SMA Observations of Magnetic Fields in High-mass Proto-clusters: *a Tale of Two Cores*

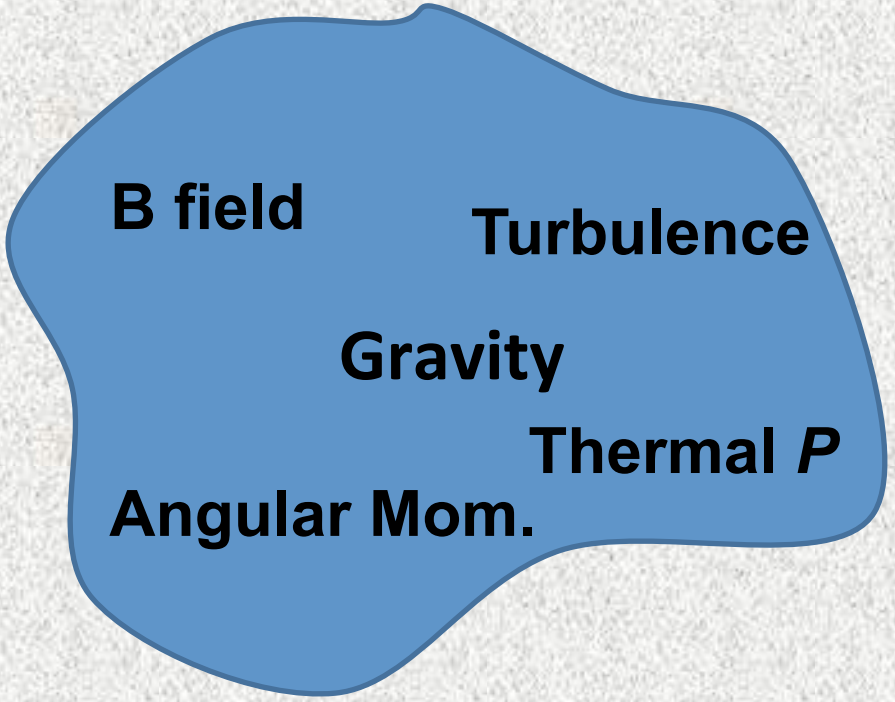
Keping Qiu
Nanjing University

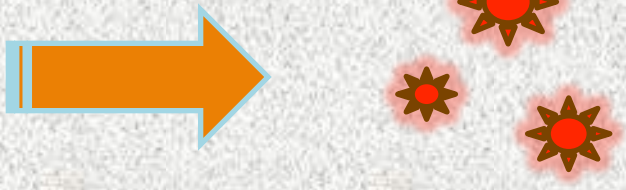
In collaboration with Q. Zhang, K. M. Menten, and the SMA polarization legacy team

Do B Fields (and/or Turb.) Matter?

Molecular Clouds

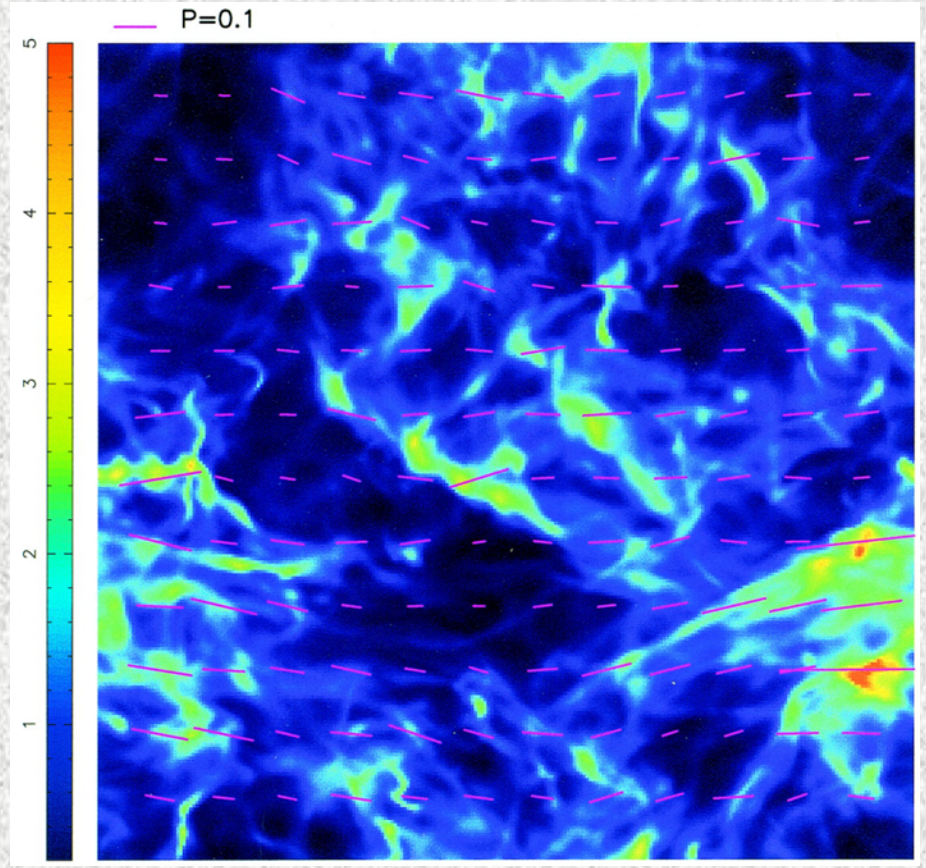
OB Stars



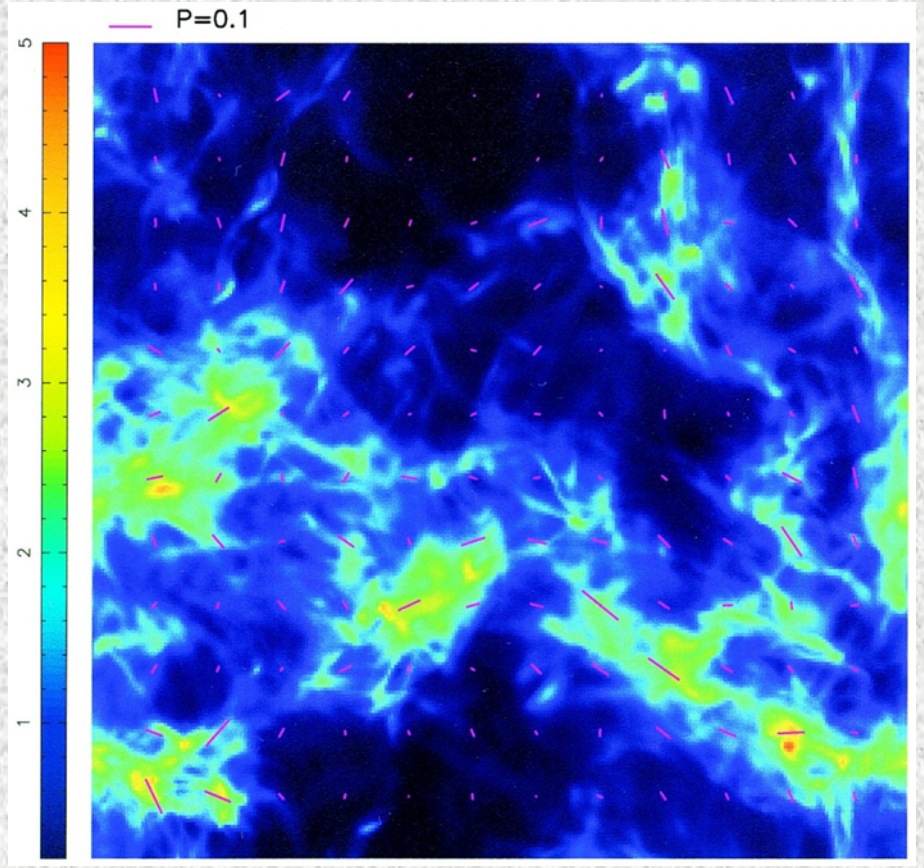


Expected B fields in Clouds:

