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Small-scale clustering of nano-dust grains in turbulent interstellar molecular clouds

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It is well established that large grains will decouple from a turbulent gas flow, while small grains will tend to trace the motion of the gas. Small grains may still cluster on scales smaller than those typical for a turbulent flow due to centrifuging of particles away from vortex cores and accumulation of particles in convergence zones (a.k.a. preferential concentration). However, this has not yet been demonstrated for *compressible* flows.

We have studied clustering and dynamics of nano-dust in simulations of high-resolution (1024^3) simulations of forced homogeneous isothermal turbulence, mimicking the conditions in centres of molecular clouds. Fig. 1 shows the correlation dimension D_2 and the average relative increase of the dust density $\langle F_{\rm incr}\rangle$ as a function of the grain-size parameter α for simulations with different assumptions regarding kinetic drag and forcing of the flow. The clustering has a maximum for around a certain α, which lies in the nano-dust range (shaded area) for a typical mass-scaling of the simulations. Combined with the fact that nano dust may be abundant, and the increased interaction rate due to turbulent motions, the values of $\langle F_{\rm incr}\rangle$ suggest aggregation of nano-dust may be quite efficient. Comparing coagulation models based on the MOMIC code by Mattsson (2016), with and without corrections for turbulent clustering and relative motion of nano dust, we can see an order-of-magnitude increase of the coagulation rate.

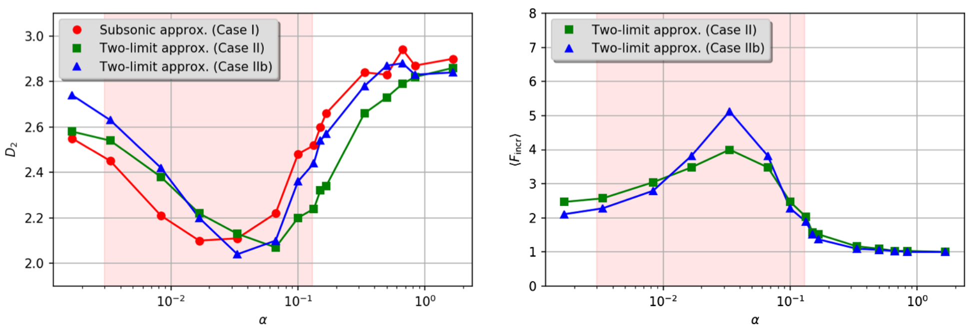

Figure 1. Correlation dimension D_2 (left)and the average relative increase of the dust density $\langle F_{\rm incr}\rangle$ (right) as a function of the grain-size parameter α for three cases: compressive forcing and a subsonic approximation for the kinetic drag (Case I); a transsonic approximation for the drag (Case II); solenoidal forcing and the transsonic approximation (Case IIb).

Finally, we note that charged nano-dust grains will have a different behaviour compared to the passive-scalar type dust in the present simulations. Whether this will further accentuate the clustering or lead to dispersion, counteracting the small-scale clustering, is unclear. Determining this will be the goal of future simulations.

Reference

Mattsson L. 2016, *Planetary & Space Science*, 133, 107

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