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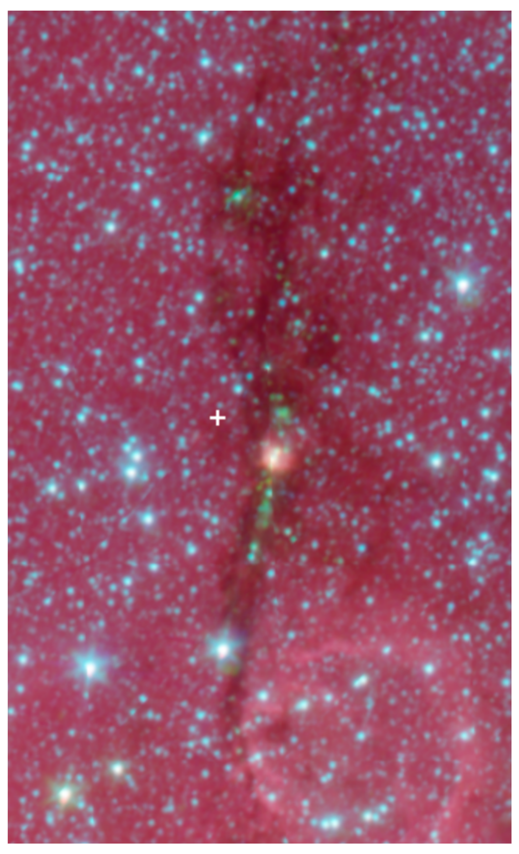
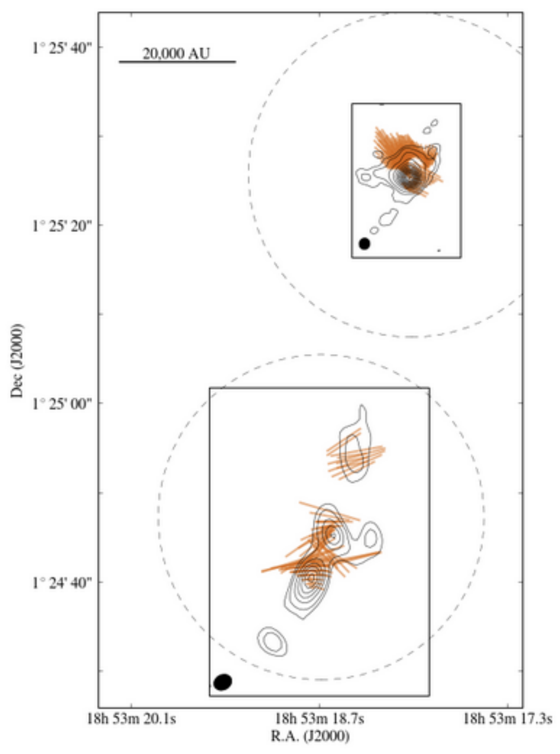
SMA POLARIZATION LEGACY PROGRAM: ANALYSIS OF G34.4+0.23 MM AND UCHII REGIONS



IRAS 18507+0121, SPITZER GLIMPSE



SMA CONTINUUM & POLARIZATION

Incubator of Star Formation
Infrared-dark Filament

Many infrared-dark structures are identified on Spitzer images. These structures are consisted of dense gas and dust, and thus host most of the star forming activities in our galaxy. IRAS 18507+0121 is an infrared-dark "filament," spanning north-south a physical length of ~ 1 parsec on the plane of the sky, at a distance of 1.53 kpc. Two different regions are identified in Spitzer observations with excessive 4.5-μm emission. The northern region is associated with a peak in millimeter emission, and bears the name "G34.4+0.23 MM." The southern region is associated with an ultra-compact HII region, and bears the name "G34.4+0.23 UCHII."

IRAS 18507+0121 is included in the SMA polarization legacy program due to its high-mass nature and the previous detection of polarization at a larger scale (Rathborne et al. 2005). The polarization at the parsec scale indicates a uniform north-south magnetic field direction, generally parallel to the filament direction. IRAS 18507+0121 has a total mass of more than 200 M$_\odot$.

The SMA observation includes two pointings covering G34.4+0.23 MM and G34.4+0.23 UCHII. The observation is done using the subcompact, compact and extended configurations. Double-sided receivers are used to get a total of 4-GHz bandwidth for each sideband, covering 332 to 336 GHz and 344 to 348 GHz in the lower and upper sideband, respectively. This spectral setup allows us to observe many molecular line transitions including CO (3-2) and $H^{13}CO^+$ (4-3).