Strong Field



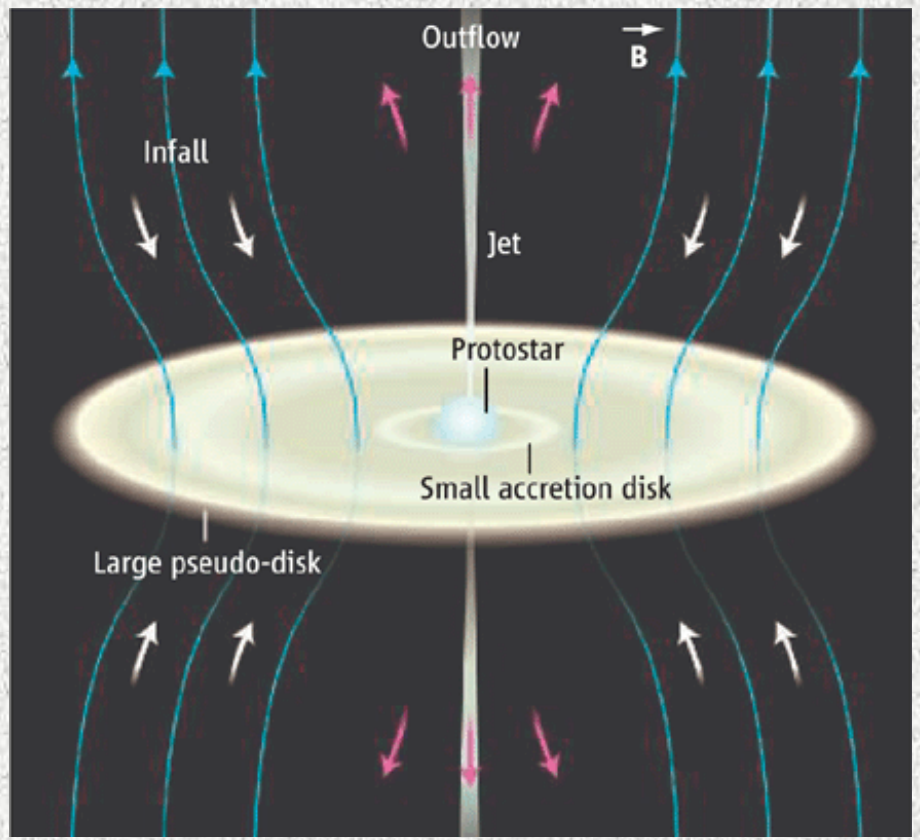
Weak Field



Ostriker et al. (2001)

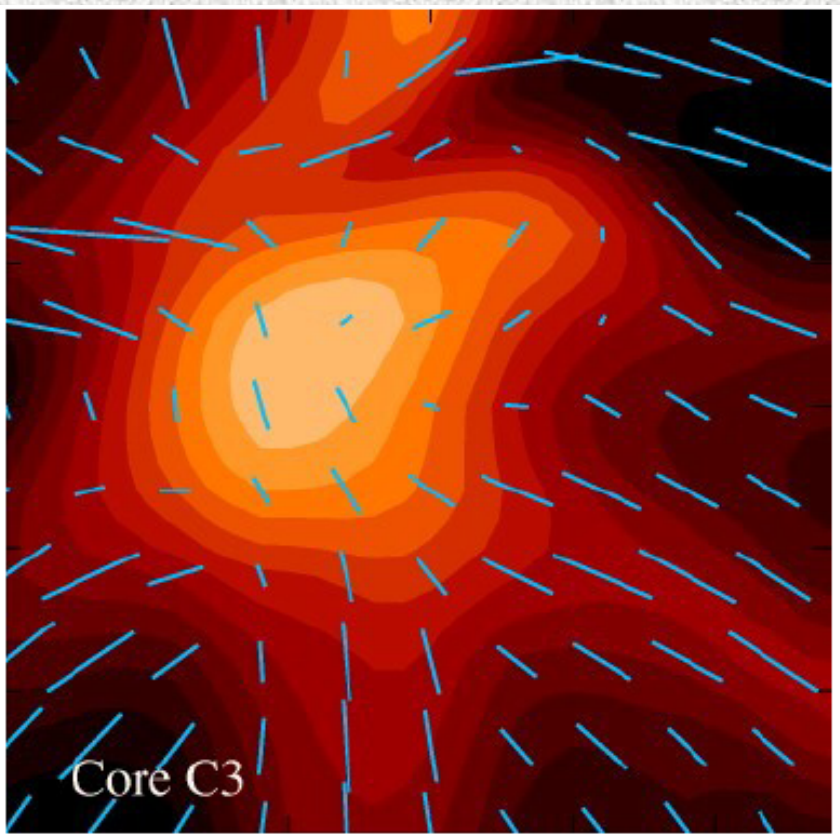
Expected B fields in Cores:

Strong Field



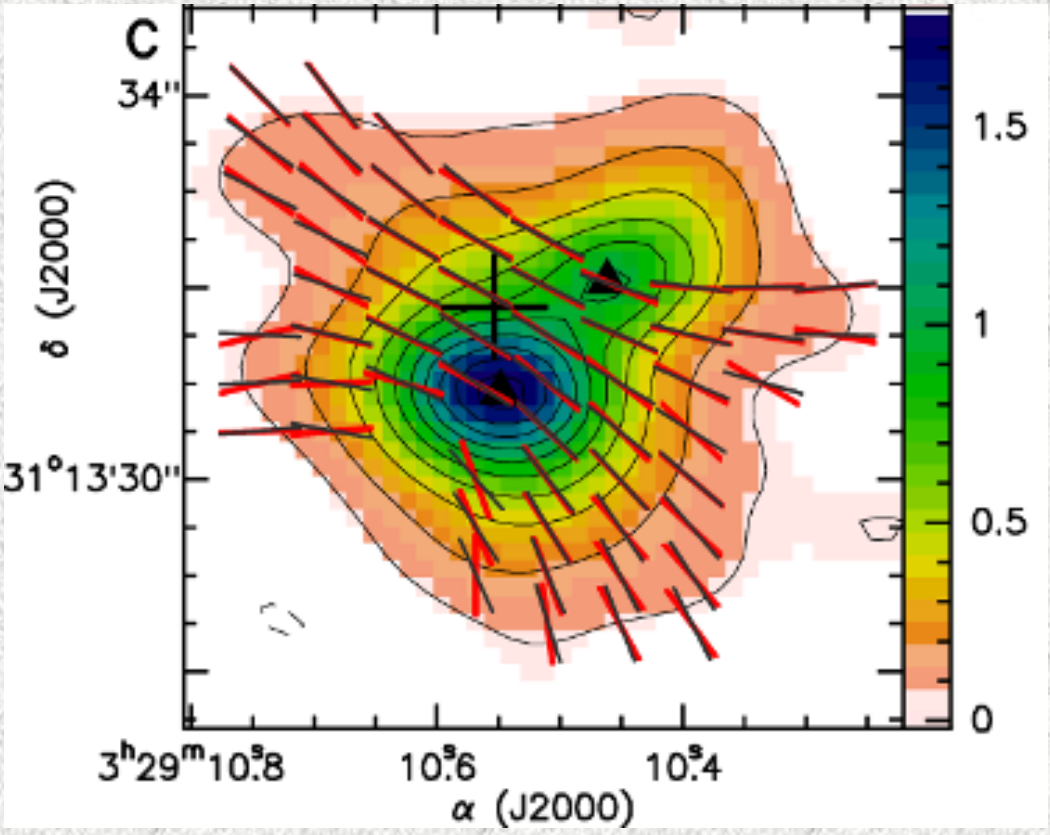
Crutcher (2006)

