Grain coagulation and ionization during the protostellar collapse

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Dust grains play a major role in many astrophysical contexts. They affect the chemical, magnetic, dynamical, and optical properties of their environment, from galaxies down to the interstellar medium, star-forming regions, and protoplanetary disks. Their coagulation leads to shifts in their size distribution and ultimately to the formation of planets. However, although the coagulation process is reasonably uncomplicated to model and compute by itself, it is difficult to couple it with multidimensional hydrodynamics numerical simulations because of its high computational cost. We propose here a simple method for tracking the coagulation of grains at far lower cost. Given an initial grain size distribution, the state of the distribution at time t is solely determined by the value of a single variable integrated along the trajectory, independently of the specific path taken by the grains. Although this method cannot account for processes other than coagulation, it is mathematically exact, fast, inexpensive, and can be used to evaluate the effect of grain coagulation in many astrophysical contexts. We also present a second method to calculate quickly the ionization of the gas-grain mixture, for a self-consistent computation of MHD resistivities and their effects on the dynamics of the gas.

Références

[1] Marchand P., Guillet V., Lebreuilly U., Mac Low M.-M., 2021, A&A, 649, 50
[2] Marchand P., Guillet V., Lebreuilly U., Mac Low M.-M., 2022, A&A, in press