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A Continuum Framework for Mixing and Segregation in Granular Flows[1] JULIO M. OTTINO, STEVEN W. MEIER, RICHARD M. LUEPTOW, Northwestern University — Mixing of granular material in three-dimensional tumblers is complicated by segregation due to differences in particle density or size. However, there is one point of simplification. All of the dynamics take place in a thin flowing surface layer. Two key experimental results lead to a continuum framework for modeling of mixing and segregation. Particle tracking velocimetry measurements indicate that the streamwise velocity decreases linearly with depth in the surface layer. Measurements across the transverse direction of the free surface show that the streamwise velocity at the midpoint of the flowing layer is a linear function of the local flowing layer length. These observations enter as assumptions into a continuum model of the flow. Segregation is modeled using constitutive relations for the buoyancy of the different particle types (varying in density) by considering them as interpenetrating continua. The model captures experimental results of segregation due to particle density or size in chaotic flow in both quasi-two-dimensional and three-dimensional tumblers.

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