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Erosion of a granular bed by laminar fluid flow[1] ASHISH ORPE, Physics Dept., Clark U, ALEX LOBOVSKY, EAPS, MIT, RYAN MOLLOY, ARSHAD KUDROLLI, Physics Dept., Clark U, DANIEL ROTHMAN, EAPS, MIT —
Motivated by examples of erosive incision of channels in sand, we investigate the motion of individual grains in a granular bed as a function of fluid flow rate to give us new insight concerning the relationship between hydrodynamic stress and surficial granular flow. A closed channel of rectangular cross section is partially filled with glass beads and a fluid and a constant flux Q is circulated through the channel. The fluid has same refractive index as the glass beads and is illuminated with a laser sheet away from the sidewalls. The bed erodes quadratically in time to a height h_c which depends on Q. The Shields criterion, which is proportional to the ratio of the viscous shear stress and gravitational normal stress, describes the observed $h_c \propto \sqrt{Q}$ when a height offset of approximately half a grain diameter is introduced. The offset can be interpreted as arising due to differences between the flow near a porous boundary and a smooth wall. Introducing this offset in the estimation of the shear stress yields a grain flux q_x in the bed load regime proportional to $(\tau - \tau_c)^2$, where τ is the non-dimensional shear stress, and τ_c corresponds to the Shields criteria.

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Arshad Kudrolli
Department of Physics, Clark University

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