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The force on a slender particle under oscillatory translational motion in unsteady Stokes flow[1] JASON KABAROWSKI, ADITYA KHAIR, Carnegie Mellon University, Chemical Engineering — Asymptotic approximations are derived for the hydrodynamic force on a rigid, axisymmetric particle executing longitudinal or transverse oscillation in unsteady Stokes flow. The slender particle has an aspect ratio $\epsilon = a/L << 1$, where L is the half-length of the particle, and a is its characteristic cross-sectional width. The frequency of oscillation is parameterized by the complex quantity $\lambda^2 = -iL^2\omega/\nu$, where ν is kinematic viscosity, ω is particle oscillation frequency, and $i = \sqrt{-1}$. Asymptotic approximations for the force are obtained in three frequency regimes: (i) low frequency, $\epsilon|\lambda| << 1$; (ii) moderate frequency, $\epsilon|\lambda| \sim O(1)$; and (iii) high frequency, $\epsilon|\lambda| >> 1$. Physical interpretations of the force in each regime are made and compared between the longitudinal and transverse oscillation cases. Our asymptotic predictions are in good agreement with the numerically computed frequency-dependent force on a prolate spheroid ($\epsilon = 0.1$) for longitudinal and transverse oscillations by Lawrence and Weinbaum (J. Fluid Mech., vol. 189, 1988) and Pozrikidis (Phys. Fluids, vol. 1, 1989), respectively.

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