Weak Field



Padoan et al. (2001)

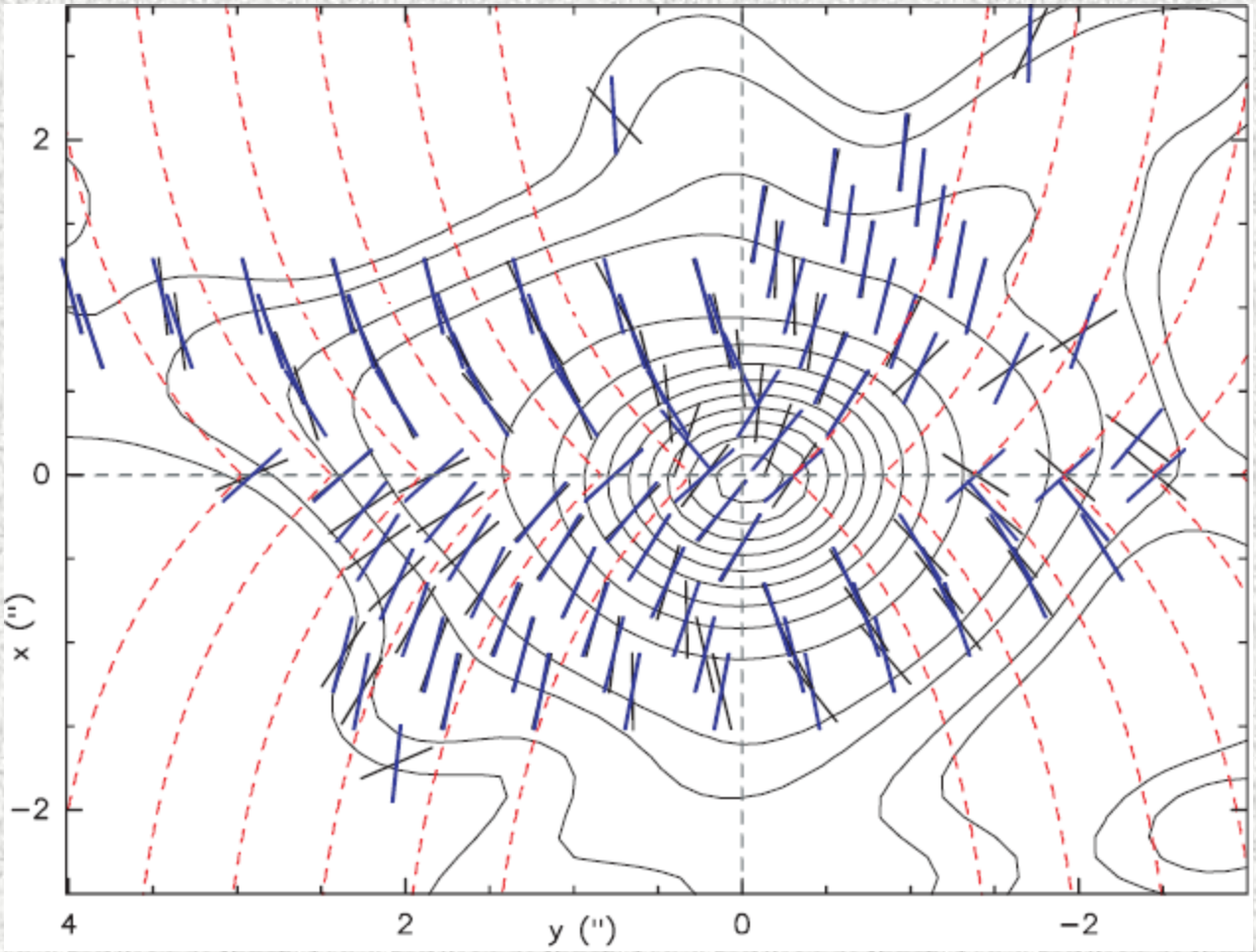
Clear-cut cases test theories:



Girart et al. (2006)

also see Rao et al. (2009) and Stephens et al. (2013)

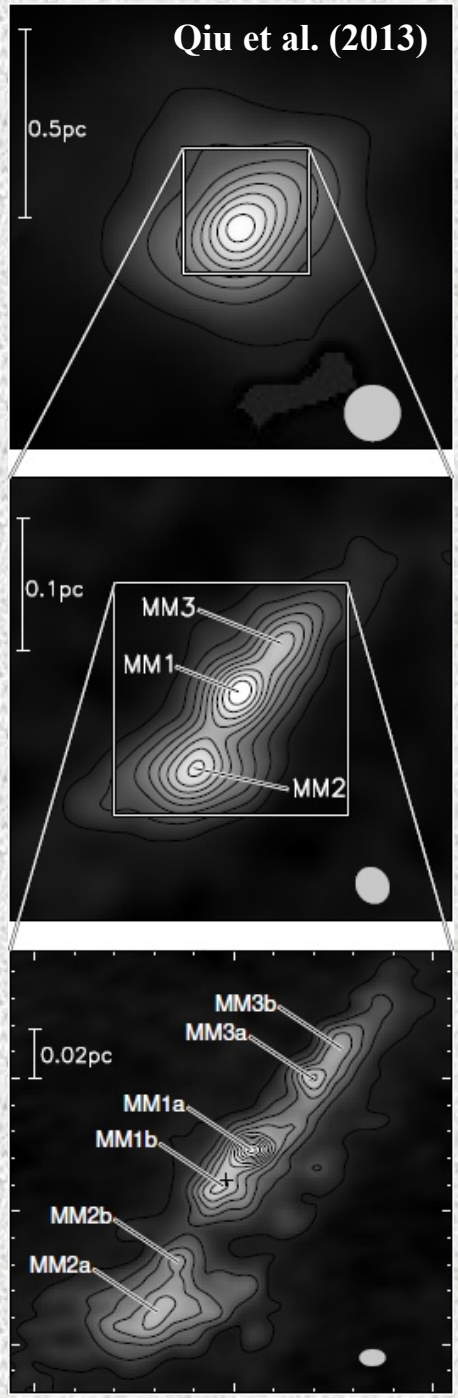
High-mass cases:

