Polarimetry with the SMA

Do magnetic fields play a role in the star formation process?

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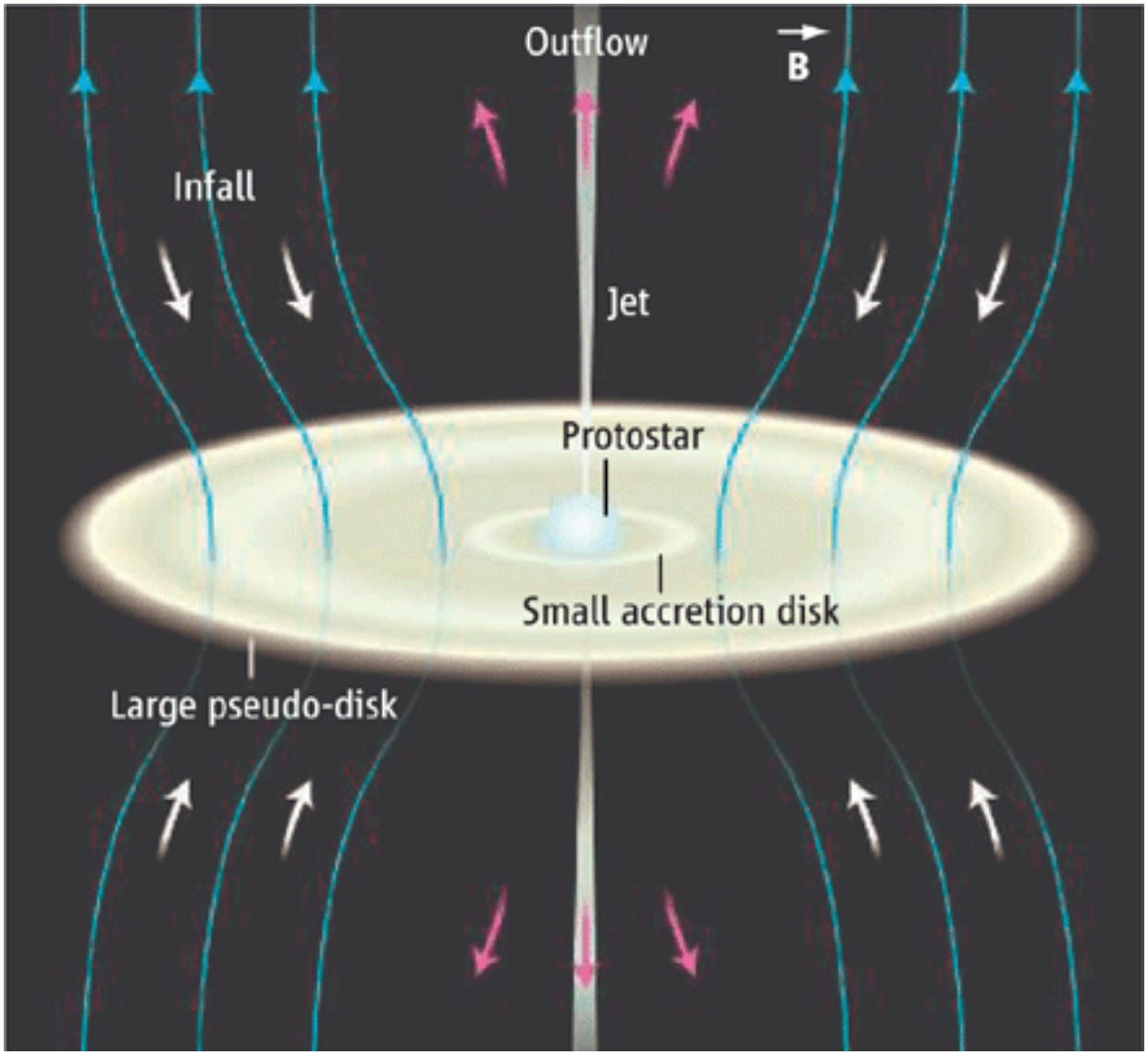
Science

- Role of magnetic fields - cloud support, ambipolar diffusion, angular momentum, fragmentation, turbulence, accretion
- Grain properties (sizes and shapes) and alignment mechanisms (classical DG + modifications, radiative torques)
- Use dust polarization to study magnetic fields



Crutcher (2006), Science, 313, 771

Advantages of Submm Polarimetry

- Single dish measurements (CSO,JCMT) - resolution (10”) is low but good sensitivity
- Interferometer array observations (OVRO, BIMA) improve resolution but inadequate sensitivity but CARMA will be useful.
- **SMA is an important instrument - Improves resolution AND sensitivity**

SMA Polarization Hardware

- SMA receivers are currently single polarization X,Y
- QWP converts linear to circular pol. X,Y => L,R
- Time multiplex using Walsh switching
- Average to get quasi-simultaneous dual-pol
- Future dual pol receiver conversion is in progress

