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Motion of a viscous slug on heterogeneous surfaces

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We present a theoretical study of viscous slug motion inside a microscopically rough capillary tube, where pronounced stick–slip motion can emerge at slow displacement rates. The mathematical description of this intermittent motion can be reduced to a system of ordinary differential equations, which also describe the motion of a pendulum inside a fluid-filled rotating drum. We use this analogy to show that the stick–slip motion transitions to steady sliding at high displacement rates. We characterize this crossover with a simple scaling relation and show that the crossover is accompanied by a shift in the dominant energy dissipation mechanisms within the system.

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