Probing Magnetic Fields with the Submillimeter Array

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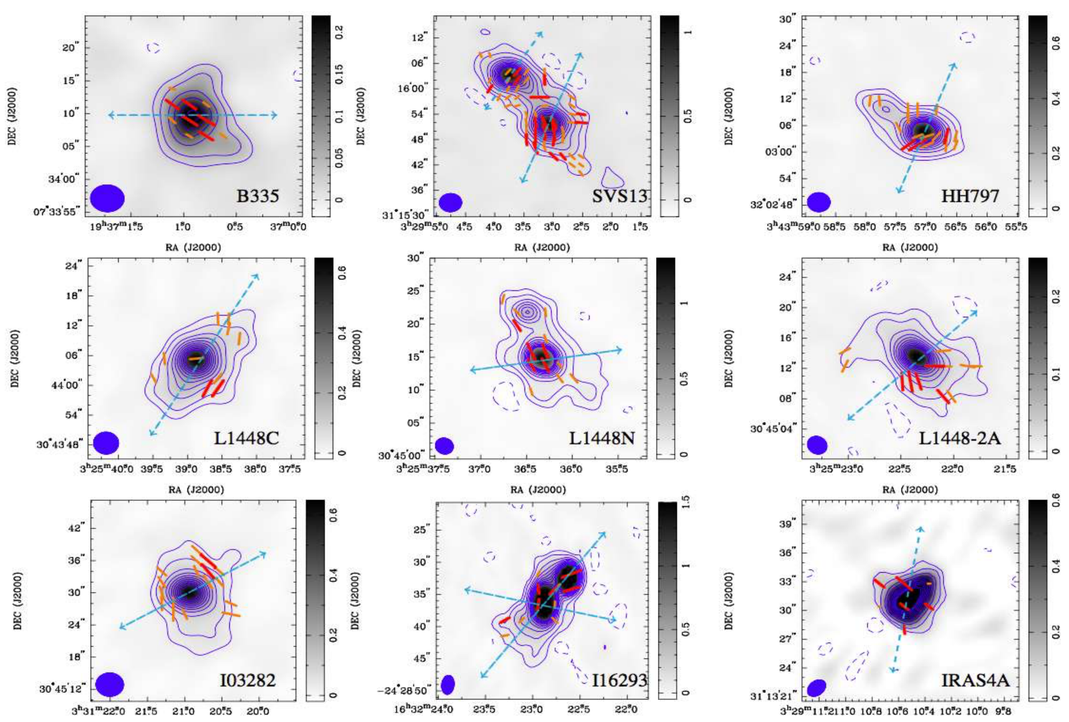
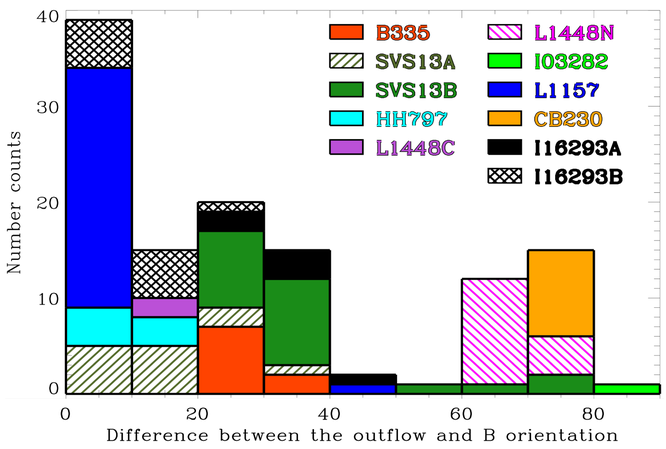
Polarimeters equipped on the Submillimeter Array (SMA) use quarter-wave plates to convert linearly polarized signals to circular ones. Before the advent of ALMA, SMA was the only sub-millimeter interferometer array that offered full polarization observations at high angular resolution. Polarimetric studies with the SMA include observations of spectral line and continuum emission from molecular clouds and stellar envelopes as well as non-thermal continuum emission from AGNs. This poster presents highlights of recent studies carried out with the SMA.

