Clustering of inertial particles in turbulent flows

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We consider particles suspended in a randomly stirred or turbulent fluid. When effects of the inertia of the particles are significant, an initially uniform scatter of particles can cluster together. We analyse this 'unmixing' effect by calculating the Lyapunov exponents for dense particles suspended in such a random three-dimensional flow, concentrating on the limit where the viscous damping rate is small compared to the inverse correlation time of the random flow (that is, the regime of large Stokes number). In this limit Lyapunov exponents are obtained as a power series in a parameter which is a dimensionless measure of the inertia. We report results for the first seven orders. The perturbation series is divergent, but we obtain accurate results from a Padé-Borel summation. We infer that particles can cluster onto a fractal set and show that its dimension is in satisfactory agreement with previously reported results from simulations of turbulent Navier-Stokes flows [Bec *et al.* 2006].

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Relative speeds of inertial particles at large Stokes numbers

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We discuss the probability distribution of relative speed ΔV of inertial particles suspended in a highly turbulent gas when the Stokes numbers, a dimensionless measure of their inertia, is large. We identify a mechanism giving rise to the distribution $P(\Delta V) \sim \exp(-C|\Delta V|^{4/3})$ (for some constant C). Our conclusions are supported by numerical simulations and the analytical solution of a model equation of motion. The results determine the rate of collisions between suspended particles.

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