Dust dynamics in the inner regions of protoplanetary discs - Global magnetohydrodynamic simulations

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ABSTRACT

The study of protoplanetary discs has recently seen tremendous progress, spearheaded by numerous observations in the radio and infrared bands (ALMA, SPHERE, GRAVITY, …). These observations help constrain models of the earliest stages of planetary formation. However, the wealth of physical processes occurring in these discs has left many important questions unanswered, especially in their inner regions (0.03 to 5 au), where core accretion occurs.

To fully understand accretion and ejection in this zone, one needs to take into account the presence of both gas and dust, as well as the influence of non-ideal magnetohydrodynamic (MHD) effects. The latter help shape the transition between an inner turbulent region (active zone) and an outer laminar region (dead zone). This transition, thought to lie around 1 au, controls the pile-up of dust at the axisymmetric pressure bump or within subsequent vortices, as well as the launching of magnetically driven winds.

Our aim is to study the interdependence of these two processes to better understand planet formation in the inner disc, using global 3D MHD simulations of the inner regions of protoplanetary discs. We will demonstrate the ability of the active/dead zone interface to concentrate solids at the cores of vortices, potentially leading to the formation of rocky planetesimals. We will also highlight the impact of magnetic winds, which can both accelerate the trapping of solids at the interface and entrain dust from the active zone to the outer disc.