Growth of porous grains in PPDs using an implicit scheme with SPH simulations

Oral presentation

Stéphane Michoulier, Jean-François Gonzalez

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In the theory of planetary formation, the process of how sub-µm to mm dust aggregates in protoplanetary discs grow into planetesimals is still poorly understood. The coagulation of grains is hindered by two major problems: the radial drift barrier and the fragmentation barrier, which prevent dust grains from surviving and ultimately forming planets. One potential solution to overcome these barriers is to consider grain porosity, which allows dust to grow faster and longer while being less sensitive to fragmentation than compact grains (Garcia 2018).

At CRAL, a porosity evolution model that can be used in 3D simulations has been developed (Garcia 2018, Garcia & Gonzalez 2020). I have implemented this model into the hydrodynamics code Phantom and added new effects such as rotational disruption, bouncing, and compaction during fragmentation. Furthermore, I have implemented a two-fluid implicit drag force scheme to run simulations with strong drag, which has allowed the new method to be 100 times faster than the explicit two-fluid one.

I will present new results of simulations of protoplanetary discs with porous grains made of silicates or water ice and discuss the efficiency of their growth compared to that of compact grains. I will also show how self-induced dust-traps (Gonzalez et al. 2017) are affected by the inclusion of porosity, and how physical processes shattering grains change the evolution of dust.