Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Chaotic Fluid Mixing in Crystalline Sphere Arrays[1] REGIS TURUBAN, University of Rennes 1, France, DANIEL LESTER, Royal Melbourne Institute of Technology, Australia, YVES MEHEUST, TANGUY LE BORGNE, University of Rennes 1, France — We study the Lagrangian dynamics of steady 3D Stokes flow over simple cubic (SC) and body-centered cubic (BCC) lattices of close-packed spheres, and uncover the mechanisms governing chaotic mixing. Due to the cusp-shaped sphere contacts, the topology of the skin friction field is fundamentally different to that of continuous (non-granular) media (e.g. open pore networks), with significant implications for fluid mixing. Weak symmetry breaking of the flow orientation with respect to the lattice symmetries imparts a transition from regular to strong chaotic mixing in the BCC lattice, whereas the SC lattice only exhibits weak mixing. Whilst the SC and BCC lattices share the same symmetry point group, these differences are explained in terms of their space groups, and we find that a glide symmetry of the BCC lattice generates chaotic mixing. These insights are used to develop accurate predictions of the Lyapunov exponent distribution over the parameter space of mean flow orientation, and point to a general theory of mixing and dispersion based upon the inherent symmetries of arbitrary crystalline structures.

[1]The authors acknowledge the support of ERC project ReactiveFronts (648377)

Tanguy Le Borgne
University of Rennes 1, France

Date submitted: 31 Jul 2017 Electronic form version 1.4