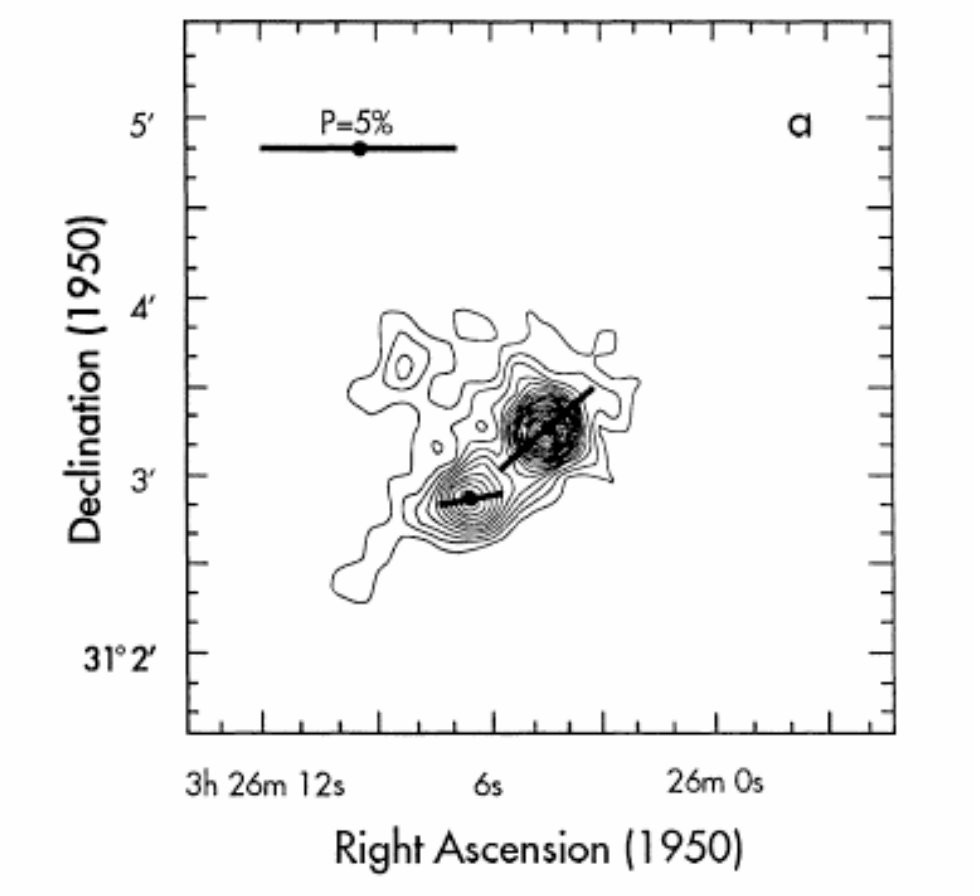
Marrone 2006 Ph.D. Thesis

NGC 1333 IRAS 4A/B (JCMT)

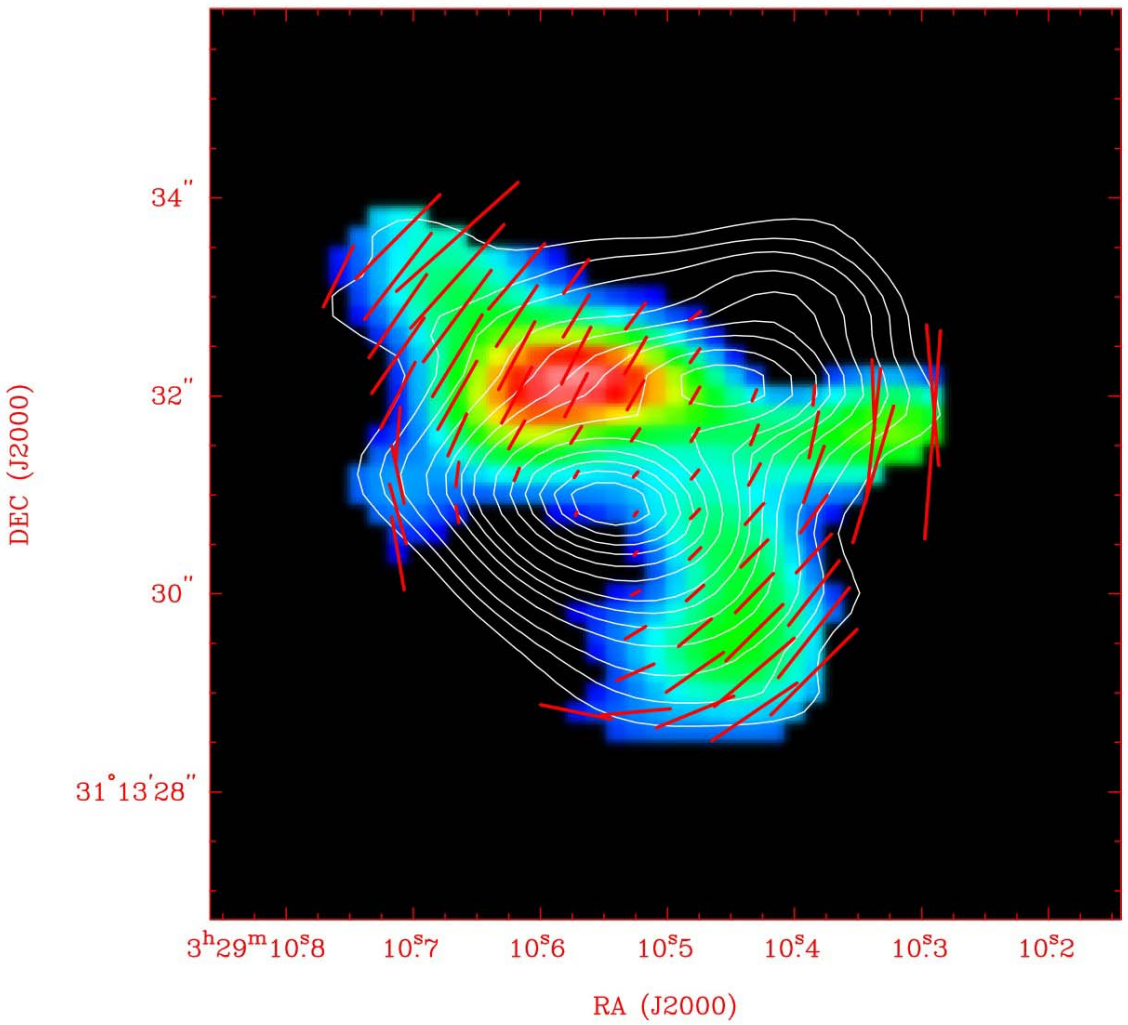
Low mass
Class0 protostar
in Perseus cloud (300AU)