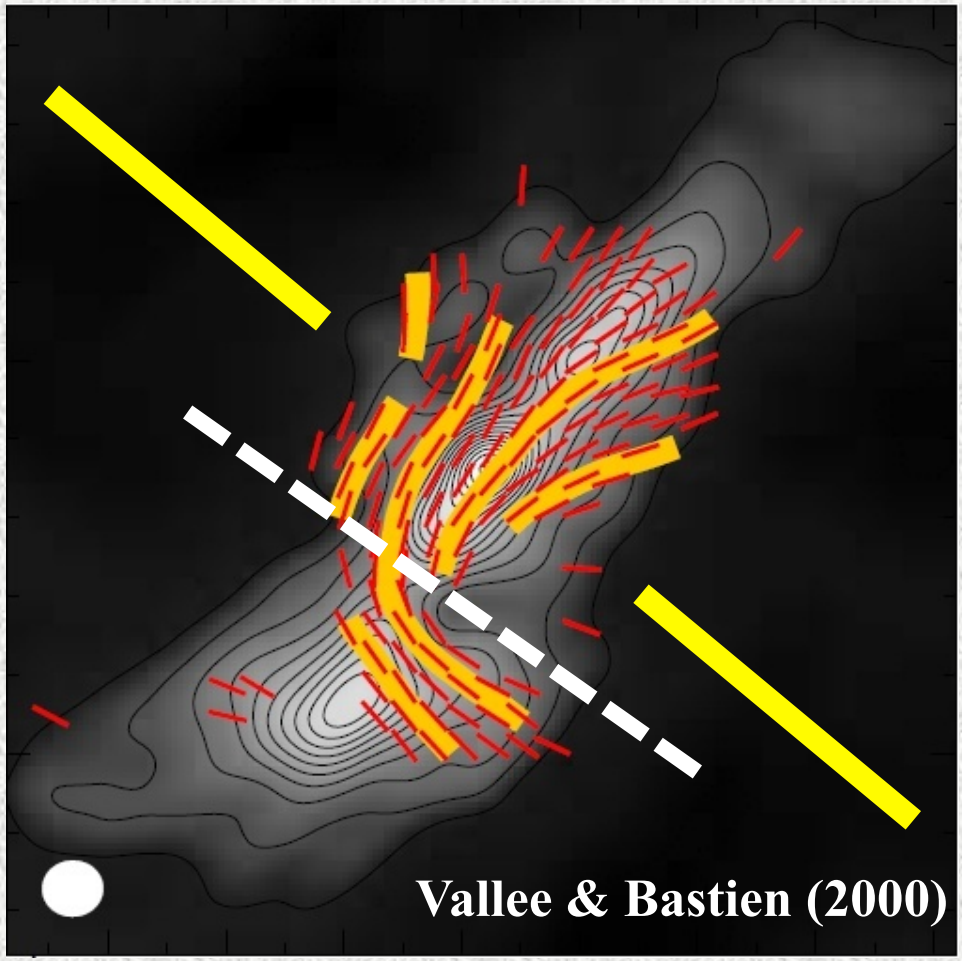


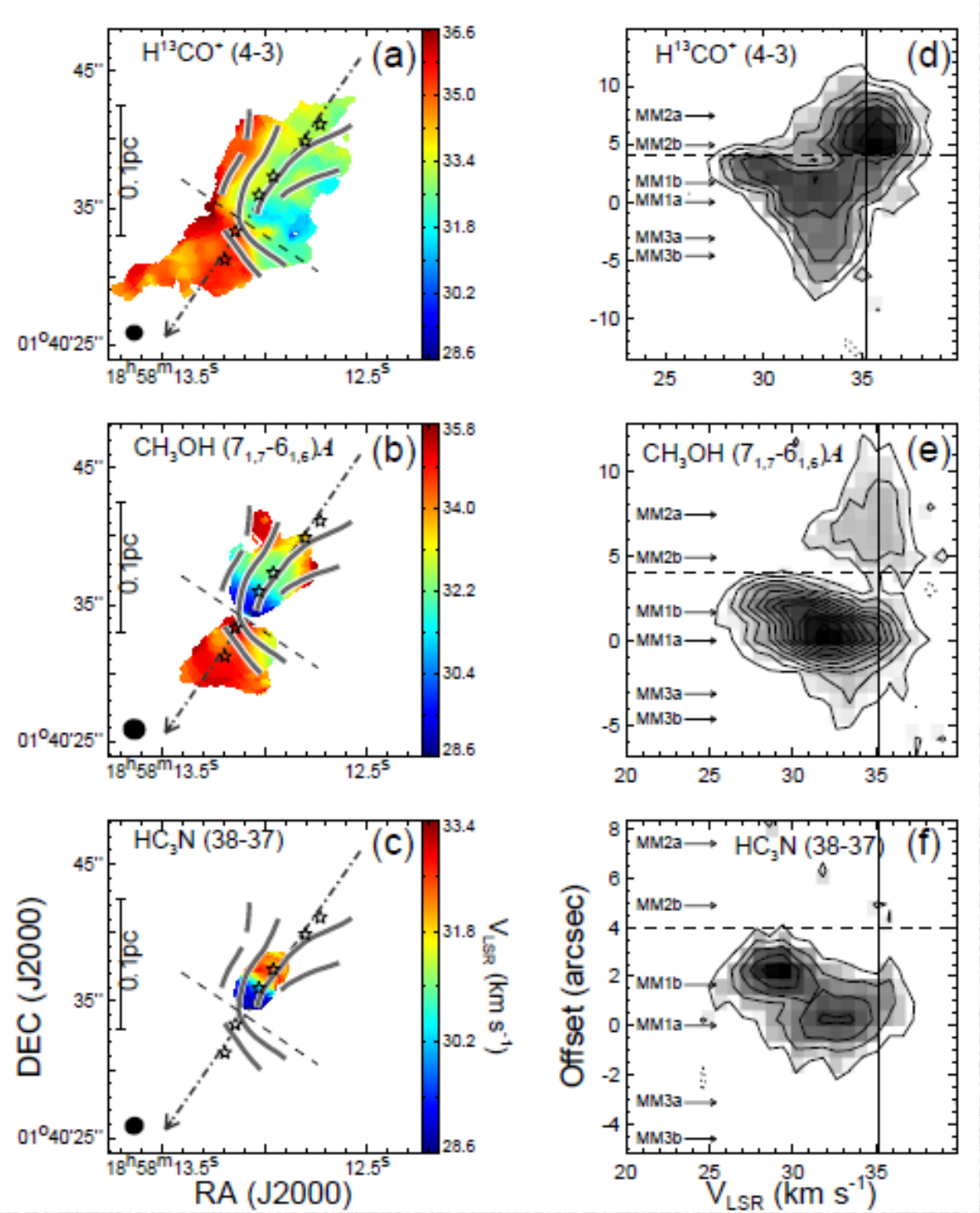
Girart et al. (2009)

