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Particle motion nearby rough surfaces CHRISTINA KURZTHALER, AMIR PAHLAVAN, LAILAI ZHU[1], HOWARD A. STONE, Department of Mechanical and Aerospace Engineering, Princeton University, NJ 08544, USA — Hydrodynamic interactions of particles with surrounding surfaces play a pivotal role in a variety of biological systems and microfluidic applications. Here, we study the motion of an externally driven particle through a viscous fluid along different boundaries that are characterized by periodic and rough surface shapes. We derive analytical expressions for the translational velocities of the particle using the Lorentz reciprocal theorem and find that the particle follows the surface shape, as anticipated by the time-reversal symmetry of Stokes flow. Moreover, our theoretical framework permits the statistical analysis of random rough surfaces, which do not affect particle motion on average but manifest themselves in the dispersion of particle trajectories. Our results are supported by numerical simulations using a boundary integral method and experimental observations. Overall, they should lay the foundation for our future understanding of microswimmer motion nearby random, heterogeneous boundaries.

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