Surface drag in a fluidized bed\textsuperscript{1} DANIEL GOLDMAN, WYATT KORFF, University of California, Berkeley — Animal locomotion on sand involves drag at the sand surface for a range of substrate conditions. Inspired by this, we study drag of a half-submerged 2 cm disk using a large aspect ratio (1200x800 particle diameters) air fluidized bed of 250\textmu m glass beads to control the properties of the granular material. We vary the air flow rate $Q$ to the bed and the drag velocity $v_d$ (0-40 cm/sec) of the disk. Below fluidization, the drag force $F_d$ increases linearly with $v_d$, with nonzero intercept; the intercept decreases as fluidization onset is approached. Above onset, $F_d$ is no longer linear in velocity, but has positive curvature. For large enough $v_d$, we observe the formation of a wake behind the disk. We find a sharp onset in drag associated with this wake after removing the viscous drag, similar to studies of wave drag in a viscous Newtonian fluid\textsuperscript{2}. The existence of an onset to wake formation resulting in rapid increase in drag in fluids at a critical velocity is a result of the competition between surface tension and gravitational restoring force; in the fluidized cohesionless grains it is not clear what mimics the effect of the attractive force.

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\textsuperscript{2}T. Burghelea and V. Steinberg, Phys. Rev. Lett. 86, 2557, (2001)