Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Sorting Category: 45. (E)

Relating Segregation Patterns and Symmetries in Chaotic Granular Flow STEPHEN CISAR, STEVEN MEIER, Dept. of Chem. and Biological Engr., Northwestern Univ., RICHARD LUEPTOW, Dept. of Mech. Engr., Northwestern Univ., JULIO OTTINO, Depts. of Chem. and Biological Engr. and Mech. Engr, Northwestern Univ. — Segregation patterns formed by time-periodic flow of polydisperse granular material (varying in particle size) in quasi-two-dimensional (quasi-2D) tumblers capture the symmetries of Poincaré sections, stroboscopic maps of the underlying flow, derived from a continuum model. The similarities are striking despite the fact that the model contains no information about particle properties. We study this phenomenon experimentally by using mixtures of bidisperse granular material in which the concentration of small particles is varied in quasi-2D tumblers with square and pentagonal cross-sections. Experimental segregation patterns can be connected to the dynamics of the underlying flow by an analysis of periodic points. Patterns vary with small particle concentration based on the location of both elliptic points that characterize islands of regular flow and hyperbolic points that characterize regions of chaotic flow seen in Poincaré sections. The calculation of the eigenvectors and unstable manifolds of hyperbolic points shows that lobes of segregated small particles stretch from hyperbolic points toward corners of the tumbler, demonstrating the connection between regions of chaotic flow and the shape of the segregation patterns. Furthermore, unstable manifolds map the shape of lobes of segregated particles. Funded by DOE, Office of Basic Energy Sciences and NSF.

Stephen Cisar
s-cisar@northwestern.edu
Northwestern University

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Date submitted: 04 Aug 2006 Electronic form version 1.4