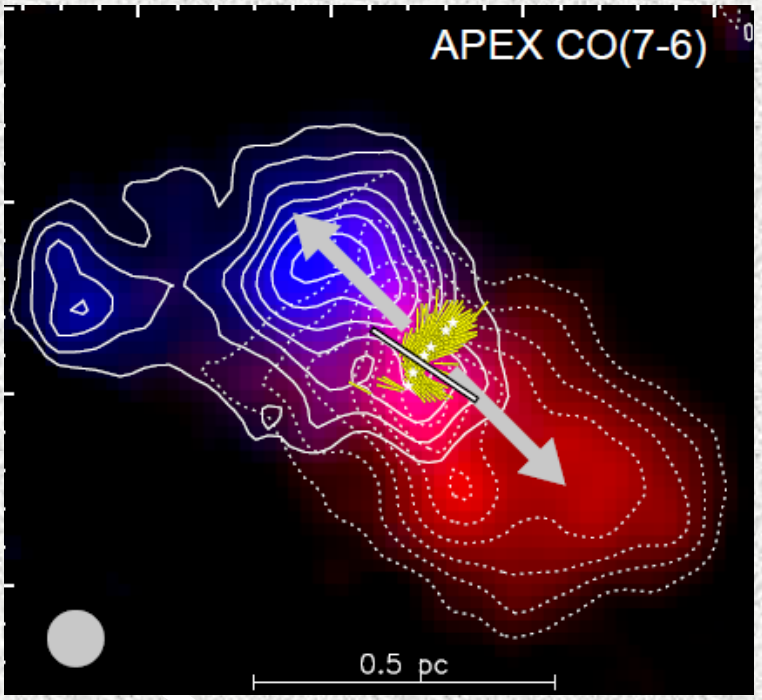
also see Tang et al. (2009)

G35.2-0.74 N

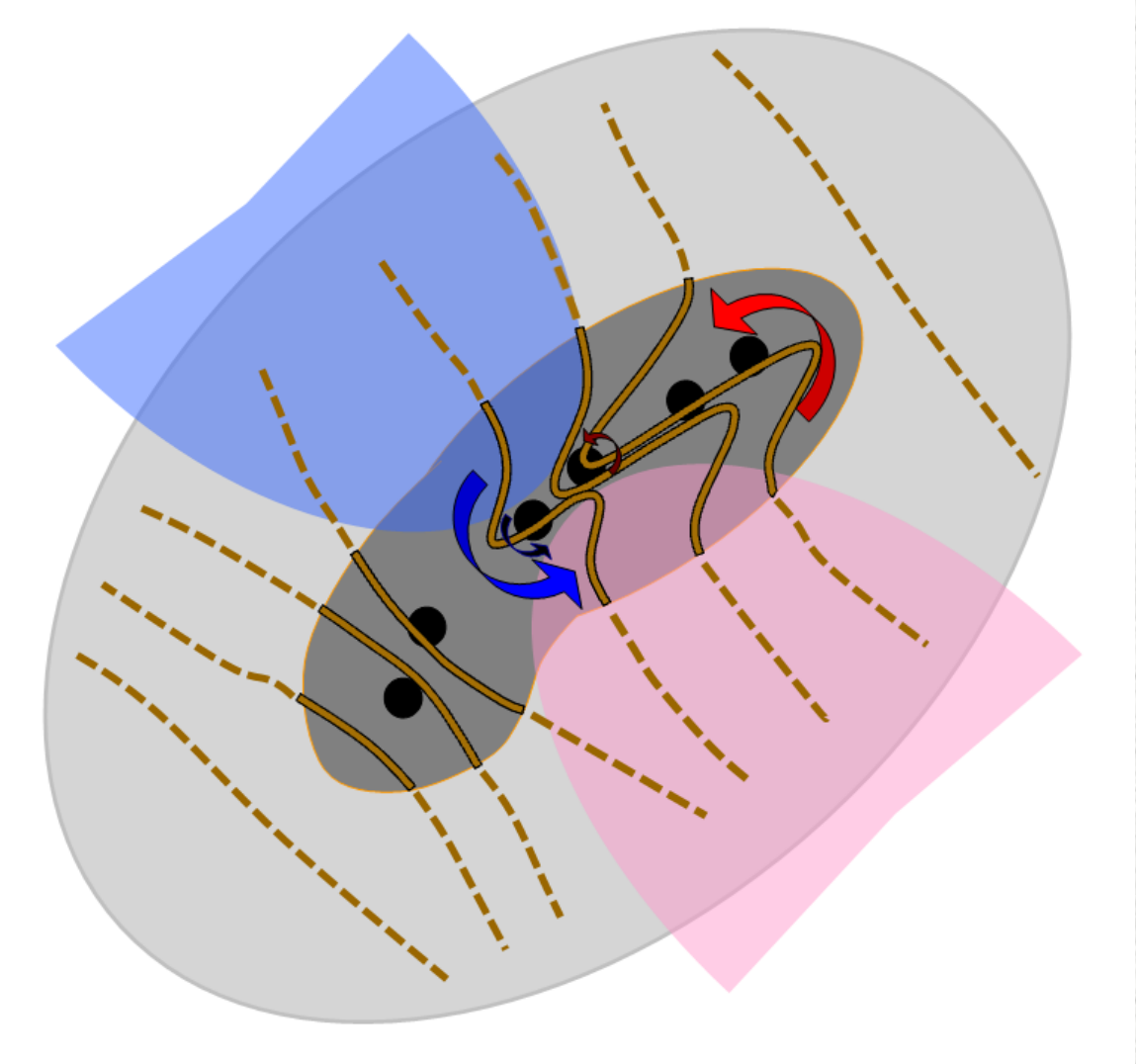

Qiu et al. (2013)
0.5pc
0.1pc
MM3
MM1
MM2
0.02pc
MM3b
MM3a
MM1a
MM1b
MM2b
MM2a


Vallee & Bastien (2000)





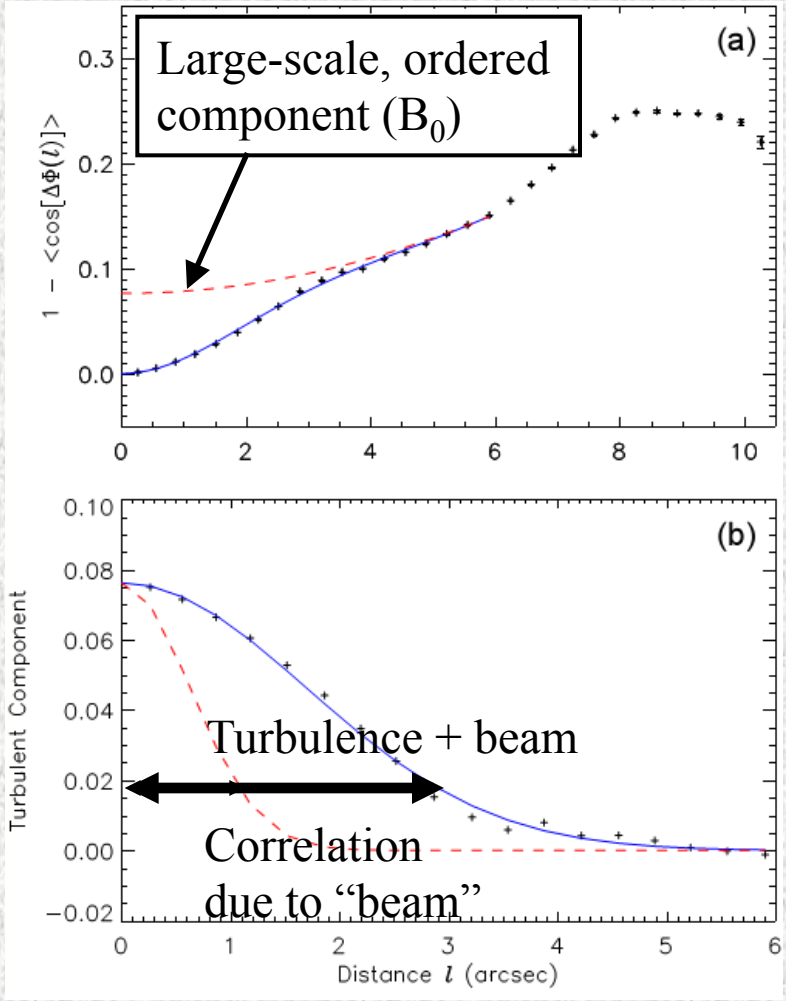
also see Sanchez-Monge et al. (2013) for the velocity field within MM1a,b



