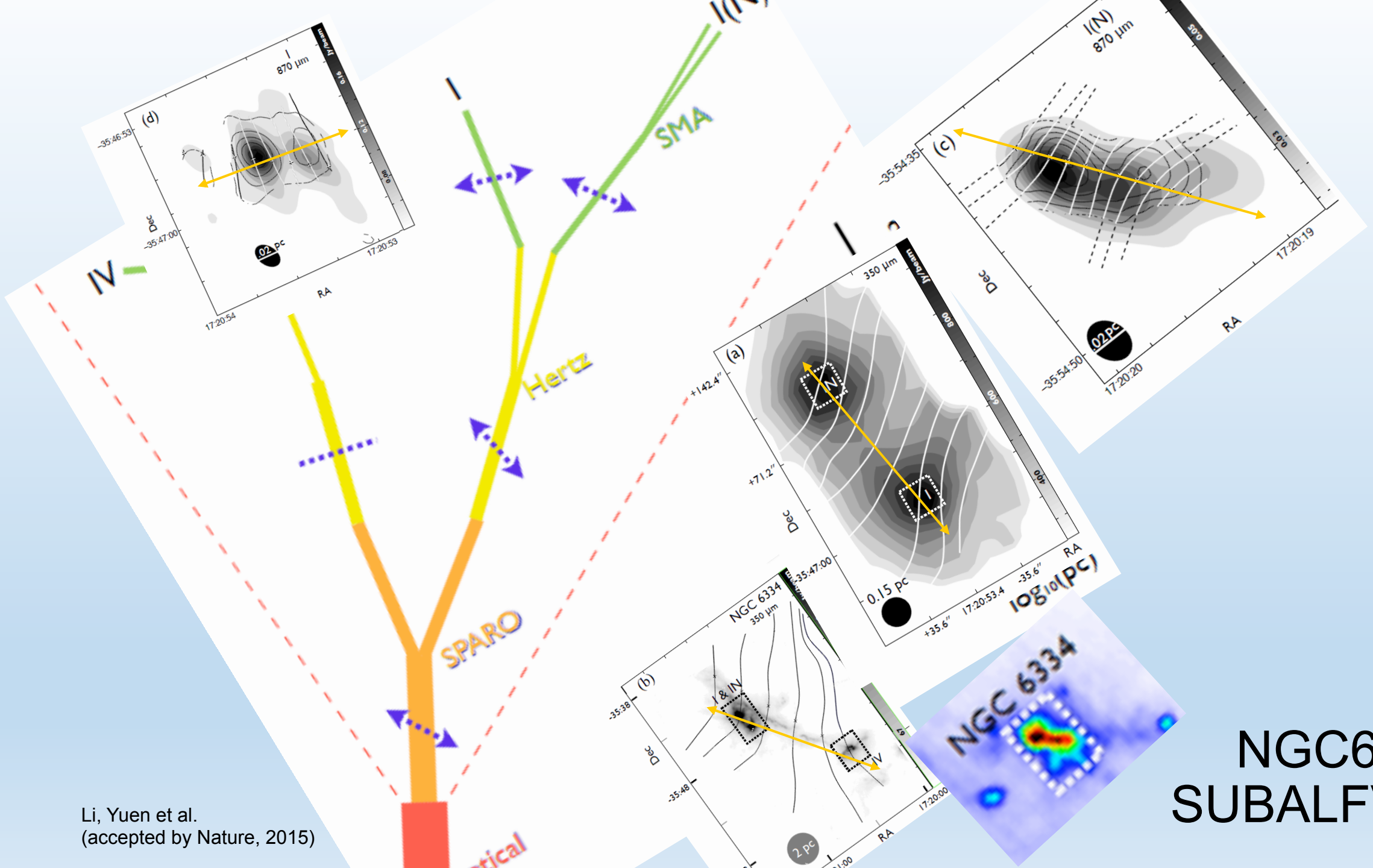
~1pc



~0.1pc



Li, Yuen et al.
(accepted by Nature, 2015)



Li, Yuen et al.
(accepted by Nature, 2015)

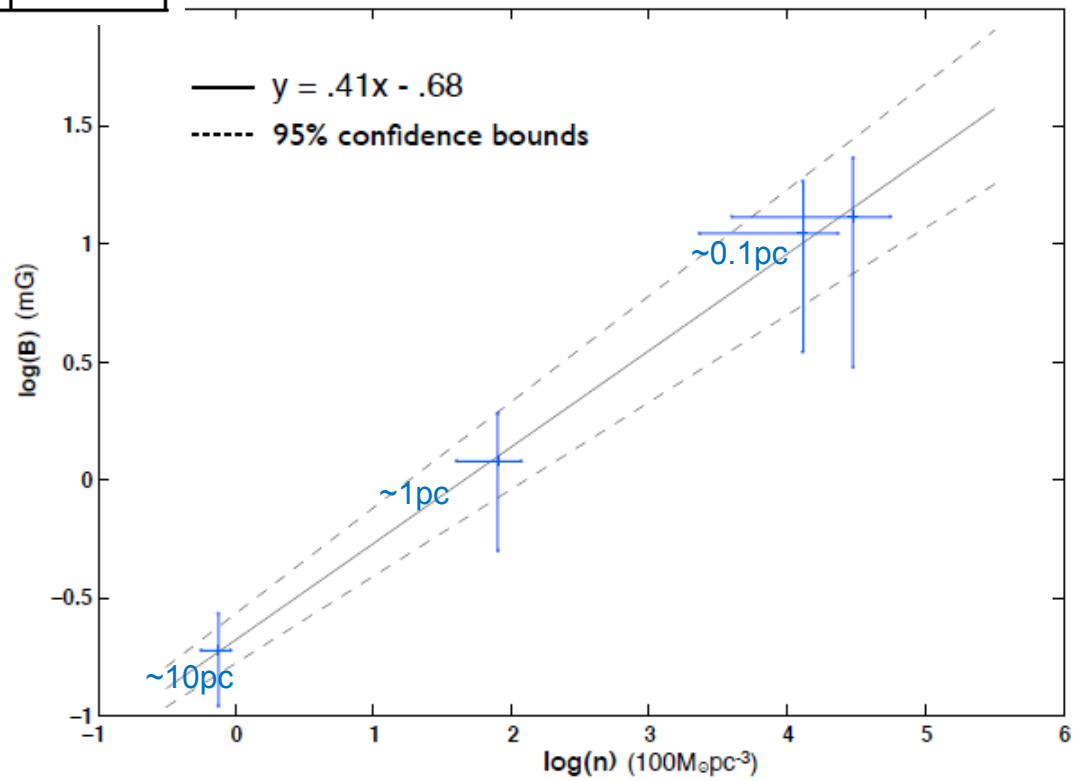
NGC6334 IS SUBALFVENIC

scale (parsec)	B (mG)[d]
10 [a]	0.19±0.08
1	1.2±0.7
0.1 (IN)	13±10
0.1 (I)	11±7.5

