Formation of low mass protostars and their circumstellar disks

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The birth process of protostars and circumstellar disks is poorly constrained due to significant observational and numerical challenges. Using high resolution 3D RHD simulations, we model the collapse of a cloud core to stellar densities, tackling 18 orders of magnitude in density and 8 in spatial extent in the process. This allows us to describe the birth and early evolution of both the protostar and circumstellar disk in unprecedented detail. We find that the nascent protostar quickly reaches breakup velocity, causing it to shed its surface material which then forms a circumstellar disk. The protostar is embedded within the disk, whose mass quickly exceeds that of the protostar. Accretion onto the disk is highly anisotropic, and accretion onto the protostar mainly occurs through material that slides on the disk surface. We also study the radiative behavior of the system, where we have shown for the first time that the protostellar accretion shock becomes supercritical, meaning it radiates most of the energy it accretes. The results reveal the structure and kinematics in the smallest spatial scales relevant to protostellar and circumstellar disk evolution.