Minchin, Sandell
and Murray 1995

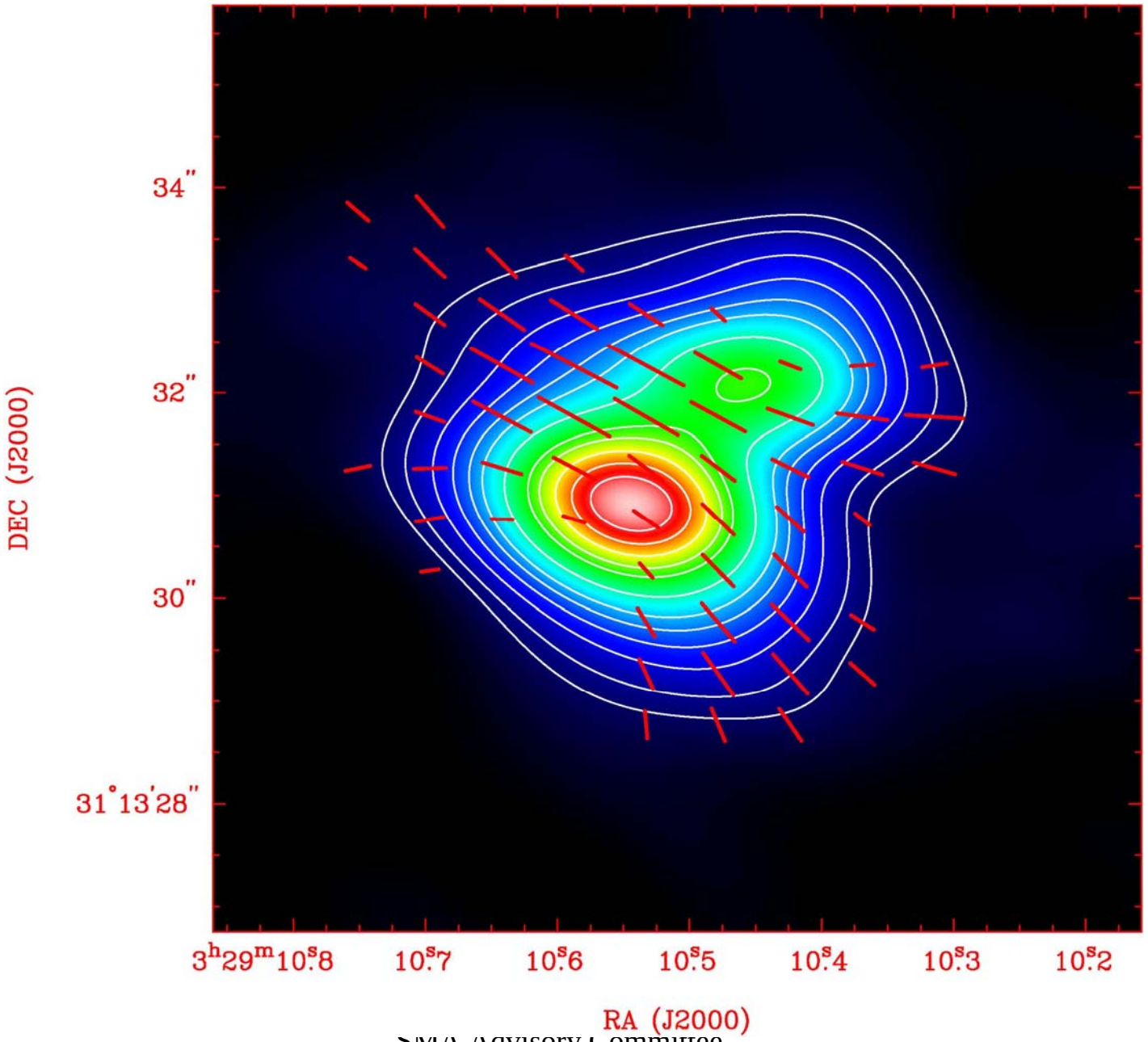
JCMT 800 micron
14 arcsec



NGC 1333 IRAS 4A (SMA)

