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Jeffery's equation: The motion of ellipsoidal bodies in incompressible viscous flows

In 1922 Jeffery derived an ODE for the motion of the principal axis of a rotationally symmetric, elongated ellipsoid in a Stokes flow. The equation is

$$\dot{\mathbf{p}} = \frac{1}{2}(\operatorname{curl} \mathbf{u_0} \wedge \mathbf{p} + \lambda(S[\mathbf{u_0}]\mathbf{p} - (\mathbf{p}^T S[\mathbf{u_0}]\mathbf{p})\mathbf{p})$$

where $S[u_0]$ is the symmetric part of the velocity Jacobian, and λ is a parameter depending on the geometry of the ellipsoid.

Jeffery's equation finds applications in flow problems arising in the manufacture of artifacts with immersed objects (glass, metal or plastic "sticks") to modify the elastoplastic behaviour of the product. In this talk, I will discuss some of these applications, and I will outline a new derivation of the Jeffery equation via asymptotic analysis from an exterior boundary value problem for the Navier–Stokes equations.

This is joint work with Michael Junk, Konstanz.