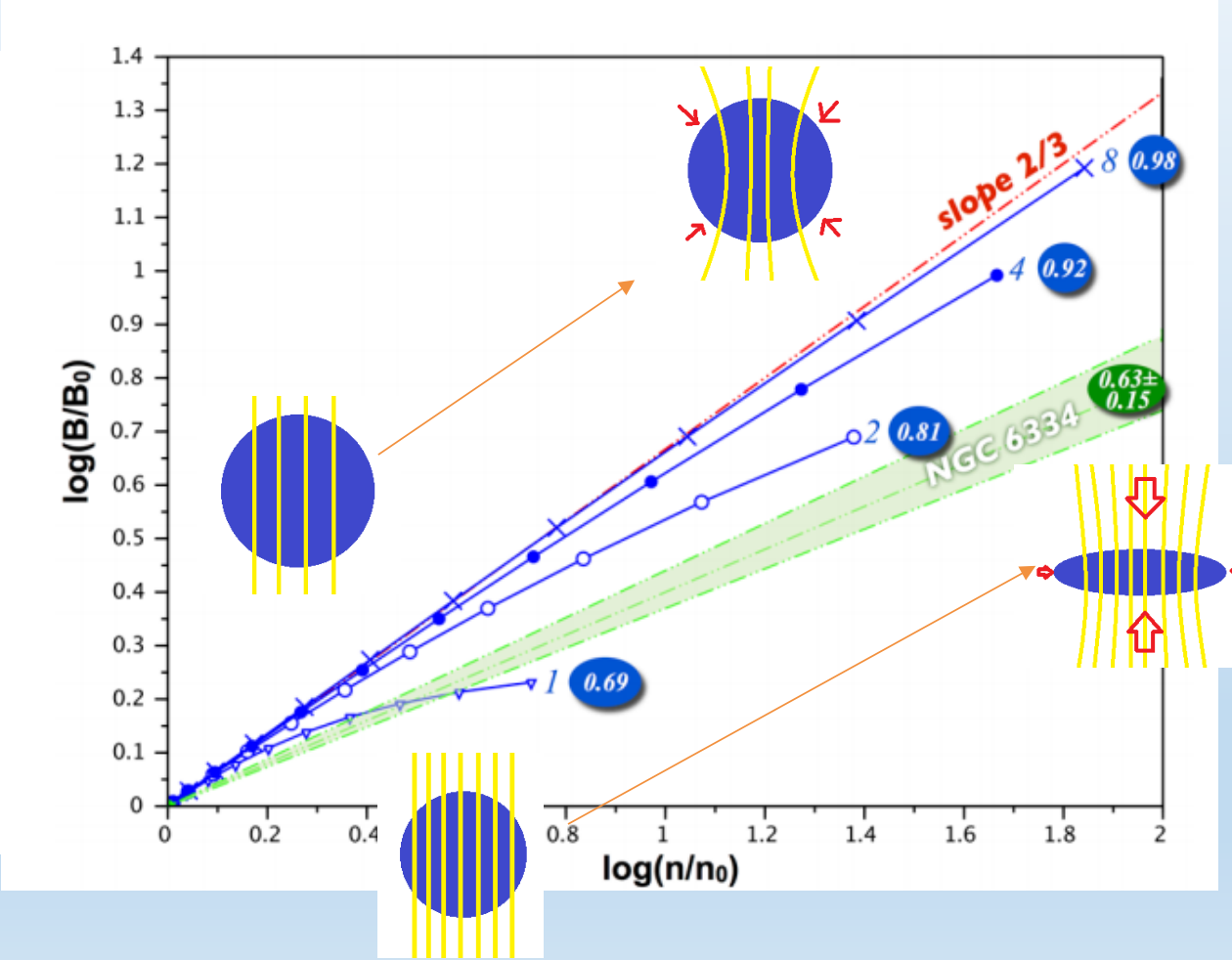
CF method = 1.4

SIMULATION:TRANS-CRITICAL B-N RELATION DEFLATES

Observation



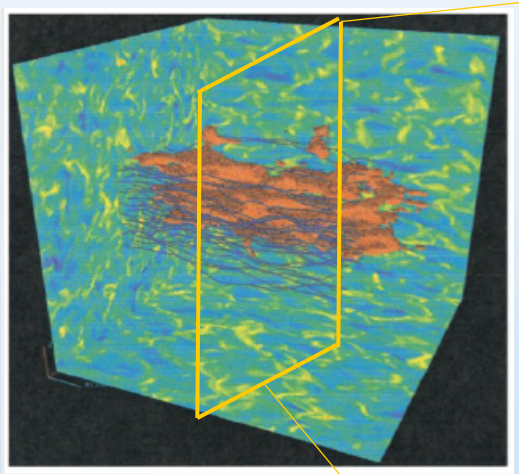
Simulation @ F. Otto



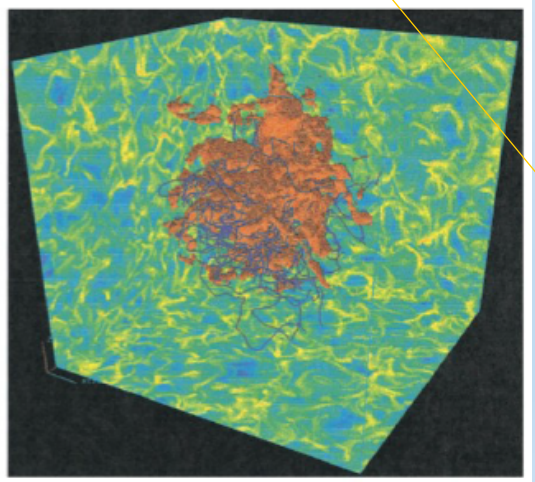
Li, Yuen et al.
(accepted by Nature, 2015)