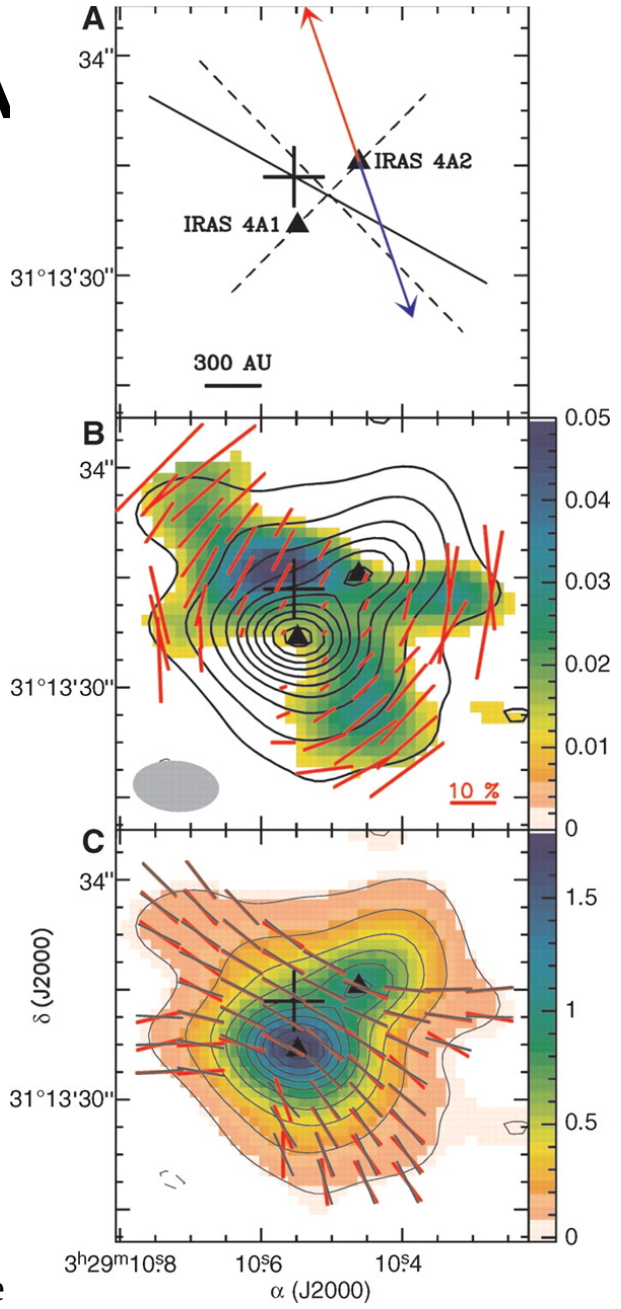


Girart, Rao, & Marrone (2006), Science, 313, 812

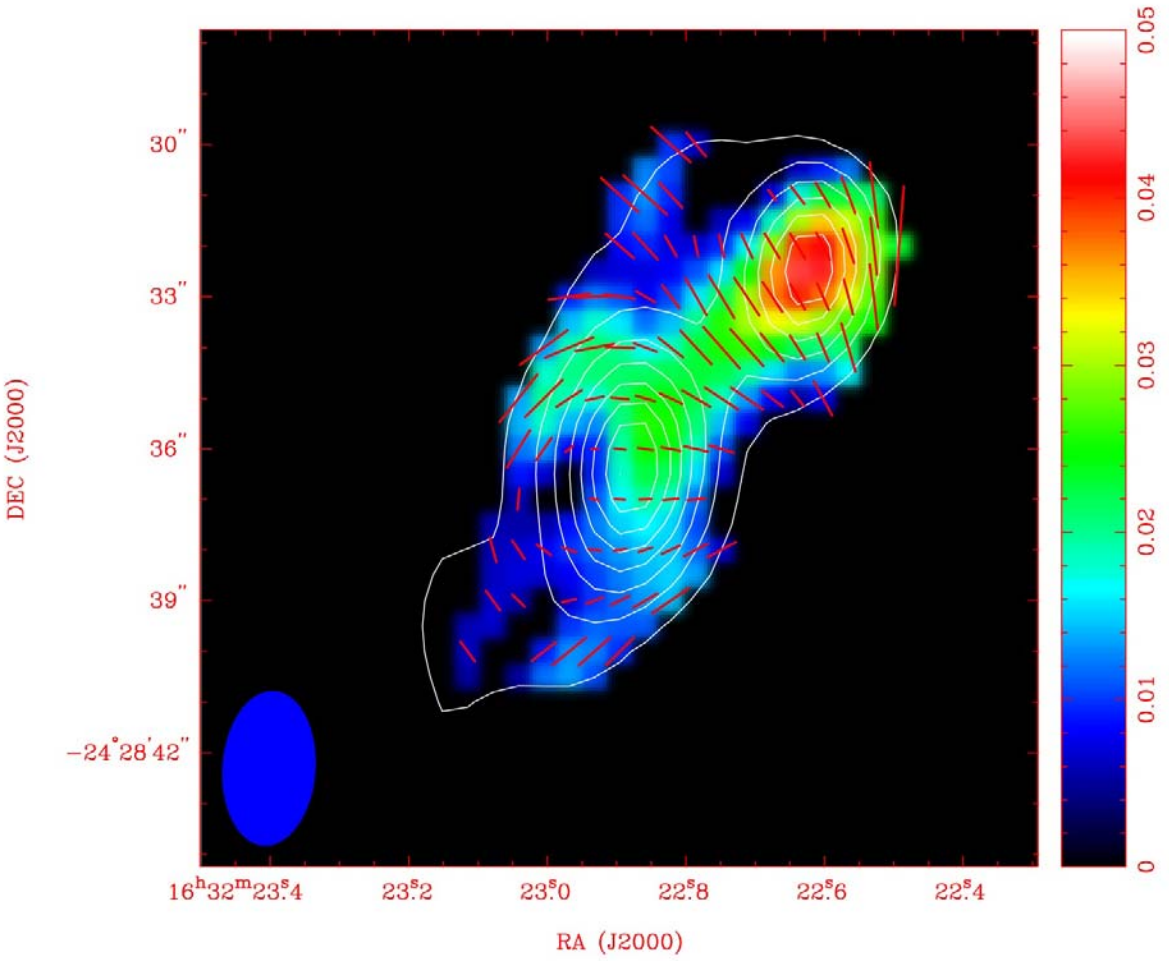

34″
32″
30″
31°13′28″
DEC (J2000)
3h29m10.s8
10.s7
10.s6
10.s5
10.s4
10.s3
10.s2
RA (J2000)

B-Fields in IRAS4A

- Predicted hourglass pinch is clearly seen
- Fit parabolic curves to B-field position angles (PA)
- Estimate strength of B-field from PA residuals and velocity dispersion (Chandrasekhar-Fermi method)
- B ~ 5mG
- Axes misalignment between cloud/B-field/outflow
- Fragmentation?



IRAS16293: Polarization



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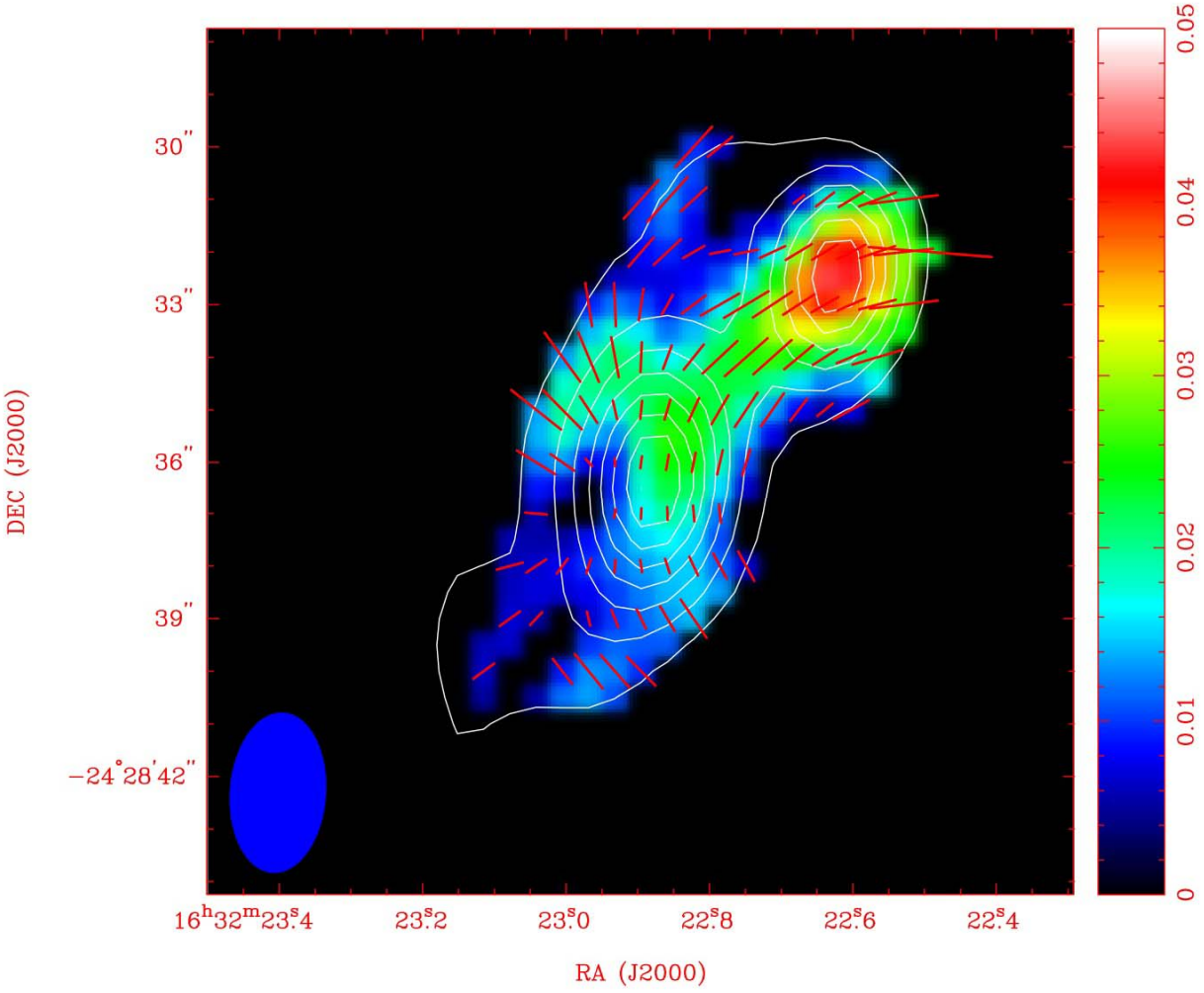
IRAS16293: Magnetic Field

