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Trying to Make Sense of Polarization Patterns in Circumstellar Disks

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Abstract. In the era of ALMA, we can now resolve polarization within circumstellar disks at (sub)millimeter wavelengths. While many initially hoped that these observations would map magnetic fields in disks, the observed polarization patterns indicate other possible polarization mechanisms. These alternative polarization mechanisms include Rayleigh self-scattering, grains aligning with the radiation anisotropy (k-RAT alignment), and mechanical alignment. Stephens *et al.* (2017) specifically showed that the polarization morphology in HL Tau changes rapidly with wavelength; the morphology is uniform at 870 μm, azimuthal at 3.1 mm, and ∼50%/50% mix of the two at 1.3 mm. Although it has been suggested that the polarized emission at 870 μm is due to scattering and at 3.1 mm is due to k-RAT alignment, both mechanisms appear to have shortcomings. Specifically, Kataoka *et al.* (2017) showed that scattering requires much smaller grains (10s of μm) than that suggested by other studies, while k-RAT alignment suggest a significant decrease in polarization along the minor axis, which is not seen. Studies of other disks have suggested that polarization may come from grains aligned with the magnetic fields, but these studies are inconclusive. Understanding and extracting information about the polarized emission from disks requires multi-wavelength and high resolution observations.

Keywords. polarization, stars: protoplanetary disks, submillimeter

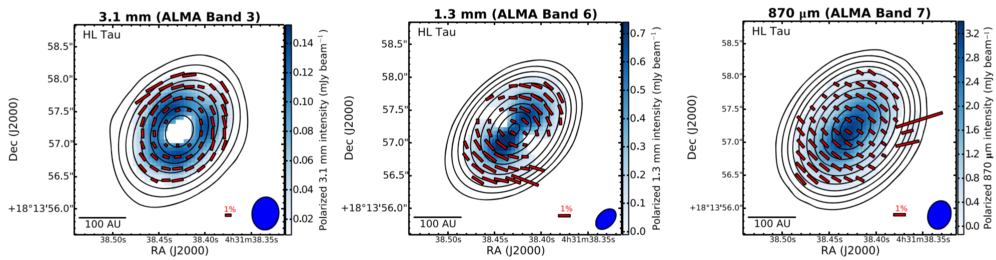

Figure 1. Images from Stephens *et al.* (2017), showing HL Tau ALMA polarization observations at 3 mm (left), 1.3 mm (middle), and 870 μm (right).

References

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