SIMULATION: HOW FRAGMENTATION DRIVEN BY MAGNETIC FIELDS

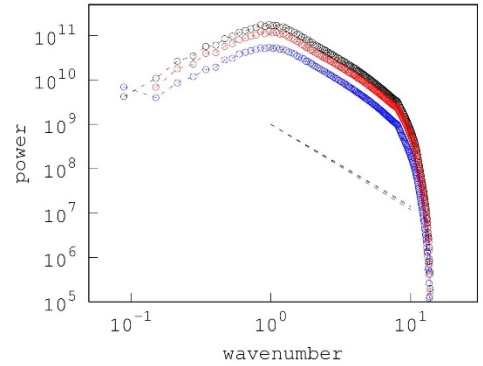
Stone et al. (1998)

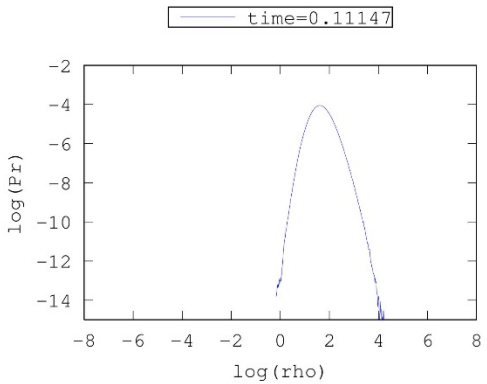


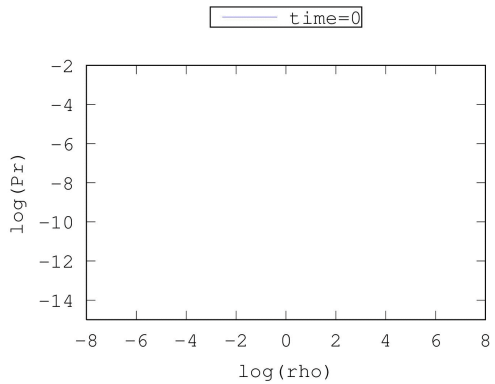
$\beta \sim 0.1$

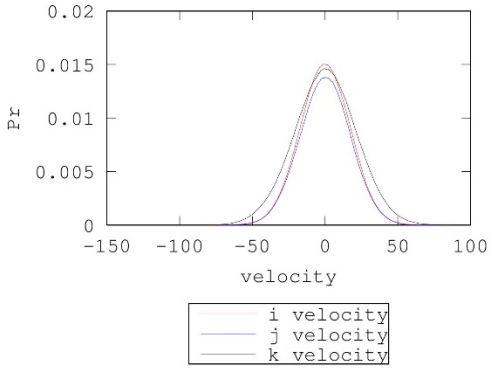


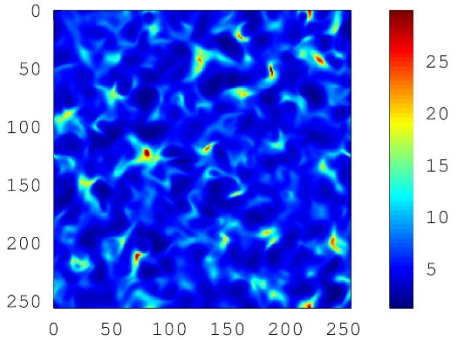
$\beta \sim 100$

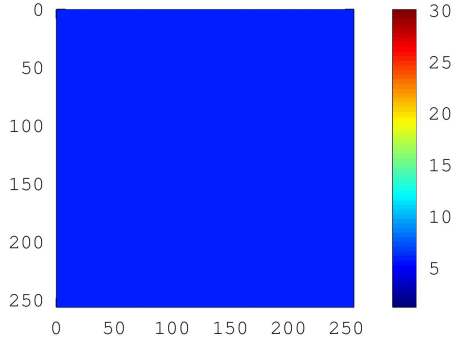










