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# Singular viscoelastic perturbation to soft lubrication

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## Abstract

Soft lubrication governs the behavior of industrial roller bearings, cells in our blood vessels, allows our articulations to work smoothly, and contactless probing of elastic properties. Previous studies showed the drastic impact it has on the motion of an object immersed in a viscous fluid next to a purely elastic wall at low Reynolds numbers. From those theoretical predictions arose a new array of forces, some analogous to high-Reynolds situations and others completely original. However, most of the previous models do not take into account the inherent viscoelasticity of realistic elastic materials such as polymers and biological membranes. Our work consists of combining the Winkler foundation for a thin compressible elastic material with a Kelvin-Voigt model to describe the soft-lubricated motion of a free infinite cylinder. From the numerical integration of its nonlinear, singular, and coupled equations of motion, we reveal the rich and unpredicted effects of viscoelasticity on the cylinder's behavior. Among them, we find a non-trivial increase of some of the previously derived purely elastic effects, the spontaneous apparition of a torque at equilibrium and a regulation to the previous models. These results open the way toward better theoretical and experimental descriptions of the interaction between a moving object and a nearby soft and complex layer, which is a widespread situation encountered in biological and microfluidic systems.

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