Constraints from zoom-simulation on accretion and outflow processes around solar mass stars

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In the context of adaptive mesh refinement simulations of the collapse from pre-stellar cores — simulated as part of giant molecular clouds — to disks, I investigate in particular the role of the magnetic field and its impact on the accretion as well as the outflow processes. The simulations cover a range of nearly 9 orders of magnitude, from 40 pc to 0.015 AU, and are carried out using the adaptive-mesh-refinement code RAMSES (Teyssier 2002, Fromang et al. 2006). The strength of large-scale magnetic fields is shown to influence the accretion process dramatically, and is furthermore key to understand the launching of jets and outflows.

The magnetic field goes through a characteristic sequence of structure evolution during the accretion process, starting out with an approximate hour-glass shape in the earliest phases of evolution, then evolving into a structure that contains a central jet and a broader disk outflow. Late in the accretion process the magnetic field is mainly oriented along the direction of rotation. However, it remains non-stationarity, with strong fluctuations in time and space being characteristic throughout the entire process. Jets and outflows, for example, are seldom symmetric - more often one side or the other dominates, only to be replaced by the opposite sense of symmetry breaking.

The results presented in this poster thus demonstrate the variability of accretion processes due to stellar environment, and illustrate how this influences the formation of protoplanetary disks. Moreover, I show that accretion, jets and outflows are not distinct processes, but that they are rather tightly coupled to each other. With respect to computational aspect, an adequately large number of cells per level of refinement is crucial to be able to model the accretion process, and the jet launching semi-quantitatively. Insufficient refinement leads to lower mass disks which are lower in mass and more homogeneous, causing them being under resolved hence smearing out the influence of turbulence. The jets are weaker and of lower speed for under resolved cases since lower resolution causes a larger launching radii for the jet, corresponding to lower Kepler speeds.

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