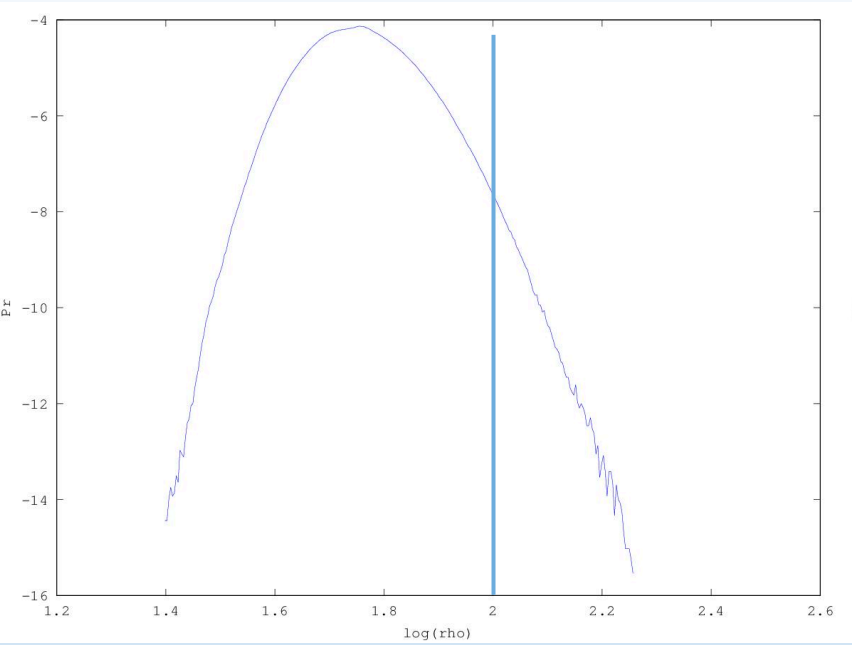


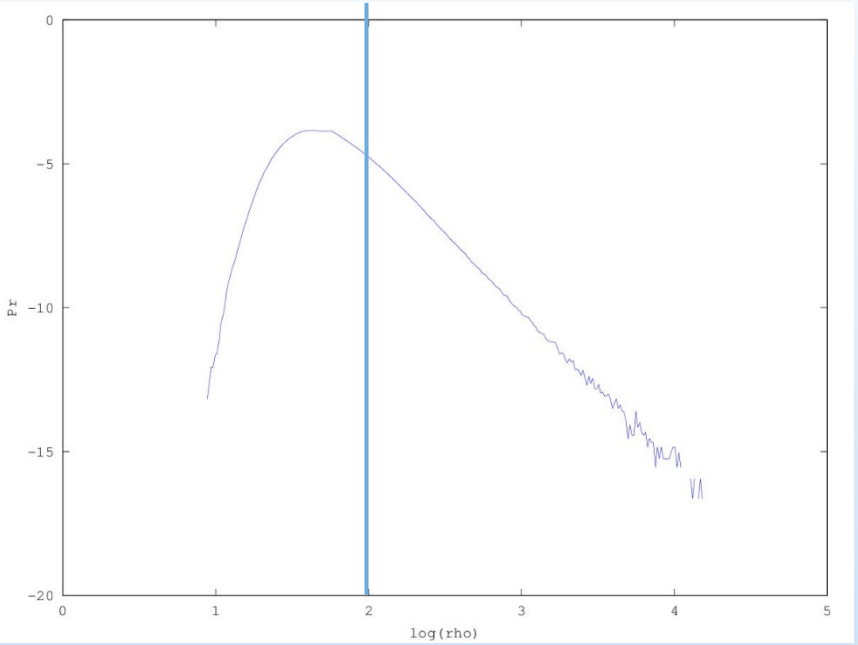
STRONG MAGNETIC FIELD β=0.1

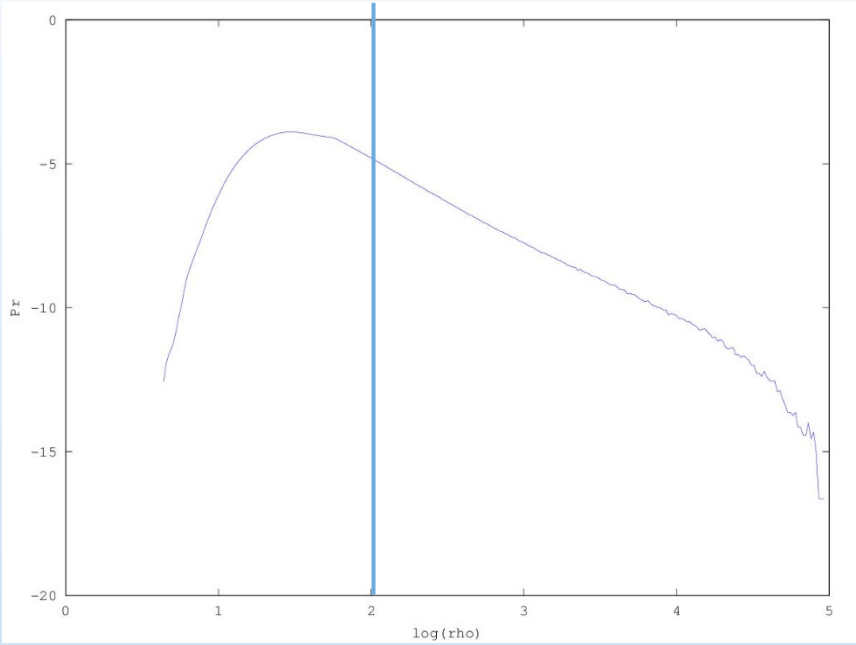
Yuen et al. (In prep)

m256b100_single

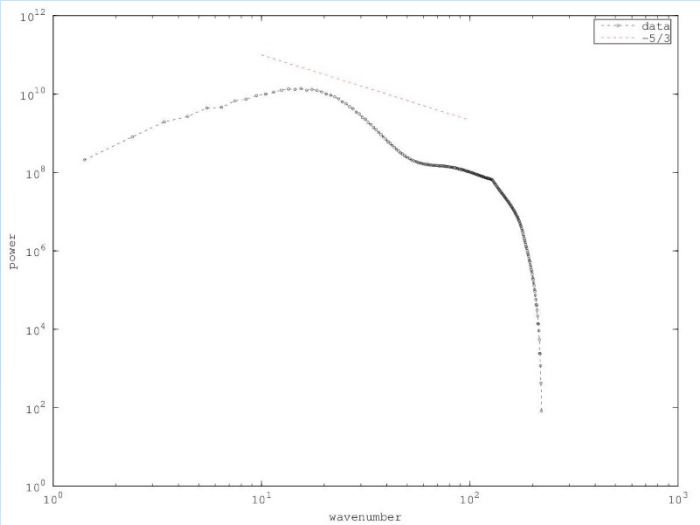
SIMULATION: HOW MAGNETIC FIELD ELONGATES DENSITY PROFILE







t=0.05



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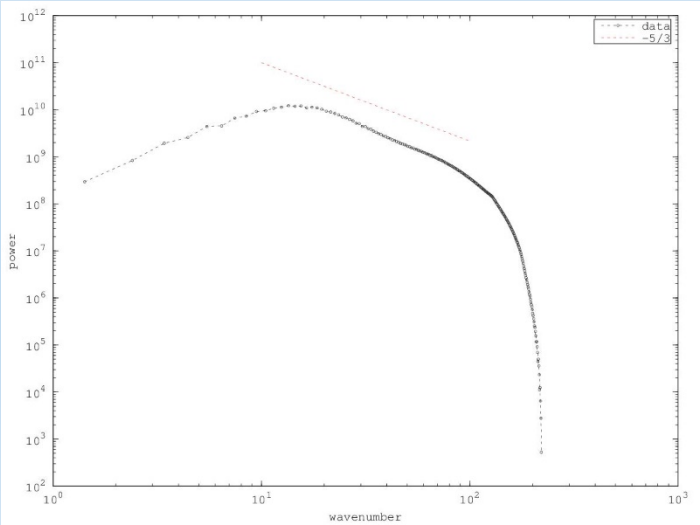

