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Coherent clusters of inertial particles in homogeneous turbulence
LUCIA BAKER, Univ of Minnesota - Twin Cities , ARI FRANKEL, ALI MANI, Stanford University, FILIPPO COLETTI, Univ of Minnesota - Twin Cities — Clustering of heavy particles in turbulent flows manifests itself in a broad spectrum of physical phenomena, including sediment transport, cloud formation, and spray combustion. However, a clear topological definition of particle cluster has been lacking, limiting our ability to describe their features and dynamics. Here we introduce a definition of coherent cluster based on self-similarity, and apply it to the distribution of heavy particles in direct numerical simulations of homogeneous isotropic turbulence. We consider a range of particle Stokes numbers, with and without the effect of gravity. Clusters show self-similarity at length scales larger than twice the Kolmogorov length, with a specific fractal dimension. In the absence of gravity, clusters demonstrate a tendency to sample regions of the flow where strain is dominant over vorticity, and to align themselves with the local vorticity vector; when gravity is present, the clusters tend to align themselves with gravity, and their fall speed is different from the average settling velocity. This approach yields observations which are consistent with findings obtained from previous studies while opening new avenues for analysis of the topology and evolution of particle clusters in a wealth of applications.

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