Growth of porous aggregates in protoplanetary discs using SPH simulations

Oral presentation

Stéphane Michoulier, Jean-François Gonzalez

March 31, 2022

In the theory of planetary formation, growth of sub-µm to mm dust aggregates in protoplanetary discs into planetesimals is still poorly understood. Coagulation of grains is hampered by problems known as the radial drift barrier and the fragmentation barrier, preventing dust grains to survive and ultimately form planets. A 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).

A porosity evolution model that can be used in 3D simulations has been developed at the CRAL (Garcia 2018, Garcia & Gonzalez 2020). I have implemented this model into the hydrodynamics code Phantom. After performing several simulations of protoplanetary discs with compact and porous grains, we find that the porous ones, made of silicates or water ice, quickly reach size of several meters. A self-induced dust-trap (Gonzalez et al. 2017) forms in the disc, where the relative velocity between grains is close to the fragmentation threshold, allowing aggregates to grow efficiently to large sizes. In comparison, compact grains do not grow up fast enough and are limited to mm-cm sized pebbles. However, fragmentation is still a barrier to dust growth, as grains effectively fragment in the inner regions and get accreted onto the star.