Magnetic fields and low mass star formation

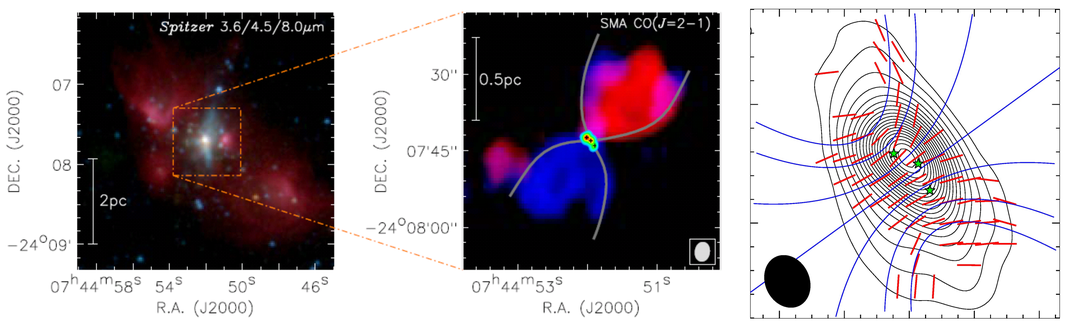


SMA 870 μm dust continuum and linear polarization observations of a sample of **Class 0 protostellar envelopes**. The blue arrows indicate the outflow direction for each object. The B-field orientations (derived from the polarization angles assuming a 90 degree rotation) are overlaid. Red bars show > 3-σ detections. Orange bars indicate the >2-σ detections (Galametz et al. 2018).



Histogram of the projected angles between the magnetic field orientation and the outflow direction. The bimodality of the distribution shows that **the envelope B-field is preferentially aligned or perpendicular to the outflow direction** (Galametz et al. 2018).

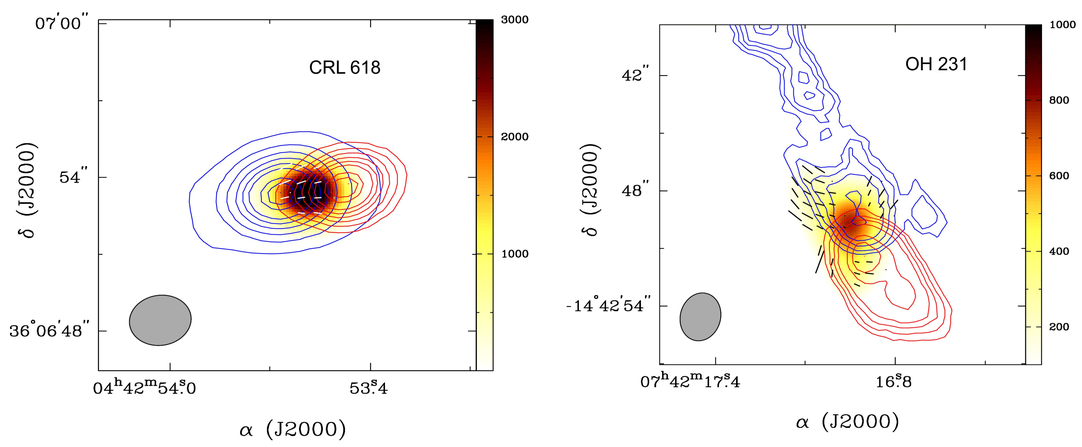
Magnetic fields and high mass star formation



Magnetic fields in the high mass star formation region G240.31+0.07. (Qiu et al. 2009, 2014). Note the hourglass shaped magnetic fields threading a dense flattened core that is perpendicular to the main outflow axis..

The Submillimeter Array is a joint project between the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy & Astrophysics

Magnetic fields in evolved star envelopes



The role of magnetic fields in the collimation and launch of outflows in PPNe and PNe is poorly studied. Panels present the ^{12}CO (3 - 2) outflows and the magnetic field in CRL 618 and OH 231.8+4.2 (Sabin et al. 2014).

The plane-of-sky component of magnetic fields is well aligned with the blue and redshifted flows and may underline the action of a magnetic launching mechanism.

