Polarimetry with the SMA

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

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

Sep 4-5, 2007  
SMA Advisory Committee
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)
- $B \approx 5\text{mG}$
- Axes misalignment between cloud/B-field/outflow
- Fragmentation?
IRAS16293: Polarization

Rao et al.

Sep 4-5, 2007
SMA Advisory Committee
IRAS16293: Magnetic Field

Rao et al.

Sep 4-5, 2007

SMA Advisory Committee
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.

Sep 4-5, 2007

SMA Advisory Committee
IRAS20126

Sridharan et al.

Sep 4-5, 2007

SMA Advisory Committee
L1551IRS5

Rao et al.

Sep 4-5, 2007

SMA Advisory Committee
HLTAU

Rao et al.

Sep 4-5, 2007

SMA Advisory Committee
NGC1333 IRAS4B

Rao et al.

Sep 4-5, 2007

SMA Advisory Committee
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

\[ \Rightarrow \text{ALMOST } \sqrt{3} \text{ INCREASE in SENSITIVITY} \]