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Shear-induced granular motion at low particle Reynolds numbers

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We study incipient motion of single spherical particles in shear flow over regular substrates at low particle Reynolds numbers. Experimental studies show a strong dependence on the substrate geometry. Numerical studies covering the entire range of particle spacings on quadratically arranged substrates show that rolling motion is always preferred to sliding motion. It also reveals how the effective zero level depends on the particle spacing. Based on the effective zero level, we propose a model for the incipient motion at low particle Reynolds numbers that compares favorably with experiments and numerics. The model takes into account the substrate geometry and does not rely on further parameters. It enables to describe incipient motion even for completely buried beads.