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Viscoacoustic Squeeze Film Force on a Rigid Disk Undergoing Small-amplitude Axial Oscillations SANKARAN RAMANARAYANAN, University of California, San Diego, WILFRIED COENEN, Universidad Carlos III de Madrid, MICHAEL TOLLEY, ANTONIO SANCHEZ, University of California, San Diego — The repulsive force felt by a rigid disk vibrating along its axis of symmetry close to a parallel surface is investigated through asymptotic reduction of the Navier-Stokes equations. It is of great interest to predict the load capacity of such squeeze film bearings due to their ubiquity in high-speed rotary equipment and contactless assembly-line transport of microelectronics. Previous attempts to relate the levitation height and force largely rely on simplifications afforded by neglecting either viscous or inertial effects. The present analysis applies the slender-flow approximation in the limit of small amplitude oscillations to derive explicit closed-form expressions for the time-averaged radial pressure distribution. The resulting levitation force is shown to depend on two dimensionless parameters – namely – the Stokes number, quantifying the relative importance of viscous stresses and local acceleration, and a compressibility parameter, comparing the timescales of acoustic wave propagation and disk oscillation. In addition to synthesizing the historically explored lubrication and acoustic limits under a unified framework, the analytical results presented serve to potentially reduce computational costs involved in feedback control of hydrodynamic bearings.

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