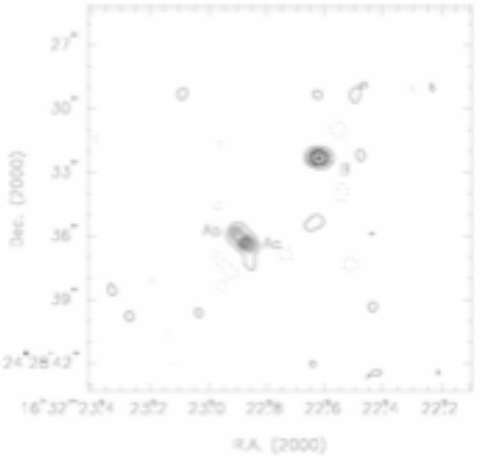


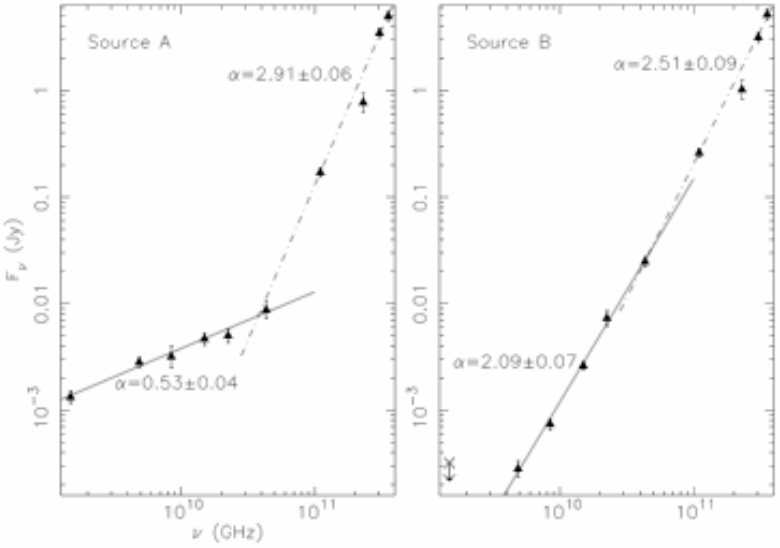
Rao et al.

IRAS16293: A and B

- Source A shows multiplicity
- A and B have different spectral indices
- Molecular outflows seem to be associated with Source A
- A and B thus appear to be at different evolutionary stages
- The magnetic field information shows that A is certainly more evolved
- Further analysis is still ongoing…

