Triaxial ellipsoids in creeping shear at high rotational Stokes numbers

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Keywords: triaxial ellipsoid, creeping shear, particle inertia

The fundamental problem of motion of triaxial particles in creeping shear is studied theoretically and numerically. The aim is to provide a basis for understanding of particle motions observed in various shear flow. In particular, the effect of particle inertia is studied. The analytical torques of Jeffery (1922) are coupled to the equations of rotation for a triaxial ellipsoid; the same methodology was used to study the motion of spheroids by Lundell and Carlsson (2010). Particle inertia induces a drift towards rotation around the shortest axis. The instabilitiy of this motion for inertia-free near-spheroids found by Hinch and Leal (1979) are here found to be stabilized for high enough particle inertia (measured by the Stokes number $St = \rho_p \dot{\gamma} l^2/\mu$ where ρ_p is the density of the particle, $\dot{\gamma}$ is the rate of shear, l is the particle length and μ is the dynamic viscosity of the suspending fluid). Thus, the chaotic motion found for some inertia-free triaxial ellipsoids by Yarin et al. (1997) are stabilized for strong particle inertia (compare figure 1 (c) and (d,e))

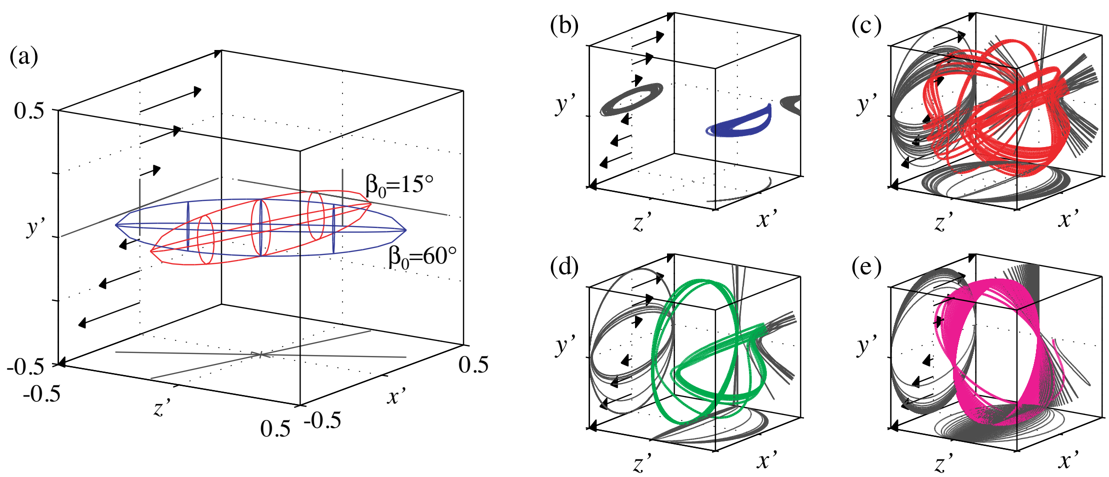

Figure 1: (a) Ellipsoids (illustrating different initial conditions) in a shear flow. (b,c) Colourcoded orbits of the particle endpoint for the two initial orientations shown in (a) for $St = 10$. (c,d,e) Orbits of the particle endpoint for $St = 10$, 100 and 1000. In (c), the particle shows a chaotic motion whereas (d,e) show a drift to a periodic motion.

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