Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Shear-segregation and mixing of sheared bidisperse granular materials KAREN DANIELS, LAURA GOLICK, Dept. of Physics, NC State Univ., LINDSAY MAY, MICHAEL SHEARER, Dept. of Mathematics, NC State Univ.
— We perform experiments on granular size-segregation in an annular Couette apparatus in which a layer of small particles mixes with, and then resegregates from, a layer of large particles beneath it. We model this process using a modification of the Gray-Thornton model in which we impose a nonlinear shear profile typical of boundary-driven, confined flows. The experimentally-measured exponential velocity profile provides an input to this one-dimensional nonlinear PDE and the resulting solution of the initial value problem is non-standard, involving curved characteristics. We further interpret these solutions by numerically connecting the segregation process to changes in packing fraction, and find qualitative agreement with experimental results. As in the experiment, mixing times are observed to be faster than segregation times. Interestingly, while the size-segregation of granular materials has generally been thought to proceed faster the greater the size difference of the particles we observe that the segregation rate is quite sensitive to both the particle-size ratio and the confining pressure on the system. As a result, we observe that particles of both dissimilar and similar sizes segregate more slowly than intermediate particle size ratios and interpret this anomalous behavior in terms of a species-dependent distribution of forces within the system.

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Date submitted: 30 Jul 2009 Electronic form version 1.4