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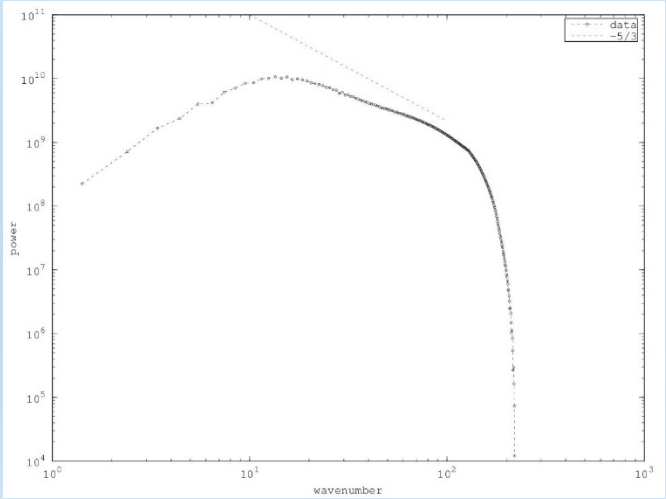
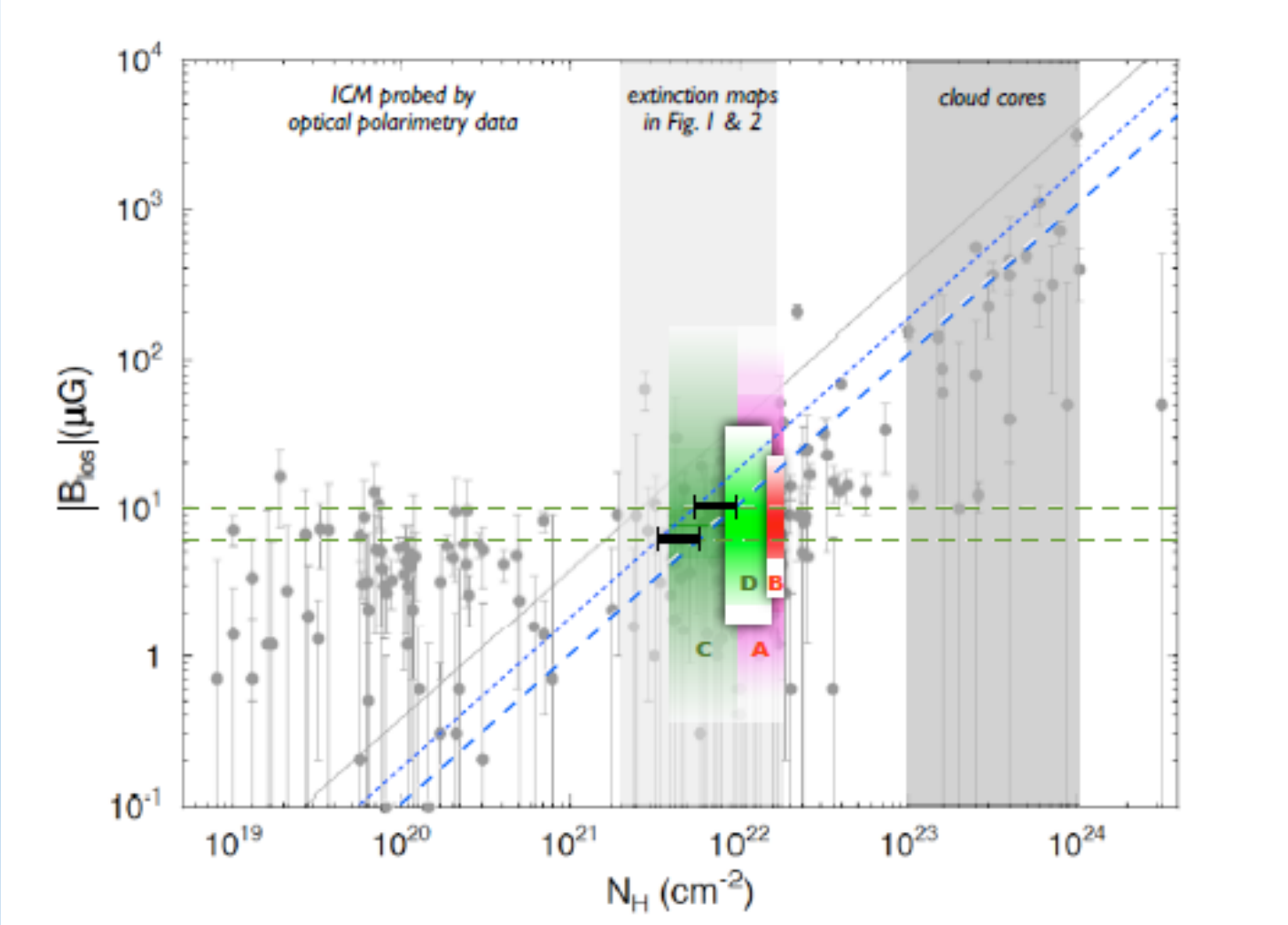


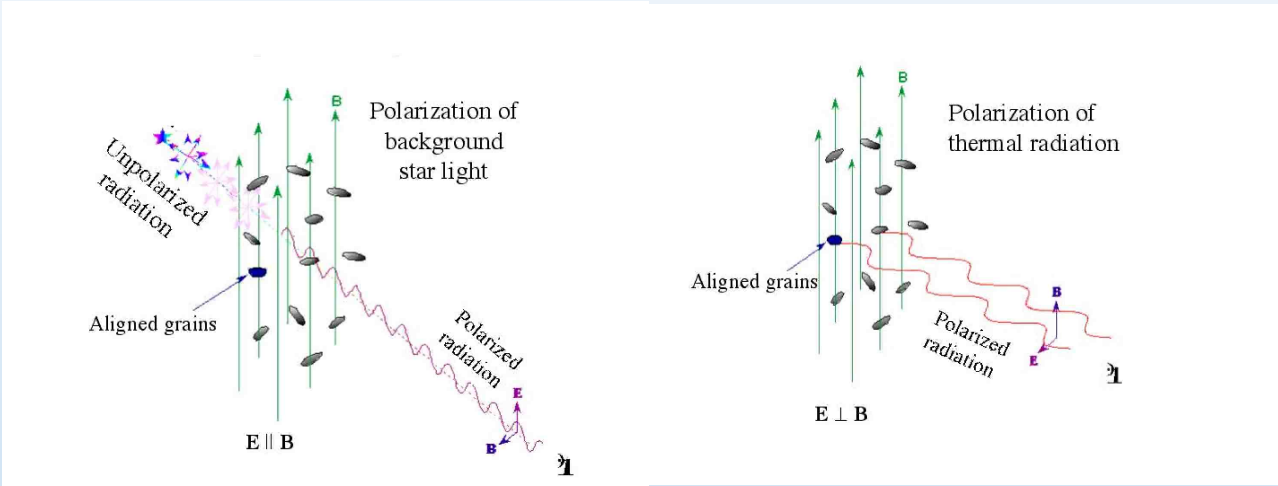
Yuen et al. (in prep)