This study is further aided by previous VLA observations of NH_3 (Lu et al. 2013). It gives us estimates of the excitation temperature and velocity at larger scale.

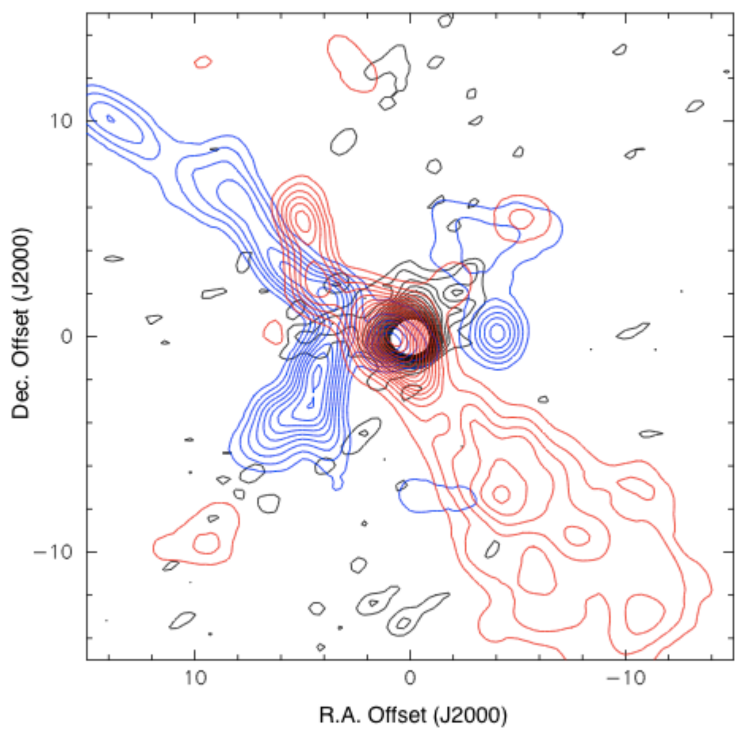
Collimation and Direction
Molecular Outflows

Molecular outflows are detected in both regions, traced by the CO (3-2) line emission. The intensities and the scales of the outflows indicate that the star formation in both regions are relatively evolved.

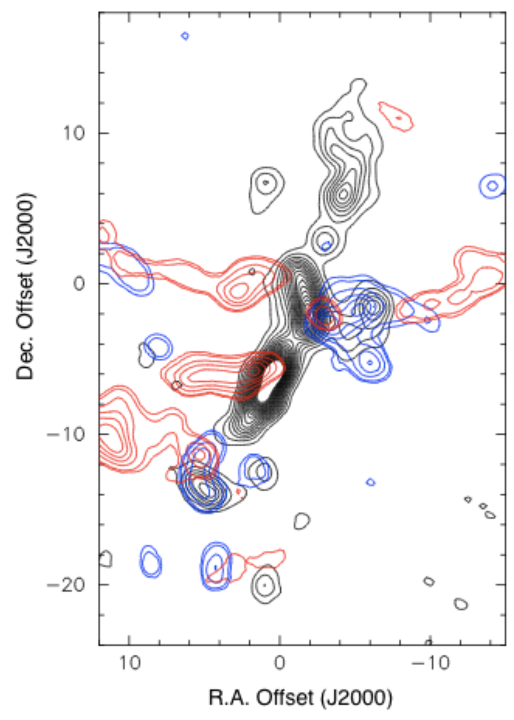
The outflow observed towards G34.4+0.23 MM is well-collimated, having a general northeast-southwest direction. This is roughly perpendicular to the elongation seen in the continuum emission at the center. Neither the direction of the CO outflow or that of the elongated continuum emission is correlated with the direction of the parsec-scale filament where G34.4+0.23 MM is embedded.

Velocity gradients of the CO (3-2) line emission are also seen east and west to the central peak in the continuum emission. These velocity gradients could be two other pairs of outflows (see the image to the right). Together with an elongated continuum emission which shows marginal peaks towards the east and the west of the central peak, these outflows could possibly be related to the fragmenting cores. The entire clump of G34.4+0.23 MM is probably forming a cluster of stars.

