Suspension of A Point-Mass-Attached Fiber in Non-Uniform Flows: Ballooning Flight of Spiders

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Abstract

Aerial dispersal of spiders, which is known as “ballooning”, enables spiders’ wide range of dispersal, sometimes transoceanic. However, it is little known about the ballooning mechanism of spiders because of observational difficulty of ballooning silks and little awareness of spiders’ ballooning flight itself. From our observation in the field and in the laboratory using a wind tunnel, we acquired the physical properties of spiders’ ballooning silks, which have been yet unknown. The spun silks are sizeable enough to lift large spiders into the air even with light upward air currents. Based on the acquired data, the fluid-dynamic characteristics of the ballooning structure is numerically explored by employing a bead-spring model (Zimm model, which can describe the anisotropic drag of a fiber). From the perspective of physics, the drag anisotropy of a spider silk is highlighted as an important factor that enables its biased suspension (toward slow-settling) in the fluctuating atmosphere. Moreover, the phenomenon of becoming trapped by an eddy in turbulence is also observed by the simulation. The fiber structure (spider silk) helps a heavy particle (spider body) to remain in an atmospheric vortical structure for a long time.

Keywords: *fiber suspension, low Reynolds number flow, turbulence, spider’s ballooning*

Biography

Moonsung Cho's background is aerodynamics and aircraft development. Moonsung Cho have participated in various projects of UAVs from close range tactical reconnaissance UAV to long endurance UAV. He was in charge of conceptual/preliminary design of UAVs and Analysis of Stability & Control. Moonsung Cho is academically interested in researching of animal locomotion, which swims and fly in a fluid medium. He enjoys solving problems with creative ideas.