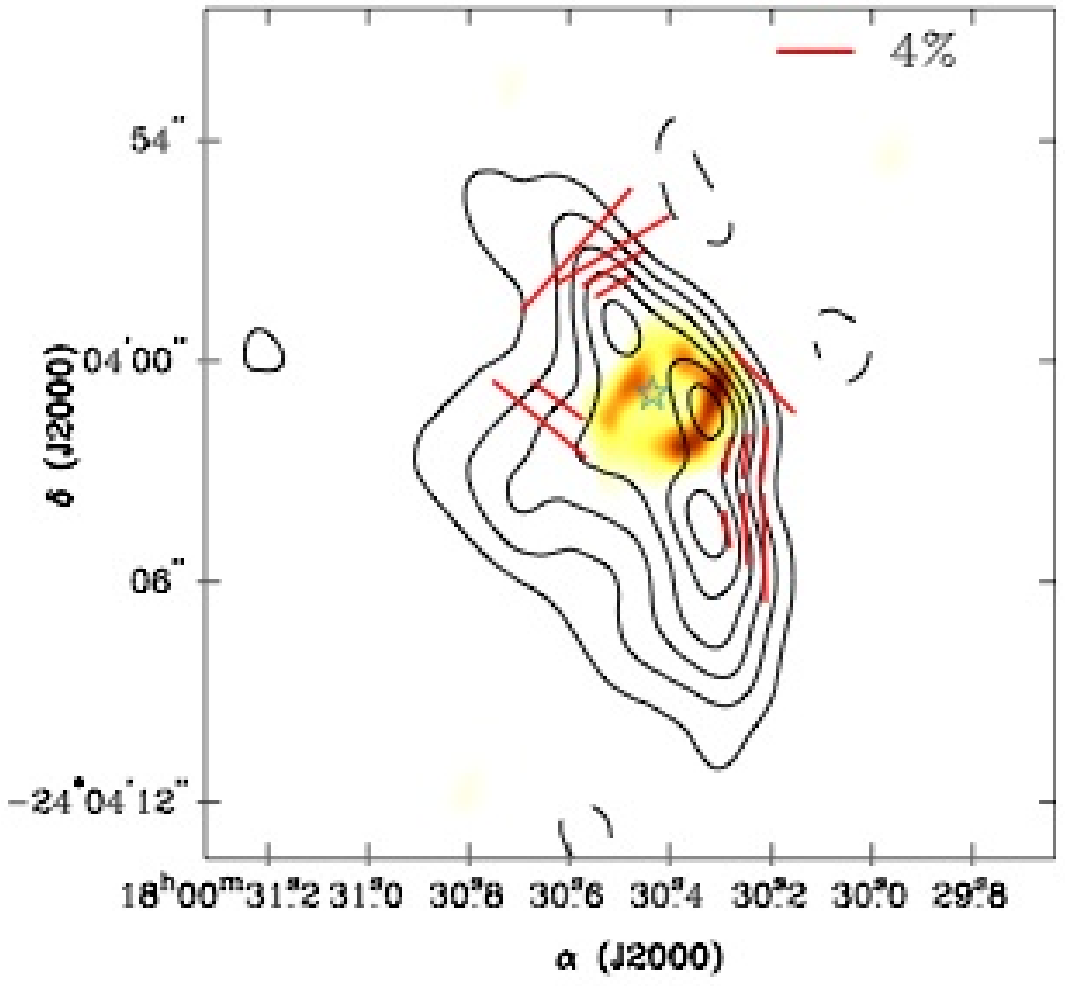
Chandler et al. 2005



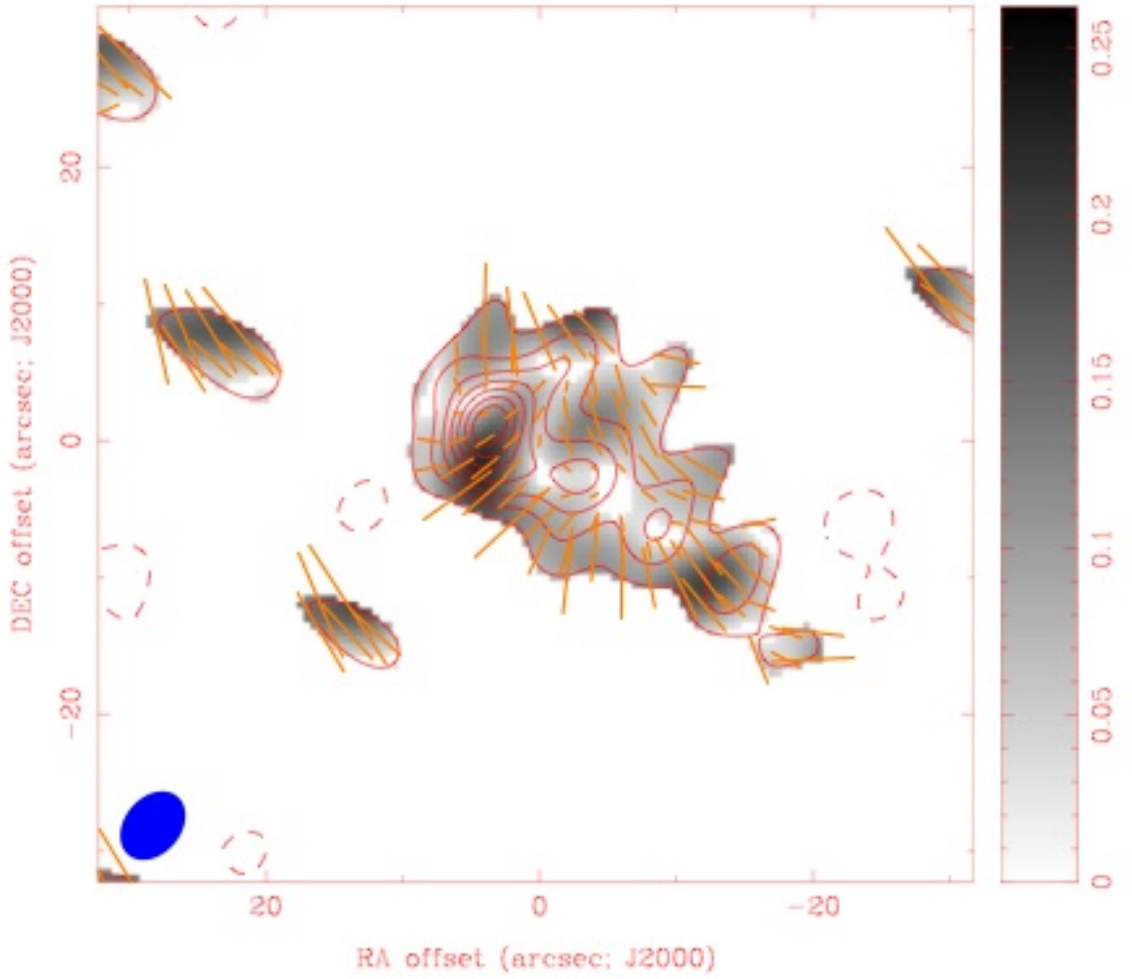


G5.89

Tang et al.

