Oscillatory motions of falling snowflakes

Jennifer Stout, Chris Westbrook, Thorwald Stein & Mark McCorquodale
University of Reading

The aerodynamics of falling snowflakes are not well understood, due to their complex and irregular shapes. We want to understand the physical parameters which control whether the particle falls steadily or in fluttering, spiralling, or chaotic trajectories. This is important information needed to relate snowflake size distributions to observed radar Doppler velocity spectra, with unsteadiness in falling snowflake trajectories and orientations broadening the width of measured Doppler spectra and influencing dual-polarisation parameters.

3D-printed analogues falling in a tank of water-glycerine mixture and micro laser machined analogues falling in air are used to simulate the behaviours of real ice particles in the atmosphere. Multi-view cameras are used to observe the fall motion of a range of snowflake analogues, and digital reconstructions of the trajectories and orientations of the analogues are analysed to develop fundamental understanding of how ice particles fall, and what properties control their motion.

In this presentation we contrast planar ice crystals with the well-understood trajectories of circular discs. The falling behaviour is found to be a function of Reynolds number, dimensionless moment of inertia, and particle shape, such as how branched the crystal is. The inclination angle planar snowflakes make with the horizontal plane is found to have a sinusoidal oscillation. The Strouhal number corresponding to the frequency of this oscillation is used to quantify and characterise the unsteadiness of oscillating cases. Strouhal number is found to vary weakly with Reynolds number for a given disk aspect ratio, but the Strouhal number decreases with dimensionless moment of inertia, such that thinner particles oscillate more frequently, corresponding well with literature for circular disks.