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The Stochastic and Driven Dynamics of Microscopic Elastic Objects Coupled by a Viscous Fluid MATTHEW CLARK, MARK PAUL, Virginia Tech — We investigate analytically and numerically the coupled motion of microscopic objects in a viscous fluid. Fluid-coupled structures are encountered across a broad range of fields, including spheres and cantilevers in microscopic instruments and fluid motion sensing in biological systems. Many small scale systems undergo high frequency oscillations with small magnitude resulting in a flow field with significant local inertia contributions that must be described using the unsteady Stokes equation. We study the fluid coupled motion of two infinite cylinders that are each attached to a spring. This geometry is chosen due to its wide use in modeling cantilevers and beams in fluid. We show that the stochastic and driven correlated motion of the two cylinders can be found from a single deterministic calculation – the response of the cylinders to an impulse in force. The stochastic dynamics are found using the fluctuation-dissipation theorem and the driven dynamics are found using transfer function theory. We derive analytical expressions for the cylinder dynamics that neglects effects of back-action. We compare our analytical expressions with finite element numerical simulations and find our analysis is valid over a range of larger separations. For small separations, with overlapping Stokes layers, we find interesting variations in both the amplitude and phase of the cylinders.

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