Contribution ID: **33** Type: **Contributed talk**

Dust Properties of Taurus Protostellar Twins in a Magnetized Environment

Wednesday 7 May 2025 16:20 (20 minutes)

The evolution of astrophysical dust during early star formation phases is crucial for understanding planet formation and the magnetic fields have a role in regulating this process. Theoretical models mainly proposed two dominant mechanisms of dust polarization with mm/sub-mm wavelengths; dust alignment due to the magnetic fields (e.g., Lazarian 2007) and self-scattering of dust grains (e.g., Kataoka et al. 2015). It is, however, still unclear how to distinguish the dominant mechanisms in observations due to the entanglement of many factors, requiring more polarization observational samples to constrain it.
IRAS 04166+2706 (K66) and IRAS 04169+2702 (K69) are young protostars within the B213 filament in the Taurus molecular cloud. These sources provide ideal laboratories for studying dust evolution and the role of magnetic fields in the early stages of star formation because they share similar ages born within the common dusty region where previous observations presented configurations of the magnetic fields at the filament scale. Here, we will present our ALMA program towards this unique system, and discuss the properties of polarized dust emission, obtained at unprecedented spatial resolutions from ~20 au to 1000 au, resolving for the first time both the protoplanetary disks and the surrounding envelopes.
Our data reveals striking differences between the two sources, despite them being embedded and born in the same environment. In particular, K66 likely has hourglass-shaped B-fields at >200au scales, and both the B-fields and self-scattering are dominant at the 20 au scale. K69 likely has compact toroidal B-fields at >200au scales and the self-scattering is dominant at the 20au scale. In this talk, I will discuss implications of these differences between the twins, focusing on dust evolution and the role of magnetic fields in shaping the star formation there.

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Session Classification: Session 3