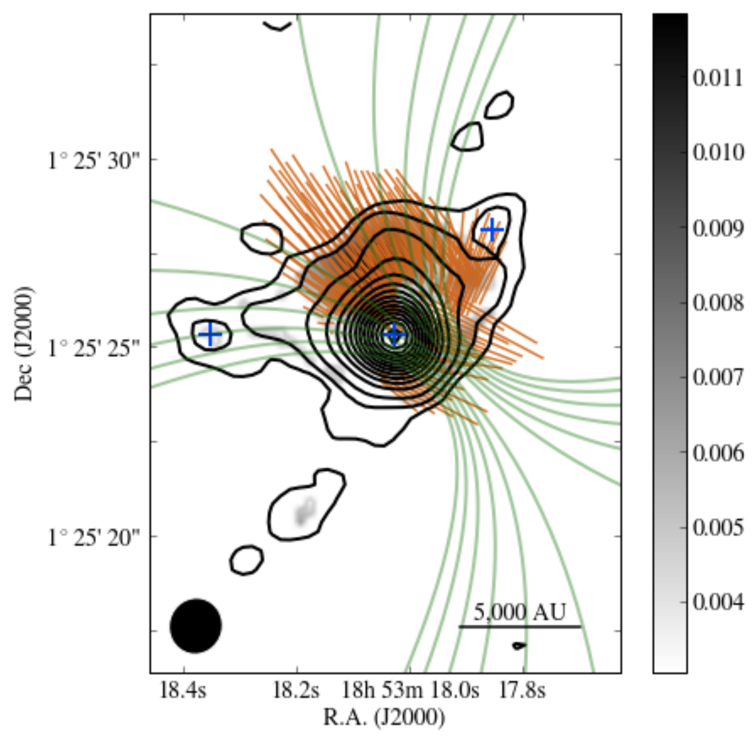
The outflows traced by the CO (3-2) emission in G34.4+0.23 UCHII are less well-paired. A series of up to five peaks can be clearly identified in the continuum emission. This suggests that the less well-paired outflows are the result of the visual confusion and/or the possible interaction between outflows.



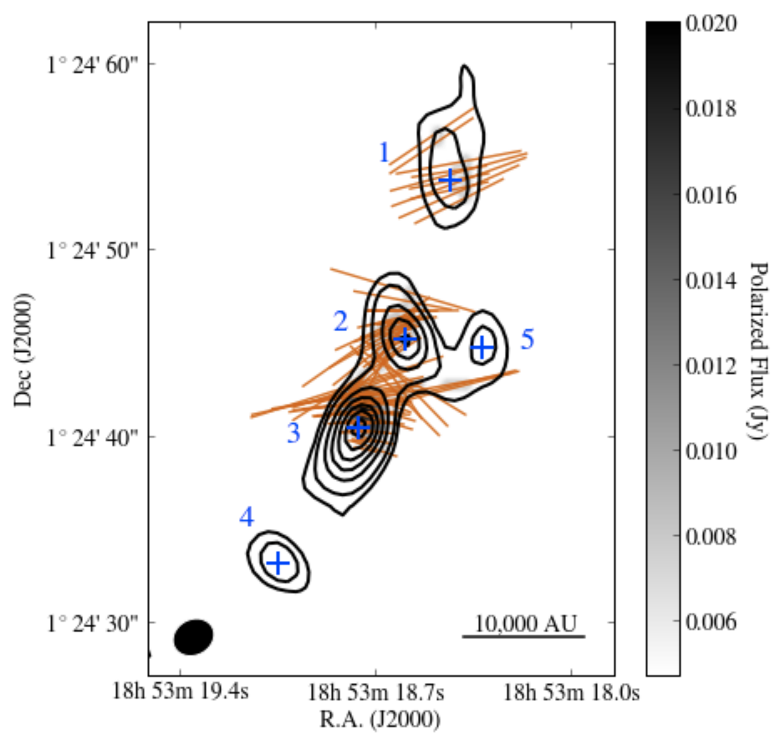
SMA CO (3-2) & CONTINUUM



SMA CO (3-2) & CONTINUUM



SMA POLARIZATION & CONTINUUM
(OVERLAID: HYPERBOLIC FIT)



