Vibrated granular rods as a confined liquid crystal

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Acting through the minimization of steric interactions, the randomizing force of entropy can produce an apparent order in particle arrangement. Here, we investigate how crowding and confinement influence the patterning of macroscopic particles by using vertically vibrated steel pins that are confined to quasi-2D containers. Even though these mechanically excited pins are in a non-equilibrium steady state, we find a density dependent isotropic-nematic transition in the "bulk" that is consistent with equilibrium scaling. Along the walls, however, rods interact sterically to form a wetting layer. These boundary interactions compete with "bulk" ordering to produce complex patterns. As rod density ρ increases, patterning shifts from bipolar to uniform alignment. We find that a continuum liquid crystal free energy functional captures key patterning features down to almost the particle size. By fitting theory to experiments, we estimate the relative values of bend and splay elastic constants and wall anchoring. We find that splay is softer than bend for all ρ and rod lengths tested, while the ratio of the average elastic constant to wall anchoring increases with ρ.