Cloud: sufficient to guide collapse
Core: rotationally twisted

Statistical analysis of P.A. dispersion

(Hildebrand et al. 2009; Houde et al. 2009; Koch et al. 2010)

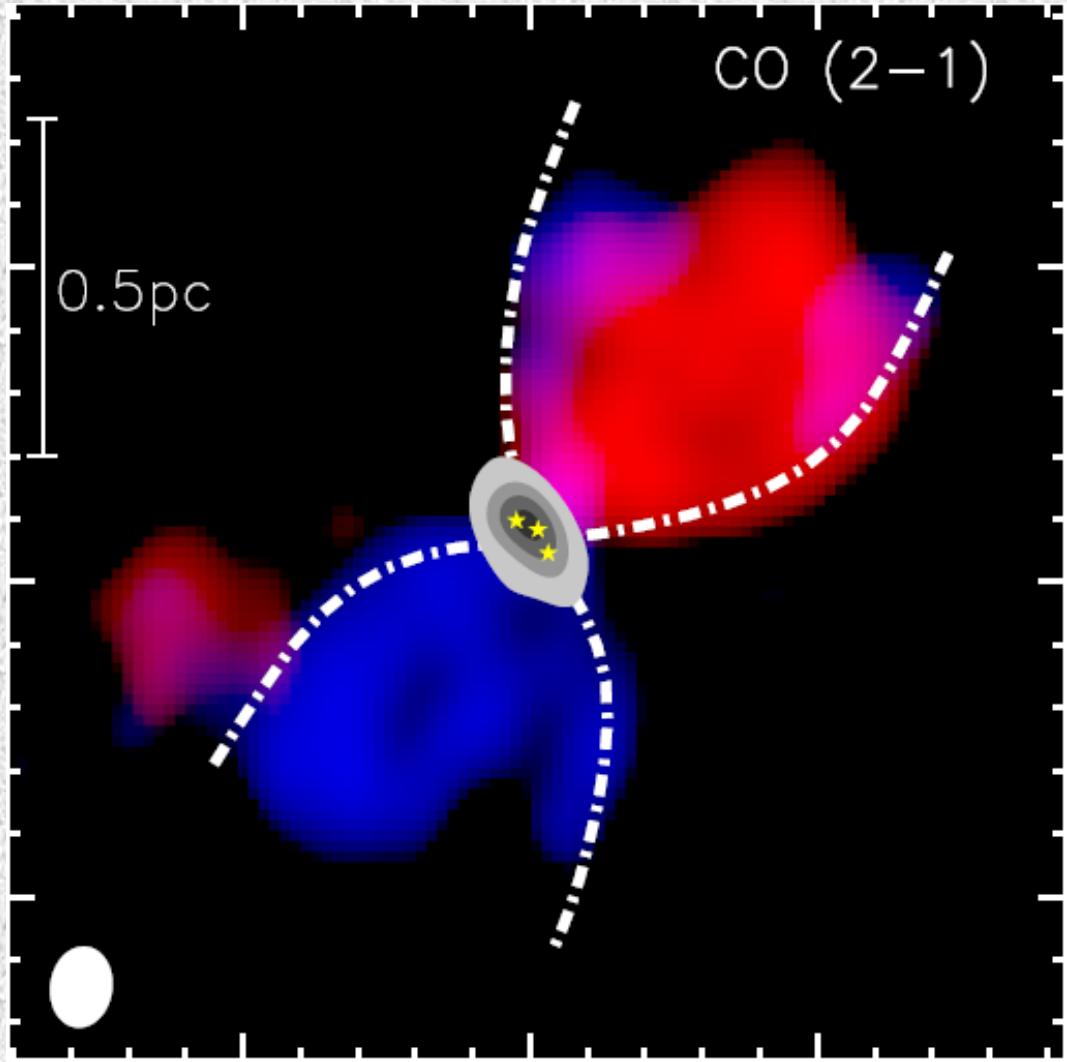


δ (mpc)	N	$\langle B_t^2\rangle/\langle B_0^2\rangle$	$\beta_{\rm turb}$	B_0 (mG)	M/ϕ_B $(1/2\pi\sqrt{G})$
15.4	3.0–8.4	0.23–0.64	0.7–1.9	1.4–0.9	1.9–3.2

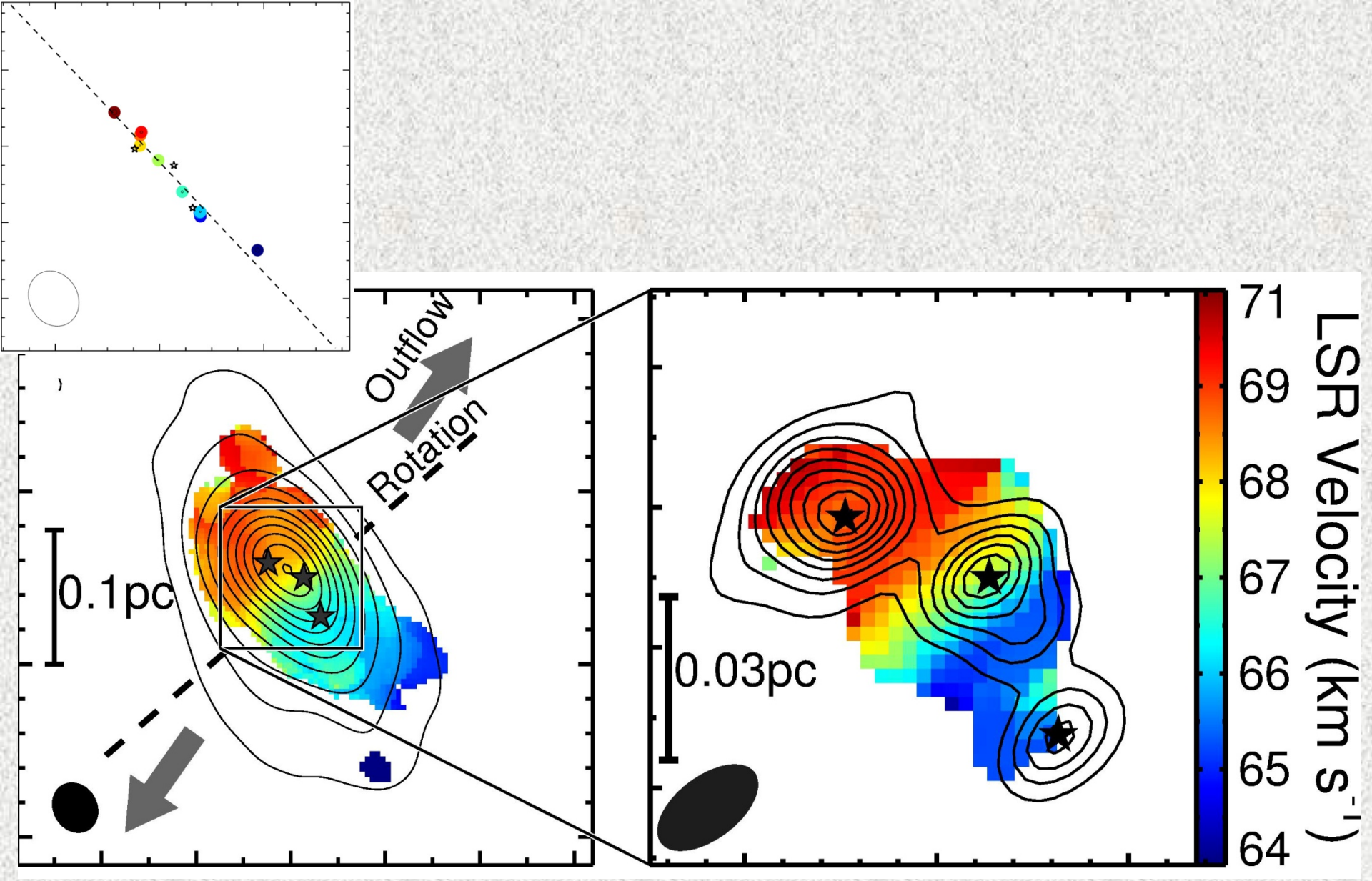
Turbulence and B field are energetically comparable