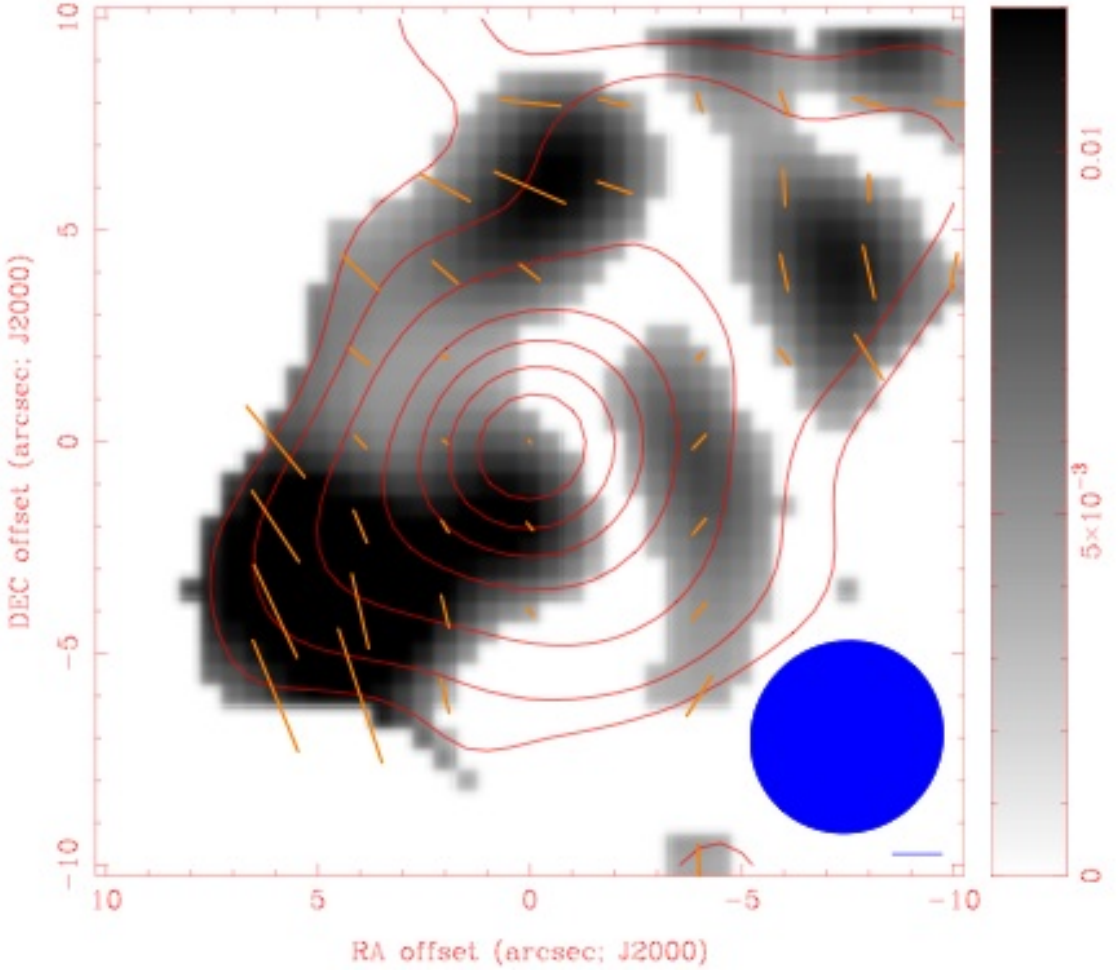


G30.79 FIR10



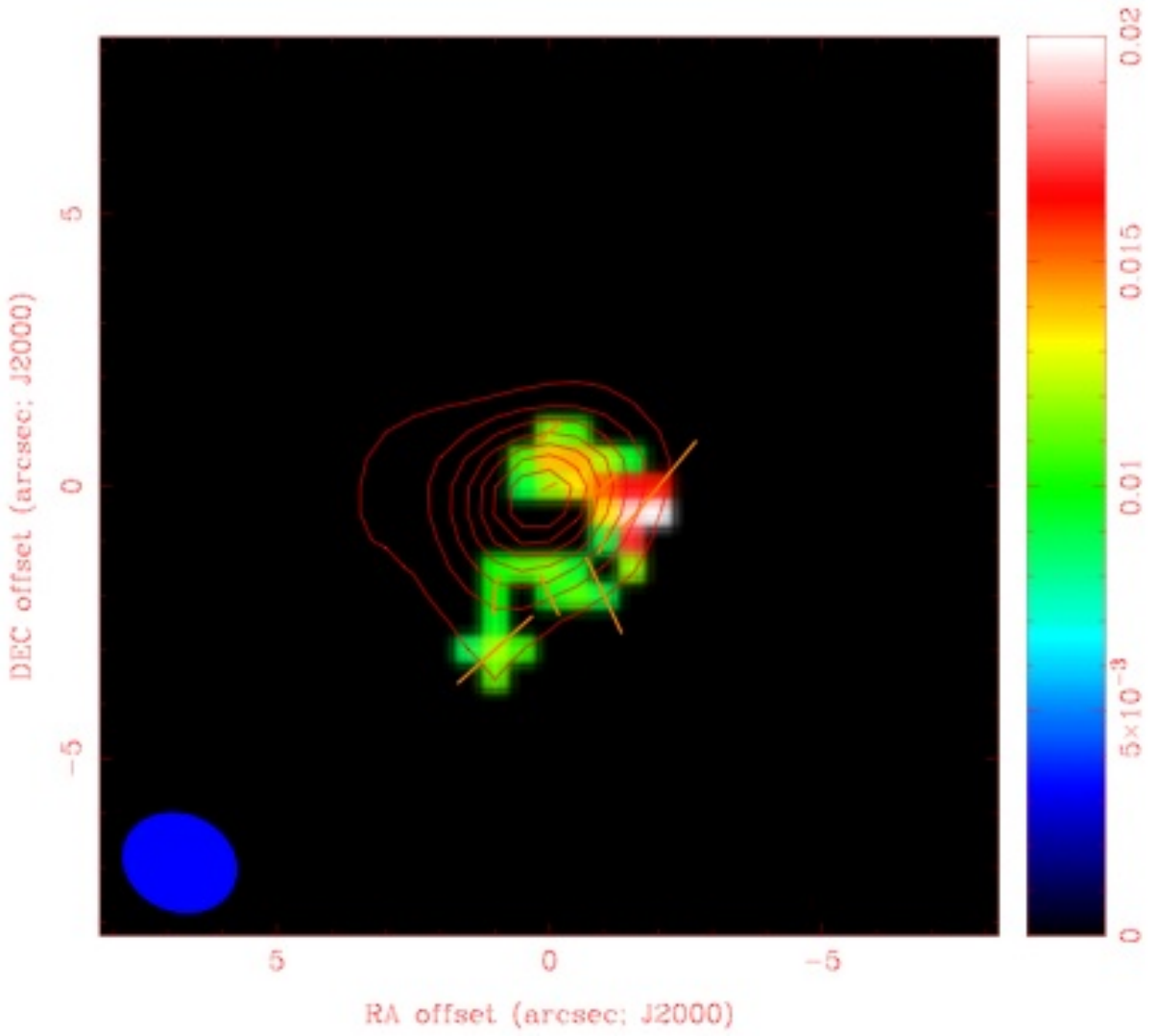
Sridharan et al.

IRAS20126



Sridharan et al.

