Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Competing segregating effects of gravity and shear rate gradients in dense granular flows in a drum: theory and simulations KIMBERLY HILL, DANIELLE TAN, University of Minnesota — A well-known rule of thumb for sheared mixtures of different-sized (same density) particles is that larger particles tend to go up (toward the free surface), and the smaller particles, down, commonly referred to as the "Brazil-nut problem" or "kinetic sieving." However, it has been recently shown that in a sheared granular mixture, larger particles may rise or fall relative to the small particles, or even rise only partway to some steady-state height in a sheared mixture. We present a theory that accounts for this complex behavior as a balance between gravity-driven segregation effects and, effectively, granular temperature gradients driven by the shear. Then, we test this theory using discrete element method simulations of different mixtures rotated in a partially-filled drum. Using the theory and simulations, we show that for all mixtures we test, the segregation fluxes are driven by the difference between the partitioning of kinetic and contact stresses among the species in the mixture subjected to a gravity-induced contact stress gradient. Specifically, all particles bear a fraction of the local contact stress equal to their local concentration in the mixture, but the smaller particles bear a higher fraction of the local kinetic stress (akin to granular temperature). This presents a new physical mechanism for kinetic sieving: even where the total granular temperature is small, the higher granular temperature of the smaller particles segregates them downward, in the direction of gravity, towards high stress and low temperature regions.

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Date submitted: 10 Aug 2012 Electronic form version 1.4