MAGNETIC CRITICAL DENSITY MATCHS WITH THE GRAVITATIONAL CONTRACTION THRESHOLD



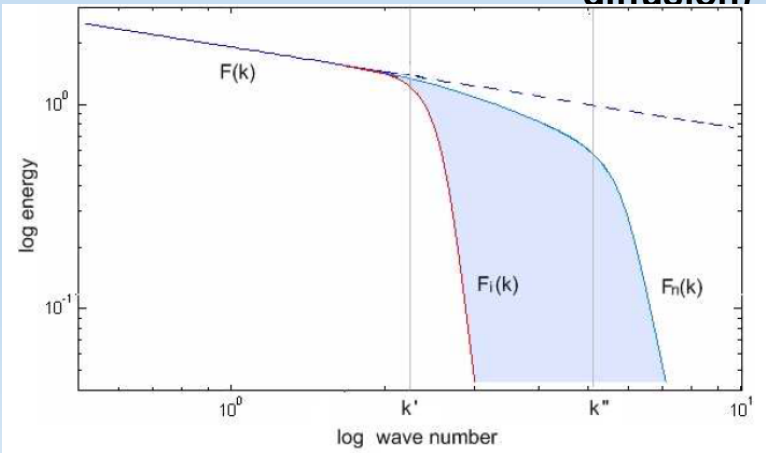
PROBING MAGNETIC FIELD STRENGTH IS LIMITED BY PROJECTION EFFECT

Plane of sky: Polarization data + grain alignment



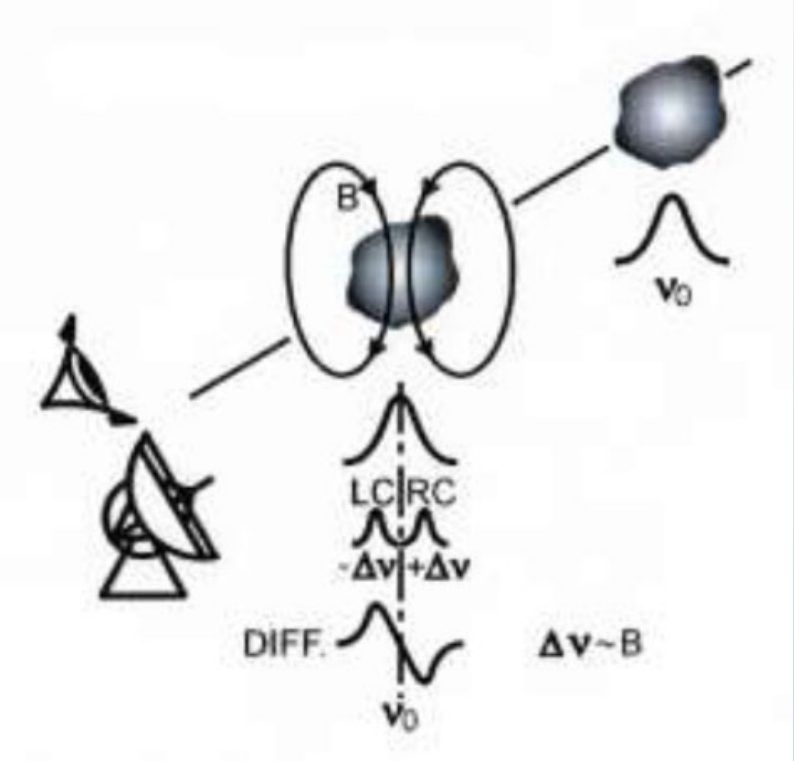
Lazarian (1994-2015,
graphs from his review in 2008)

Plane of sky: Ion-neutral linewidth difference (with ambipolar diffusion)



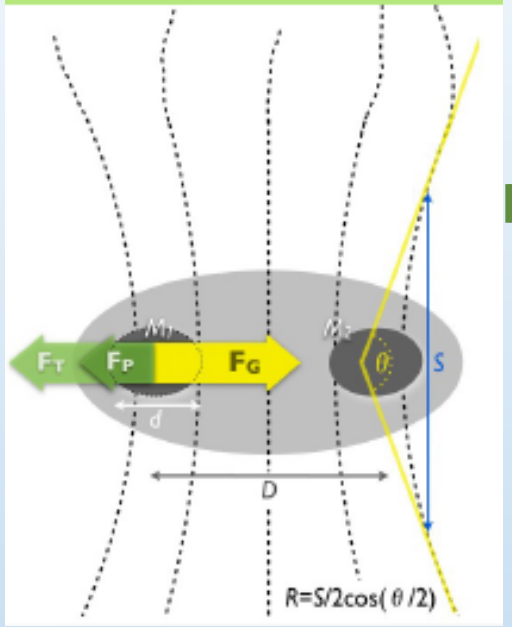
Li and Houde (2008)

Line of slight: Zeeman measurement



ESTIMATION OF 3D MAGNETIC FIELD STRENGTH FROM POS DATA

Force balances in dual-core system

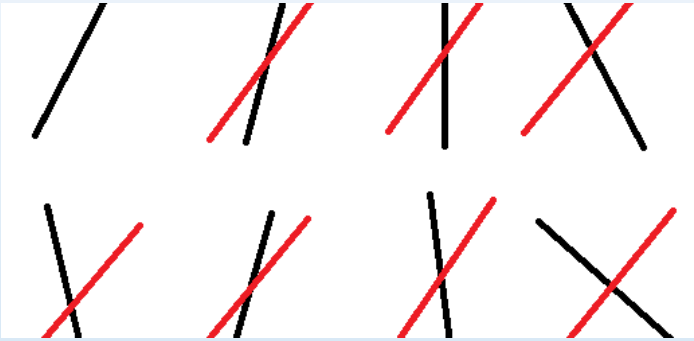


Li, Yuen et al.
(accepted by Nature, 2015)

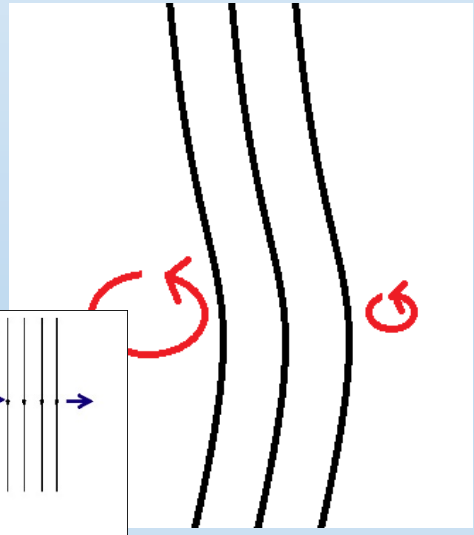
CAN THIS GO RIGHT?