L1551IRS5



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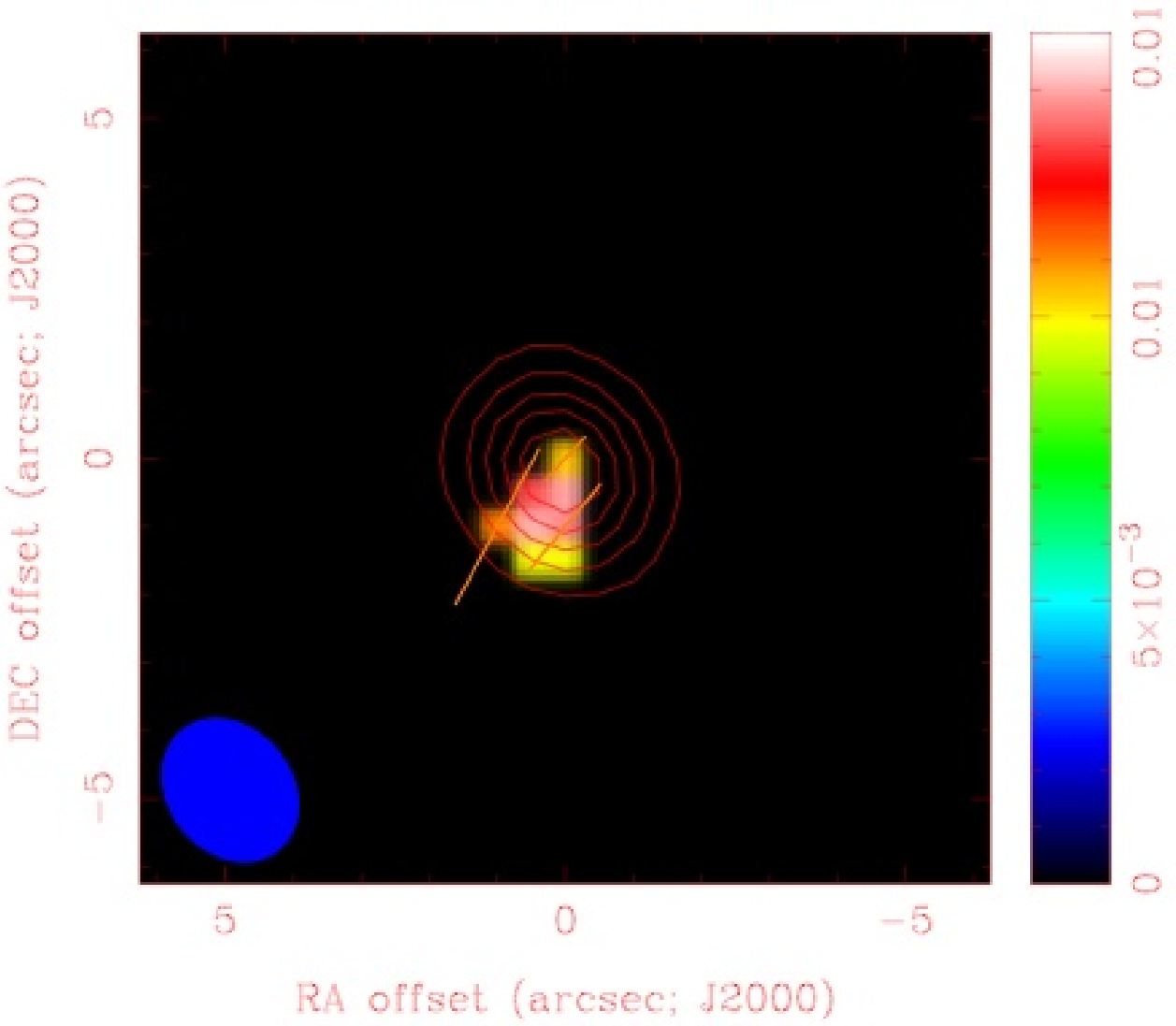
HLTAU



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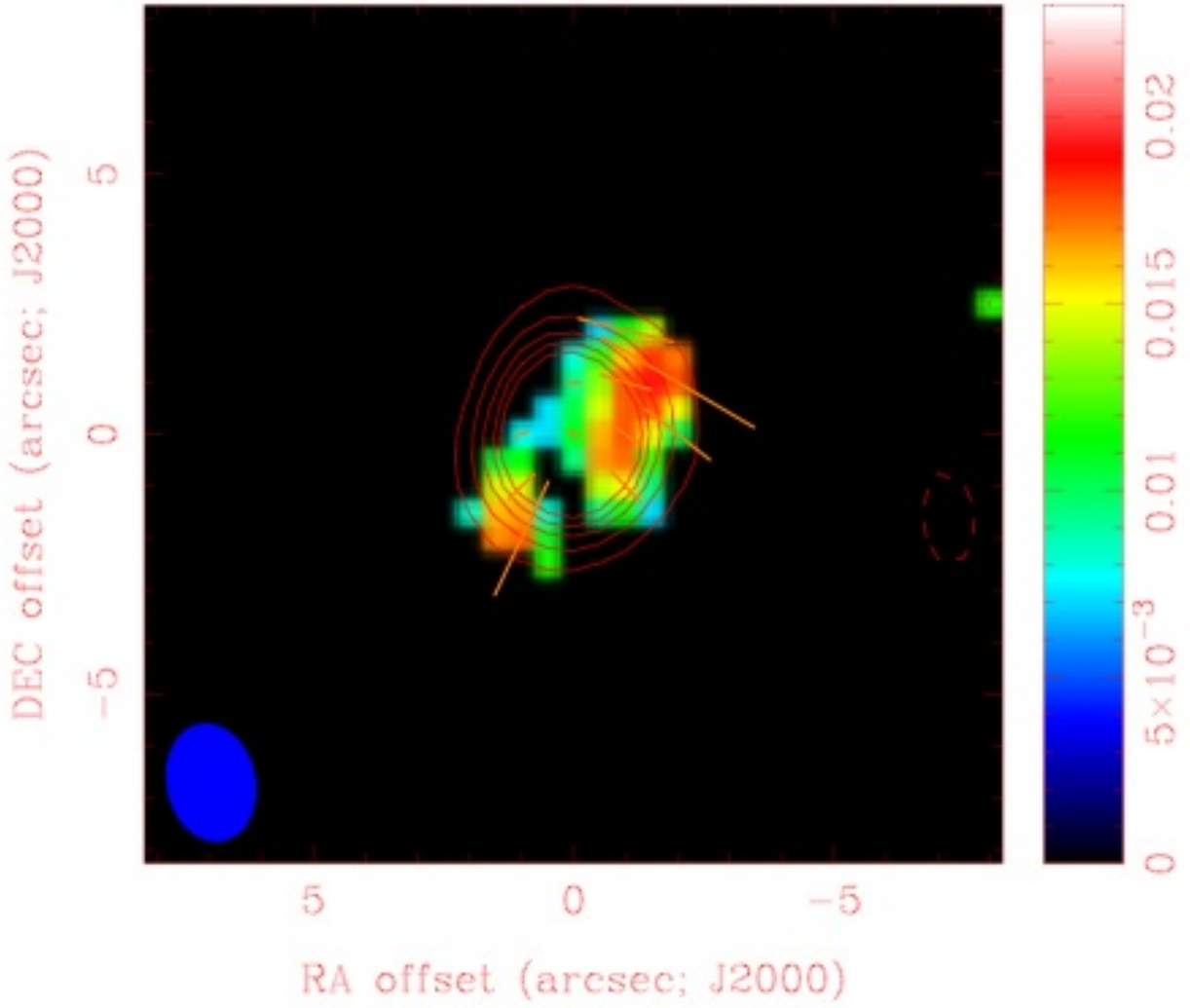
NGC1333 IRAS4B



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Future of SMA Polarization Observations

- We have a number of other observations with collaborators within the SMA and outside
- The targets are mainly well known YSOs
- High mass star forming regions such as G5.89, G30.79, IRAS20126 etc.
- Low mass regions such as HLTAU, VLA1623, etc.
- In the future we will have dual polarization capability ==> ALMOST √3 INCREASE in SENSITIVITY