A Lagrangian analysis for inertial particles clustering in turbulence using three-dimensional Voronoï tessellations

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We study the clustering of inertial particles in homogeneous isotropic turbulence using data sets from numerics in the point particle limit and one experimental data set by three-dimensional Voronoï analysis. The clustering behavior is investigated at different density ratios, particle response times (i.e. Stokes numbers St) and several Taylor-Reynolds numbers. The Probability Density Functions (PDFs) of the Voronoï cell volumes of light and heavy particles show a different behavior from that of randomly distributed particles, implying that clustering is present. The results are consistent with previous investigations. The small Voronoï volumes of light particles correspond to regions of higher enstrophy than those of heavy particles, indicating that light particles cluster in higher vorticity regions. The Lagrangian temporal autocorrelation function of Voronoï volumes shows that the clustering of light particles lasts much longer than that of heavy or neutrally buoyant particles. Due to inertial effects arising from the density contrast with the surrounding liquid, light and heavy particles remain clustered for much longer times than the flow structures which cause the clustering.