Questions

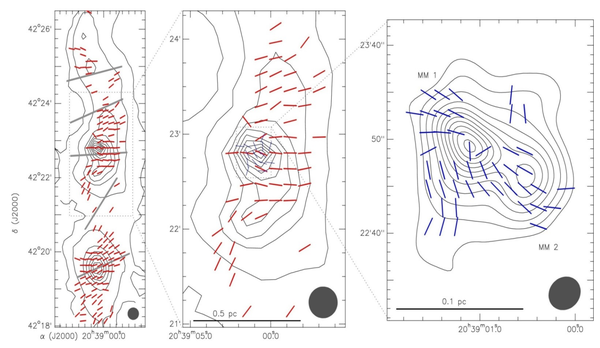
What is the role of magnetic fields supporting dense cores?

What is the role of magnetic fields in the fragmentation of clouds and the formation of stellar clusters?

Are magnetic fields the primary engine for launching jets and outflows?

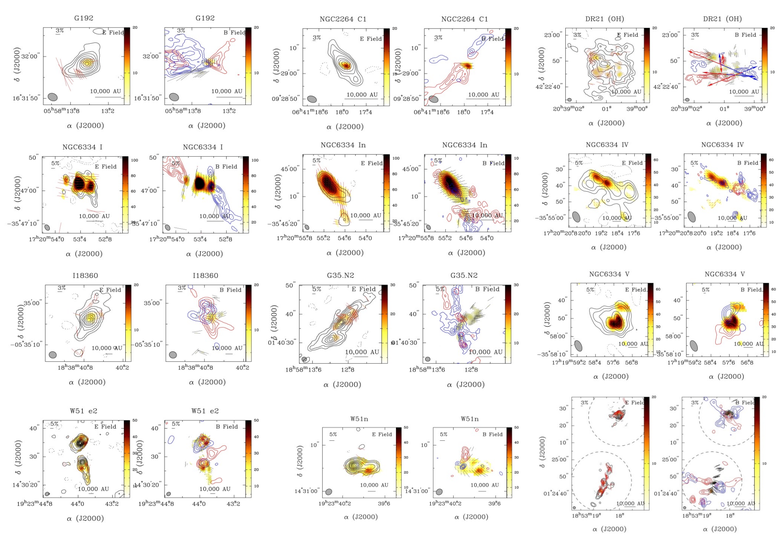
Do magnetic fields regulate the formation of protostellar disks?

Surveys

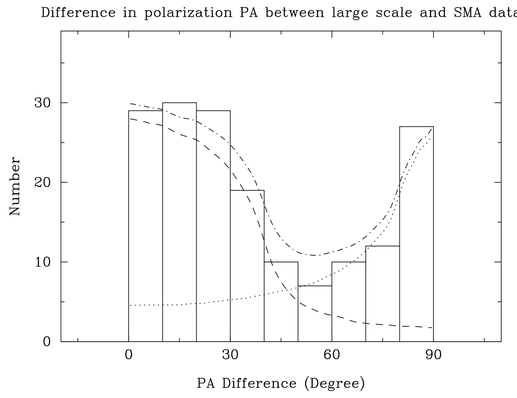


Magnetic fields in the DR 21 filament (Girart et al. 2013). Left panel: contour map of the dust emission at 850 μm toward the DR21 region, overlapped with the B segments (red bars) (Vallée & Fiege 2006; Matthews et al. 2009). DR 21(OH) is the brightest core located at the center of the panel. Middle panel: zoom-in of the previous panel toward DR 21(OH). Right panel: contour map of the dust emission at 880 μm obtained with the SMA. Blue bars depict the B segments.

Survey of magnetic fields for a sample of **14 high mass star forming regions** (Zhang et al. 2014). The left panel for each object overlays the E-field on top of the dust continuum emission while the right panel shows the B-field overlaid on the red and blue shifted lobes of the CO 3-2 outflow.



Difference in polarization PA between large scale and SMA data



Projected angles between polarizations at the clump scale and the core scale. The bimodal distribution indicates that the **B-field is dynamically important during the fragmentation of clumps and formation of dense cores in cluster formation** (Zhang et al. 2014).