Point-by-point estimation on one set of data

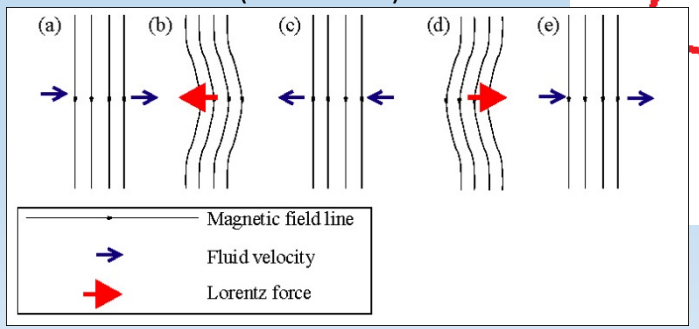
Magnetic correlation
(HH method, Houde et al 2009)



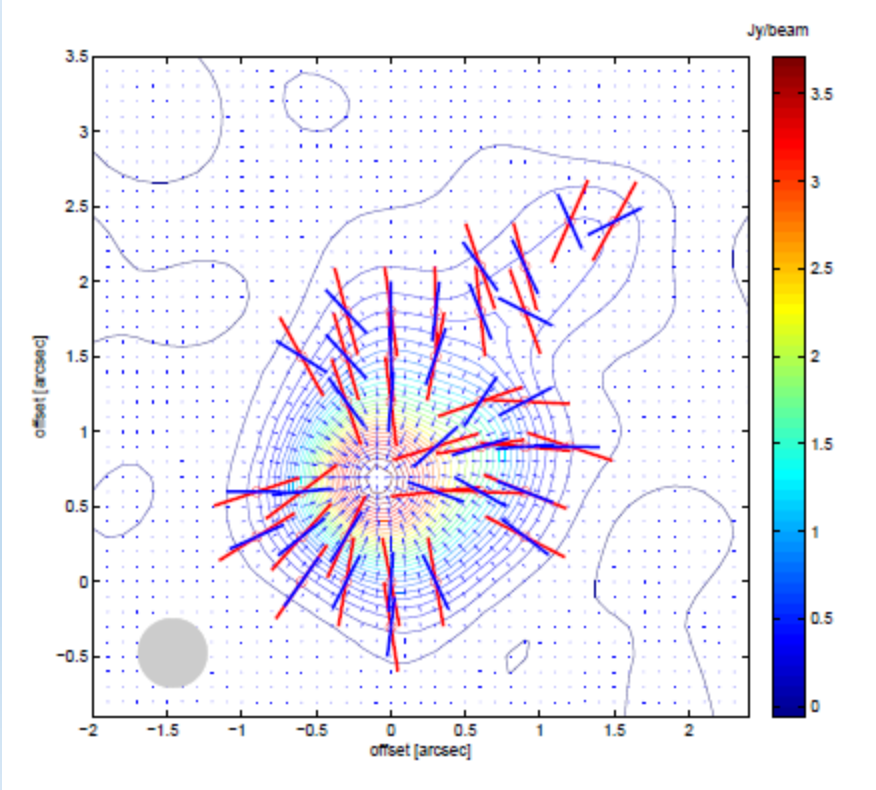
One estimation on one set of data



Magnetic tension balance turbulence
(CF Method)



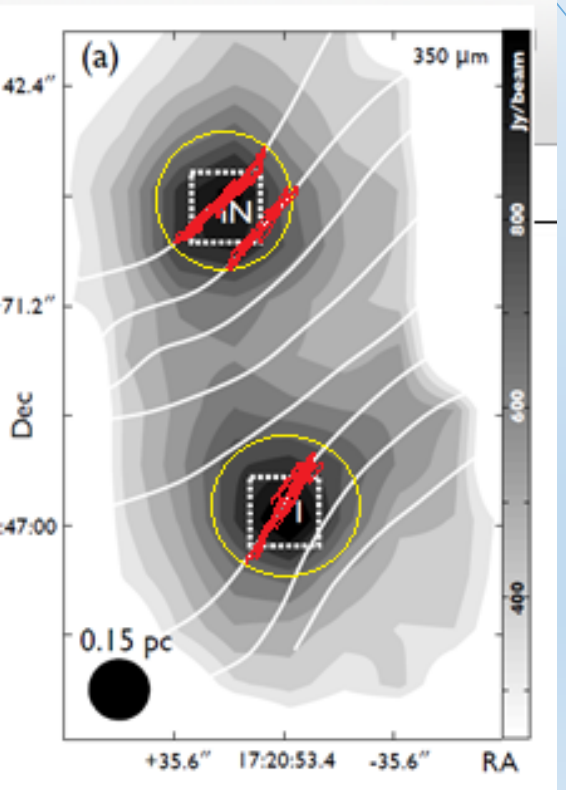
Gravity balance magnetic pressure + tension
Koch et al. (2012), Zhang et al. (2014)

