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Diffusion and organization in driven particles systems

Paul Chaikin*, **David Pine, Jeremie Palacci, John Royer**

Center for Soft Matter Research
Dept. of Physics, New York University, New York, NY, USA
*chaikin@nyu.edu

Over the past several years we have been studying a phenomena, Random Organization, whereby apparently random interactions between particles in a driven system lead to their self-organization [1]. Particles in a viscous flow with periodic shear initially collide and undergo chaotic diffusive motion. The collisions allow the system to explore different local configurations and evolve. If the underlying physics is reversible, as at low Reynolds number, we obtain absorbing, halted, reversible states, but above a threshold strain the motion remains chaotic. In a similar phenomena for irreversible frictional interactions, simulation results show that periodically sheared *granular* matter exhibits diffusive motion that evolves into a spatially disordered *limit cycle* where each individual grain follows a different exactly retracing loop [2].

In the previous systems with external drive the organized states are spatially random but temporally periodic. In a separate system with random self-propelled colloidal swimmers we find evolution from a gas phase to clusters or even crystals due to their collisions [3]. The crystals are dynamic and form rotate, evaporate and explode. They are spatially periodic but time chaotic.

In all of these microscopically inhomogeneous systems, irreversible processes arising from collisions and dissipative interactions facilitate the exploration of local configurations. Feedback on the local force distributions and dynamics provide a mechanism for a system to evolve into absorbing (halted), time periodic or stationary states or to remain chaotic.

References

[1] L. Corté, P.M. Chaikin, J.P. Gollub, D.J. Pine: *Random Organization in periodically driven systems*. Nature Physics **4**, 420–424 (2008)

[2] J. Royer, P.M. Chaikin: *Precisely cyclic sand*. to be published (2013)

[3] J. Palacci, S. Sacanna, A.P. Steinberg, D.J. Pine, P.M. Chaikin: *Living crystals of light-activated colloidal surfers*. Science **339**, 936–940 (2013)