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Particle Shape and Dynamics of Granular Matter: Swarming to Swirling[1]

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We will discuss a series of experiments performed with granular rods, dimers, and flexible chains on a vibrated plate to illustrate the effect of particle shape on self-organization. A non-spherical shape is shown to lead to not only states which resemble nematic and smectic phases but also causes novel dynamics [1]. The ratchet mechanism which leads to vortex motion in a collection of rods on a vibrated plate and drift motion in a bouncing dimer will be discussed [2, 3]. The friction at the point of contact between particle and the substrate, and the coupling about the center of mass of a non-spherical is proposed to lead to observed motion. Exploiting this mechanism we construct mechanical self-propelled particles (SPP) using rods with asymmetric mass distributions. We then investigate the SSP number fluctuations, flow fields, and orientation order inside a container as a function of number density and excitation, and compare their statistics with recent models of active nematic particles and living cells.

1. "Vortices in vibrated granular rods," D.L. Blair, T. Neicu, and A. Kudrolli, Phys. Rev. E 67, 031303 (2003).
2. "Anisotropy driven dynamics in vibrated granular rods," D. Volfson, A. Kudrolli, and L.S. Tsimring, Phys. Rev. E 70, 051312 (2004).
3. "Dynamics of a bouncing dimer," S. Dorbolo, D. Volfson, L. Tsimring, and A. Kudrolli, Phys. Rev. Lett. 95, 044101 (2005).

[1]In collaboration with G. Lumay, S. Dorbolo, K. Safford, D. Volfson, and L. Tsimring. Funded by NSF-DMR 0605664.