Contribution ID: **43** Type: **Poster**

Resistive Collapse of 2D Non-rotating Magnetized Isothermal Toroids: Formation of Pseudodisks

The collapse of singular magnetized toroids (Li & Shu 1996) is a natural representation of an early phase in star formation, bridging the prestellar and protostellar phases of the collapse of molecular cloud cores. We revisit the collapse study of Allen et al. (2003), now with explicit nonideal MHD (Ohmic diffusivity η) and higher resolution using a code able to cover a broader range of the magnetization parameter $_0$. Galli-Shu equatorial pseudodisks form for all values of H_0 and η, and the asymptotic central mass growth rate is in the scale $\dot{M}_* \sim (a^3/G)(1 + H_0)$, where a is the sound speed, consistent with previous results and predictions. The explicit Ohmic diffusivity makes the field line structure less radial than in previous work, connecting the pseudodisk more effectively to its surroundings. Matter can fall efficiently onto the pseudodisk surfaces, forming oblique shocks, where shock heating and large density gradients raise the possibility of rich astrochemistry. Pseudodisk size and structure are influenced by magnetic diffusivity. Force and velocity ratios were computed to explore the magnetic support within the pseudodisk and its induced slowdown in infall velocity. Magnetic diffusivity was measured to control the strength of these effects and their location within the pseudodisk. The dependence of the field line configurations, pseudodisk structure, and velocity ratios on magnetic diffusivity has observable consequences for collapsing envelopes.

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Session Classification: Session 3