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# Slippery ellipsoidal particles under viscous shear

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The classical no-slip condition holds when a flowing liquid adheres to the surface of a particle. However, for ultra-thin particles with atomically smooth surfaces, such as ‘disk-like’ graphene or ‘rod-like’ carbon nanotubes, the liquid has been shown to slip over the surface instead. We investigate theoretically and computationally the effect of such hydrodynamic slip on the motion of isolated axisymmetric ellipsoidal particles in a viscous shear flow field when subject to a Navier-slip boundary condition. Assuming negligible Brownian fluctuations, we show by applying the reciprocal theorem how to calculate analytically the motion of the particles when the slip length is small compared to the length of the particle. These analytical predictions agree with computations based on the Boundary Element Method for the incompressible Stokes Equations. In particular, we find that the presence of Navier slip changes qualitatively the motion of the particle. Under no-slip, the ellipsoidal particles classically follow a complex periodic orbit, known as a ‘Jeffery orbit’. We find these periodic orbits disappear at a threshold value for the Navier slip length for all geometric aspect ratios other than unity (i.e. spherical particles). For slip lengths greater than this threshold, the particles align indefinitely in the flow with time. This result is due to slip reducing the tangential traction distribution over the planer surface of the particle when the surface is aligned in the flow direction. Our results suggest that ultra-thin particles like graphene or carbon nanotubes will align under certain flow conditions.

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