## Aerodynamics and Flow Control Seminar Series

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# Nonlinear Flow Response of Soft Hair Beds

**Dr. José Alvarado**
*Postdoctoral Associate*
*Department of Mechanical Engineering*
*Massachusetts Institute of Technology (MIT)*

**ABSTRACT**
We are 'hairy' on the inside: beds of passive fibres anchored to a surface and immersed in fluids are prevalent in many biological systems, including intestines, tongues, and blood vessels. These hairs are soft enough to deform in response to stresses from fluid flows. Yet fluid stresses are in turn a ected by hair deformation, leading to a coupled elastoviscous problem that is poorly understood. Here we investigate a biomimetic model system of elastomer hair beds subject to shear-driven Stokes flows. We characterize this system with a theoretical model that accounts for the large-deformation flow response of hair beds. Hair bending results in a drag-reducing nonlinearity because the hair tip lowers towards the base, widening the gap through which fluid flows. When hairs are cantilevered at an angle subnormal to the surface, flow against the grain bends hairs away from the base, narrowing the gap. The flow response of angled hair beds is axially asymmetric and amounts to a rectification nonlinearity. We identify an elastoviscous parameter that controls nonlinear behaviour. Our study raises the hypothesis that biological hairy surfaces function to reduce fluid drag. Furthermore, angled hairs may be incorporated in the design of integrated microfluidic components, such as diodes and pumps.

**SPEAKER'S BIO**
Traditional approaches to mechanics work best for systems that are rigid, dry, in vacuum, linear, passive, in thermal equilibrium, and unaware of their environment. Not so with biological systems, which comprise soft, wet materials; include deformable and hierarchical geometries; generate macroscopic force with molecular activity; and are controlled and observed by regulatory pathways. This intersection of biology, physics, and engineering motivates José's experimental research, which includes contractile active gels, emulating muscle behaviour, and fluid-structure interactions. José Alvarado received his PhD in physics in 2013 at AMOLF in Amsterdam, Netherlands. He is currently a postdoc in mechanical engineering at MIT.

**VENUE, DATE & TIME**
City, University of London
Room: C308
Building: Tait Building
Date: 10th January, 2018
Time: 11:30-13:00

**ORGANIZERS** Prof. Christoph Bruecker, Prof. Alfredo Pinelli, Dr. Mohammad Omidyeganeh

**CONTACT** Narges.Aalinezhad.1@city.ac.uk