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Force and torque on a rotating sphere close to and within a fluid-filled rotating sphere ANTHONY DAVIS, University of Alabama — The logarithmic term in each of the force and torque formulas can be readily found from lubrication theory (O'Neill & Majumdar,ZAMP,1970). The challenge is to find exactly the O(1) terms, a feat achieved by O'Neill & Stewartson (JFM,1967) for a fixed sphere close to a translating plane by means of deceptively intricate asymptotic manipulations. These are now strategically mimicked to determine the exact O(1) terms for the more complicated rotating sphere within a rotating sphere case, generating a pair of functions and second order linear D.E's to be solved numerically. The resulting force and torque coefficients facilitate the determination of the position and rotational speed of a sphere that is heavier than the fluid. Recent experiments by Mullin and coworkers have demonstrated, in slow viscous flow, the possible existence, when a sphere rotates close to a translating plane or rotating sphere, of the cavitation bubble suggested by Taylor (JFM 1963) and posited by Goldman, Cox & Brenner (ChEngSci,1967) as an explanation of the observed disparity between theory and experiment. The latter's asymptotic estimates for small gaps were obtained by extrapolation from the exact series solutions for translation and rotation at arbitrary separation and are more commonly cited. Since the bubble occurs in the 'inner field', when it exists, the lubrication theory suffices to determine its shape, the normal force due to the induced asymmetry and adjustments to the sphere's position and possibly reversed rotational speed.

Anthony Davis
University of Alabama

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