Investigating Preferential Concentration Effects in Homogeneous Shear
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In particle-laden flows, preferential concentration is the tendency of inertial particles to leave vortical regions and gather in straining regions. It results in particle clustering which can be difficult to model and simulate. When the suspension’s mass loading is of order unity, often the case for gas-solid flows, the non-zero slip velocity between phases might lead to sustained clustering that can strongly modify the flow. However, for a homogeneously sheared flow, there are equal rotation and strain rates leading to no preferential concentration. Sinusoidal perturbations alter this balance in a controlled way offering rare insights into the way particles migrate in an inhomogeneous flow and the way they feed back to the fluid flow. For such disturbances, the growth rate is on a time scale equal to the inverse of the shear rate. The theory predicts an algebraic evolution of the perturbations. This is confirmed in numerical simulations based on Eulerian and Lagrangian models. However, differences eventually appear. Firstly, a secondary Rayleigh-Taylor instability is shown to occur in Lagrangian simulations leading them to diverge from the linear theory. Secondly, the Eulerian approaches fail when the perturbation wavelength is comparable to the average inter-particle distance.