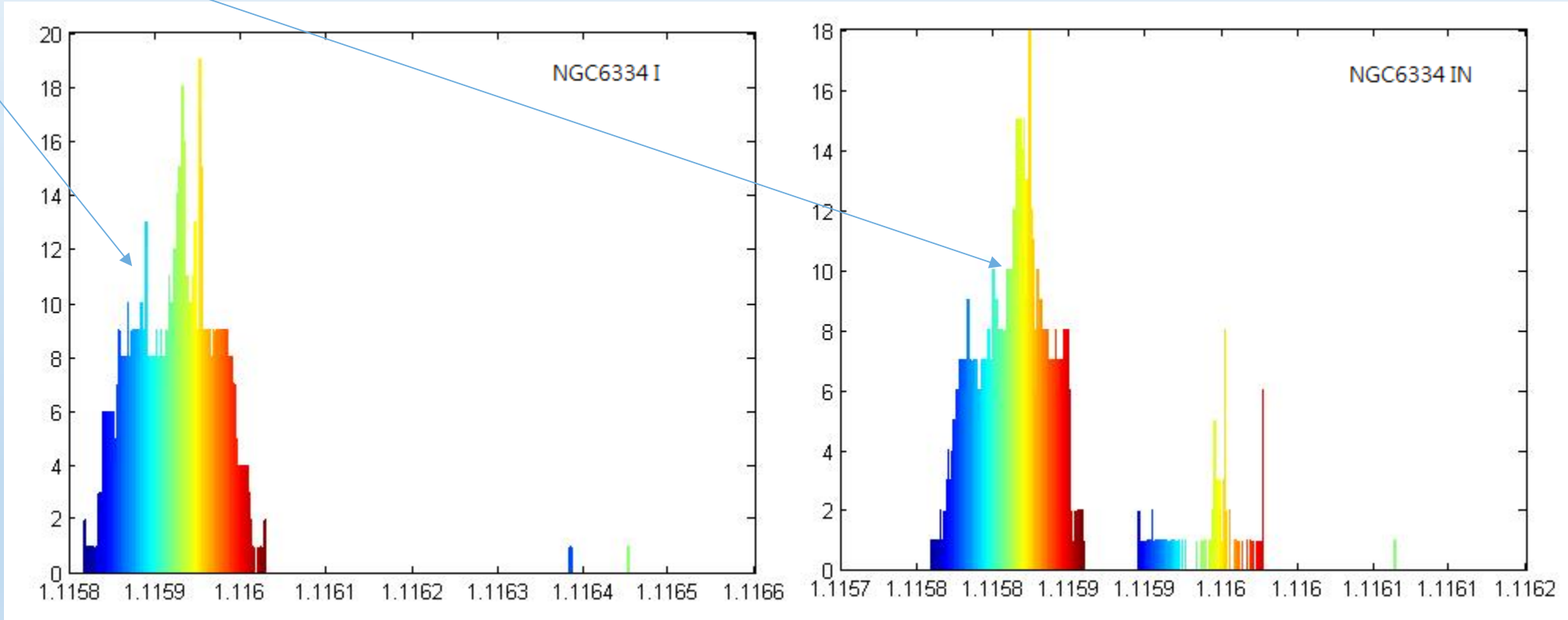


PRELIMILARY RESULT: FORCE BALANCE AROUND CORES

CF method = 1.4

scale (parsec)	B (mG)[d]
10 [a]	0.19±0.08
1	1.2±0.7
0.1 (IN)	13±10
0.1 (I)	11±7.5





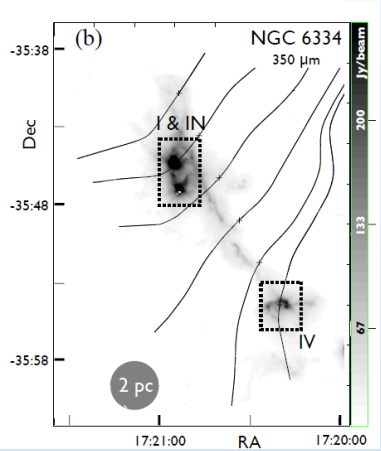
Yuen, Law et al. (in prep)

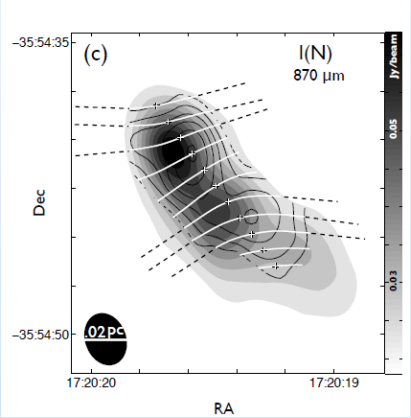
SUMMARY

1. SELF SIMILAR MAGNETIC FIELD FROM 10PC TO 0.1PC
2. DIRECTION OF FIELD DOES NOT CHANGE SIGNIFICANTLY OVER ENTIRE SCALES
3. SUB-ALFVENIC-TRANS-CRITICAL SCENARIO ELONGLATES THE CLOUD TO BE PERPENDICULAR TO MEAN FIELD DIRECTION
4. MAGNETIC FIELDS FAVLOR MASSIVE STAR FORMATION AND CLOUD FRAGMENTATION
5. BETTER ESTIMATION OF MAGNETIC FIELD ENABLES US GETTING MORE MAGNETIC INFO FROM THE MAP

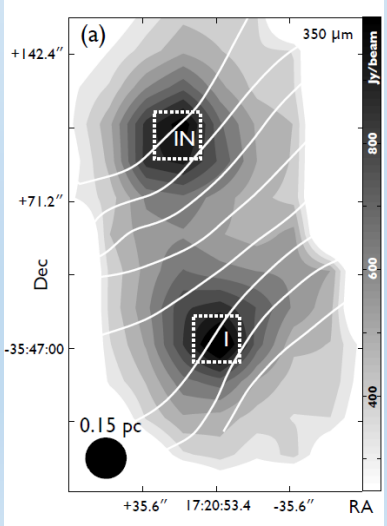
MAGNETIC FIELDS PLAY A CRUICAL ROLE FOR CLOUD FRAGMENTATION

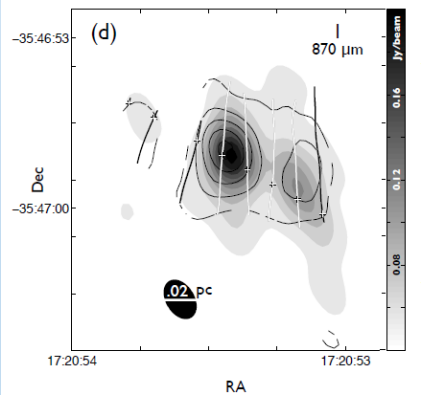
(AT LEAST IN NGC6334)





10pc





0.1pc

1pc