LadHyX Seminar – September 17th, 10:45 am

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Why does a vibrating sheet stick to a wall?

When an elastic sheet vibrates very close to a wall, the fluid-structure interactions between the driven sheet and the lubrication flow in the intervening air layer produce a rich response. In some cases, the sheet acts as a seemingly contactless suction cup: experiments have shown small robots manoeuvring on a ceiling while carrying hundreds of grams, and large grippers lifting tens of kilograms.

This work aims to understand some of the basic mechanisms behind these counterintuitive observations. In the overdamped limit, elastohydrodynamic interactions between the forced sheet and the fluid film produce a low-Reynolds-number swimmer that is attracted toward the wall. Balancing this attraction with gravity yields a finite hovering height and maximum load, providing a simple, tractable model of a contactless suction cup that qualitatively reproduces the experimental observations.

Quantitative agreement, however, requires additional physical complexity: the sheet undergoes large deformations and may excite resonant modes, the Reynolds number is finite, and air compressibility may play a role. I will discuss our attempts to study these additional effects, focusing in particular on compressible, inertial lubrication dynamics. I will conclude by briefly presenting our preliminary experimental setup and efforts to measure the pressure in the air layer and sheet deformation.