Abstract
The dispersion of a collection of particles is relevant to many natural phenomena such as pyroclastic flows (i.e. fast-moving currents of hot gas and rock fragments produced by a volcanic eruption), turbidity currents (i.e. sediment-laden flows down a slope usually in lakes and oceans) and the mixing and spreading of pollutants in lakes and oceans. Here, we consider the motion of a cloud of particles settling because of gravity in an otherwise pure liquid and enquire about its following time evolution. A cloud composed of solid spherical particles falling under gravity in a quiescent fluid can be regarded as an effective medium of excess mass and the problem can be related to that of the sedimentation of a spherical drop of heavy fluid in an otherwise lighter fluid. However, the cloud is unstable even in the complete absence of inertia and without needing to perturb its initial shape. It has been observed first to remain roughly spherical with a leakage of particles in a vertical tail and then to evolve into a torus which breaks up into two droplets in a repeating cascade. The discrete nature of the particles is fundamental in the understanding of these instabilities. Simple simulations using a point-particle approach, which contains the minimal physics of the long-range interactions, capture this dynamics. Faster breakup is observed for clouds of anisotropic particles such as fibers, due to the self motion of the anisotropic particles. When inertia is finite, the cloud also deforms into a flat torus that eventually destabilizes and breaks up into a number of secondary droplets but particle leakage is much weaker. While this evolution resembles that observed in the Stokes regime, the physical mechanisms involved are qualitatively different. The cloud evolution can be strongly determined by the importance of wake-mediated interactions. If the cloud settles now in a flowing fluid instead of a quiescent fluid, there is a coupling between particle-particle and particle-fluid interactions. This two-way coupling is evidenced for a cloud settling in a cellular flow field which is a simple model flow capturing key features of vortical effects on particles.

Bio
Elisabeth Guazzelli is Distinguished Senior Researcher (Directeur de Recherche de Classe Exceptionelle) at the CNRS (Centre National de la Recherche Scientifique) and affiliated with the IUSTI Laboratory of CNRS - Aix-Marseille University. She did her undergraduate studies at Ecole Normale Superieure of Fontenay aux Roses and got her PhD at University Paris Sud in physics. Her research interests are in the field of particulate multiphase flows, such as granular media, fluidized beds, suspensions, and sedimentation. She leads a very active and diversified research group in Marseille composed of ten permanent researchers. She is also Rector of the International Centre for Mechanical Sciences (CISM) in Udine (Italy). Since 2005, she has been an Associate Editor of the Journal of Fluid Mechanics and is presently acting as the JFM Rapids Editor. She also served in the Editorial Committee of Annual Review of Fluid Mechanics from 2011 to 2015. She was elected Fellow of the American Physical Society in 2008 and of the European Mechanics Society (EUROMECH) in 2010. She is the recipient of the EUROMECH Fluid Mechanics Prize 2016.