Vibration-Induced Propulsion of a Rigid Body in a Viscous Liquid

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Abstract

The physical system comprised of a rigid body propelling in a viscous liquid by means of a vibration-inducing mechanism appears in many engineering applications, from underwater robotics to the delivery of drugs inside the human body. As such, an important question regarding the mechanics of such devices is the following: under what conditions does the time-periodic driving mechanism cause the body to propel (as opposed to simply "oscillate" back and forth)?

Mathematically, this system can be modeled as a coupled fluid-structure interaction problem as follows: consider a rigid body $\mathcal{B}$, contained in a Navier-Stokes liquid occupying the whole space outside of $\mathcal{B}$, which moves freely (without constraint) under the action of a time-periodic force $\boldsymbol{f}$, with amplitude δ. In this talk, we will provide quantitative sufficient conditions that ensure $\boldsymbol{f}$ *propels* $\mathcal{B}$; namely, the center of mass of $\mathcal{B}$ covers any given distance in a finite time. This is part of a joint work with Giovanni P. Galdi and Thomas Richter (University of Magdeburg, Germany).