Three-dimensional swarming states induced by hydrodynamic interactions

Maria D'orsogna*[1]

[1]CSUN (CSUN) – 18111 Nordhoff Avenue Northridge CA, United States

Abstract

Swarming patterns arising from self-propelled particles have been extensively studied, particularly in two-dimensions and in the absence of an embedding medium. We consider the dynamics of more realistic three dimensional self-propelled particles interacting in a fluid medium. The fluid interaction terms generated by direct short-ranged pairwise interactions may impart much longer-ranged hydrodynamic forces, effectively amplifying the coupling between individuals. We consider two limiting cases of fluid interactions, a "clear fluid" where particles have direct knowledge of their own velocity, that of others and of the fluid, and an "opaque fluid" where particles are able to determine their velocity only in relation to the surrounding fluid flow. We discuss emergent patterns that are unstable in fluid-free environments and that become stabilized by opaque fluid couplings such as rotating mills.

*Speaker