SMA POLARIZATION & CONTINUUM

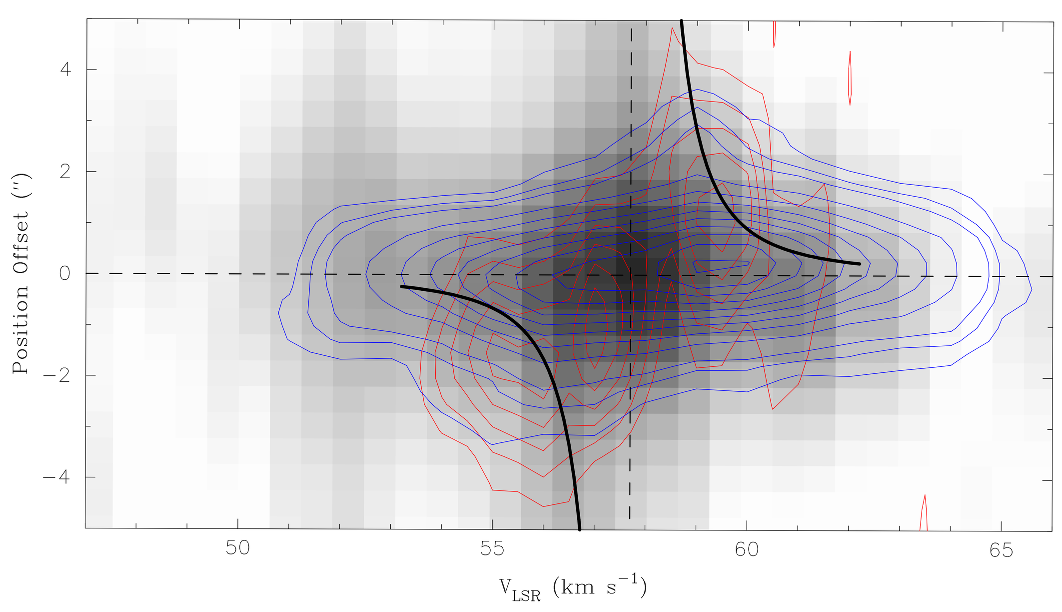
Polarization has it all
Magnetic Fields

Polarized continuum emission is detected towards both regions, with effects of depolarization seen at the highest continuum peaks in both regions. In this study, we derive the direction of the magnetic field based on the polarization direction. It is simply assumed that the magnetic field points perpendicular to the polarization direction traced by the (sub-)millimeter continuum emission.

In G34.4+0.23 MM, we see a general trend of the magnetic field direction pointing northeast-southwest. This is roughly perpendicular to the direction of the outflow and does not seem to correlate with the direction of the parsec-scale filament which G34.4+0.23 MM is embedded in, again.

The resolved directions seen in G34.4+0.23 MM shows a rough pinched "hourglass" morphology. The pinched morphology is predicted to co-exist with accretion-driven outflows. However, the nature of the observed profile is less well-determined.

The magnetic field direction in G34.4+0.23 UCHII runs generally perpendicular to the filament direction. This is also *perpendicular* to the magnetic field direction detected at the parsec scale.



VLA NH_3 (2, 2) IN GREY, SMA $H^{13}CO^+$ (4-3) IN RED & CH_3OH ($7_{1,7}$–$6_{1,6}$) IN BLUE

Position-Velocity Diagram
Keplerian Rotation?

The position-velocity diagram along a "cut" through the (possibly) fragmenting disk traced by the continuum emission in G34.4+0.23 MM shows a profile of potential rotation (see the plot to the left). The general trend matches roughly with the Keplerian rotation of a 50 M$_\odot$ disk. However, the position-velocity diagram could also be explained by other mechanism including a simple infall of materials.

Conclusion
High-Mass Star Formation

The polarization legacy program (Zhang et al. 2014, *submitted*) aims at observing the polarization and disentangling the relation between the magnetic field and the formation of massive stars/star clusters. Here in IRAS 18507+0121, we observe two regions: G34.4+0.23 MM and UCHII. The result shows the genuine natures of these regions: G34.4+0.23 MM is likely a **fragmenting massive "clump"** at the edge of forming a cluster/stellar system; and G34.4+0.23 UCHII is a typical example of **star formation along a filamentary structure**.

G34.4+0.23 MM has a total mass probed by the continuum emission of ~ 90 M$_\odot$. The magnetic field direction and the outflow direction align parallel with each other, and roughly perpendicular to the elongation seen in the continuum emission. Neither is correlated with the direction of the parsec-scale filament.

G34.4+0.23 UCHII is consisted of a series of up to five cores. The outflows and the magnetic field direction are generally perpendicular to the filament direction and the magnetic field direction at the parsec-scale.

References

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