A Supercritical core with strong B field, significantly fragmenting

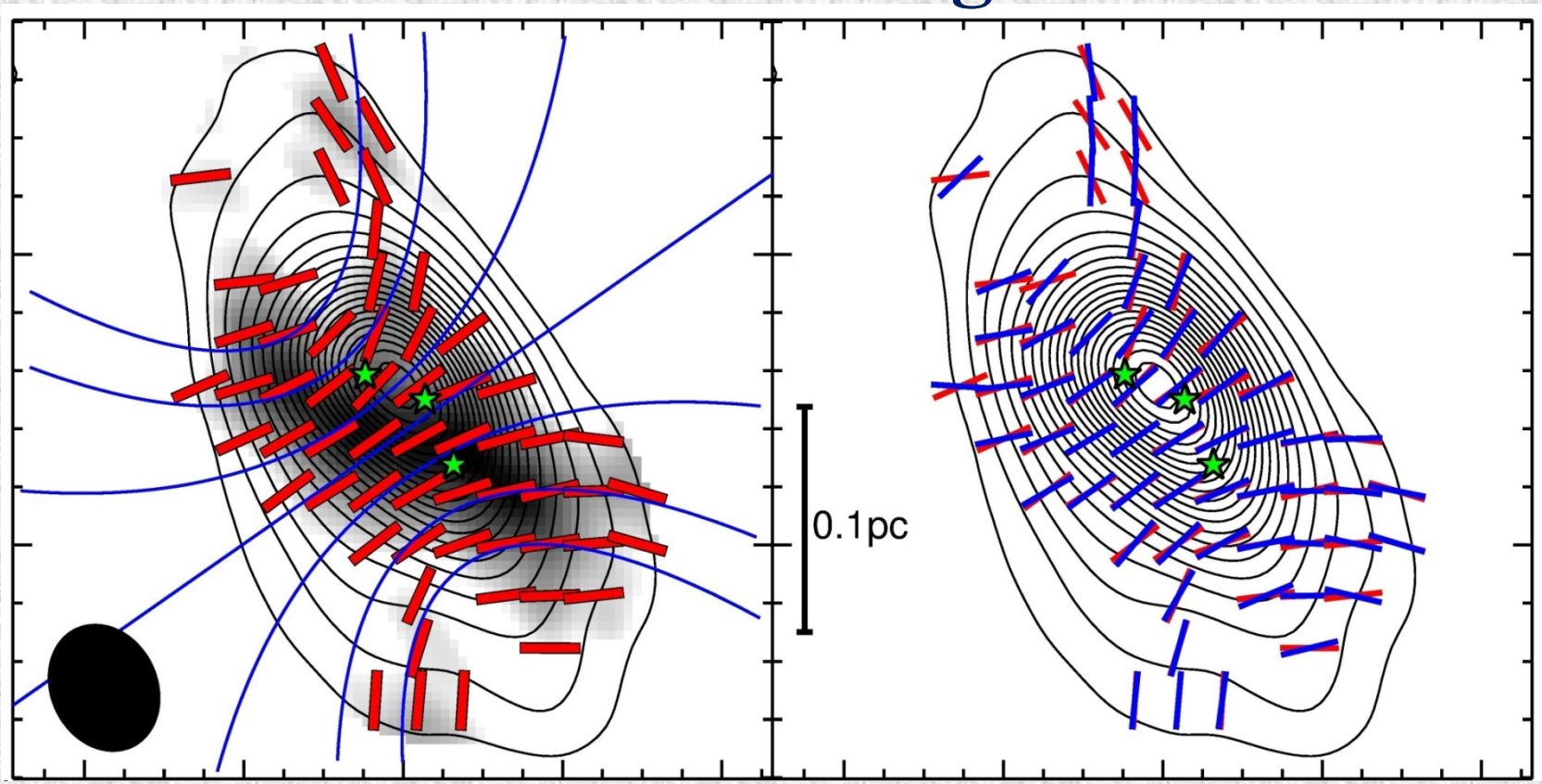
G240.31+0.07



Qiu et al. (2009)


Outflow
Rotation
0.1pc
0.03pc
71
69
68
67
66
65
64
LSR Velocity (km s-1)

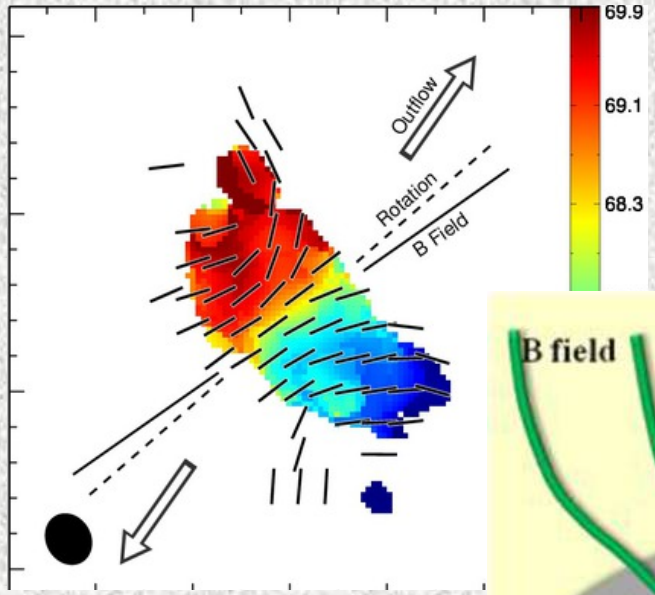
A clear hourglass



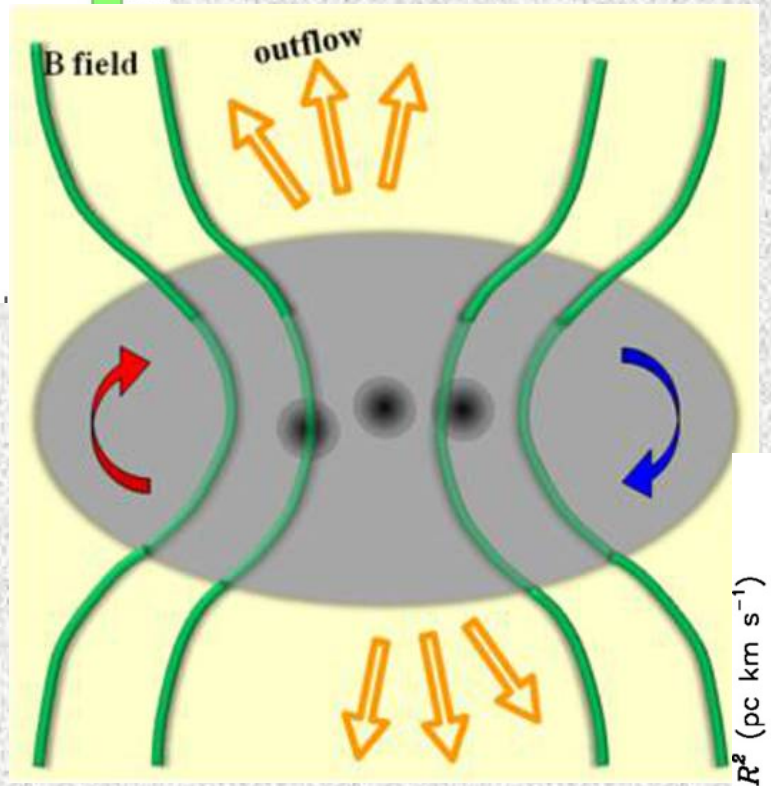
Fit to a family of parabolic functions: $y = g_i + g_i C x^2$ (e.g., Girart et al. 2006)

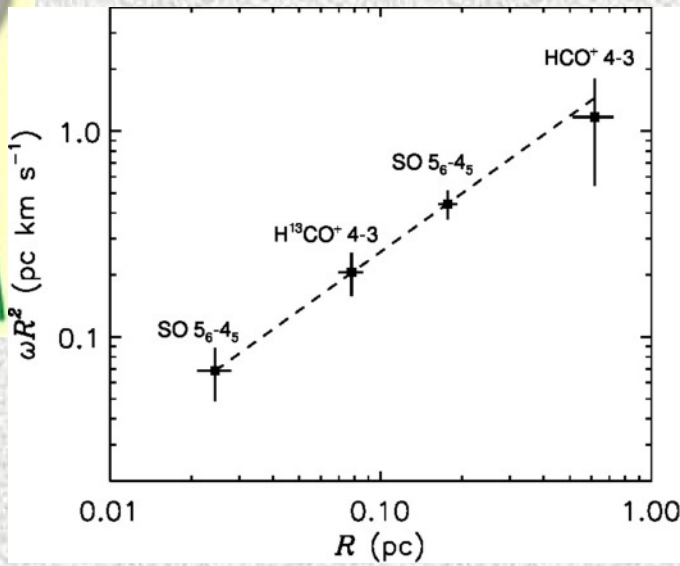
B ~ 1.0 mG (C-F method)

1.6 mG (field curvature, e.g., Schleuning et al. 1998)



B_{pos} (mG)	B_{turb}	M/ϕ_B	ω/B
1.0	0.4	1.8	0.2
1.4 – 0.9	0.7 – 1.9	1.9 – 3.2	0.4 – 0.6



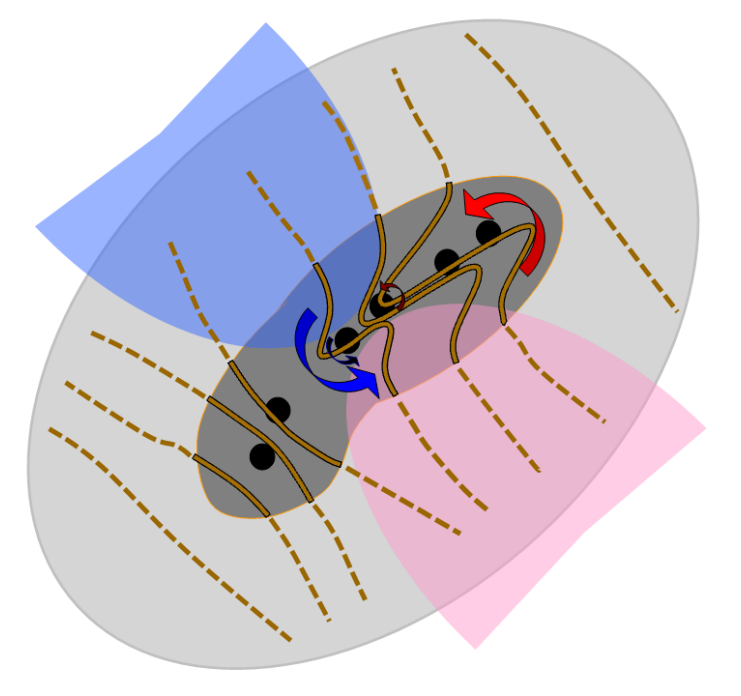


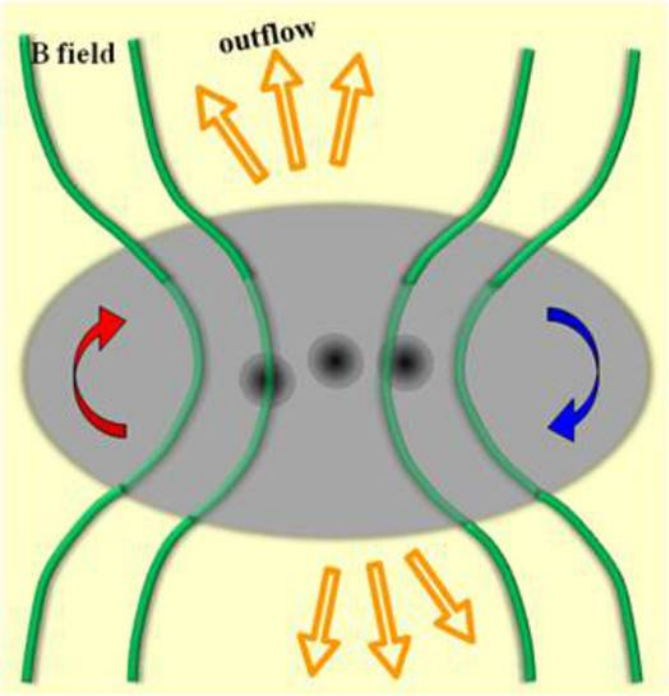
Remarks

- ***Well-ordered*** **B fields seen in the two** ***filamentary*** **and** ***fragmenting*** **cores:**
  G35.2N — *L-shape* (from *poloidal* to *toroidal*)
  G240.31 — *Hourglass* (*outflow*, *rotation*, *flattening*, *B fields* – all in the right place!)

- **B fields are *crucial* (at least in "clouds/clumps → cores");**
- **Kinematics are *of great importance* in interpreting the morphology of the B fields;**

- **Strong B fields (μ ~ 2) are not sufficient to suppress core fragmentation.**





Thanks for your attention!