Electronic supplementary information (ESI)

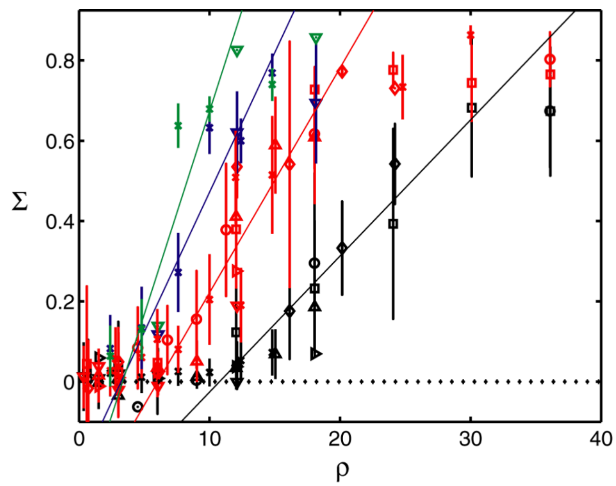

Fig. S1. Liquid crystal-like ordering of granular rods occurs at various vibration frequencies f. The granular isotropic-nematic (I-N) phase transition changes with varying frequency f, at constant dimensionless acceleration, $\Gamma = 4$, and constant container height-to-rod-diameter ratio $H/D_r = 20$, where $f = 30\text{Hz}$ (black), 50Hz (red), 70Hz (blue), and 90Hz (green). For circular radius $= 7$ cm container: $L/D_r = 20$ (△), 40 (□); circular radius $= 15\text{cm}$ container: $L/D_r = 20$ (▷), 40 (×), 60 (○); square container: $L/D_r = 20$ (▽), 40 (◇). Line show the linear least squares fit of the data in the transition region (see Material and Methods). Bars represent the standard deviation from 3 to 100 experiments.

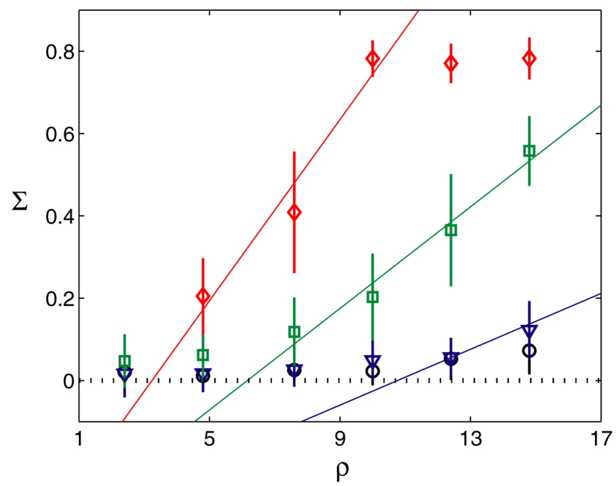

Fig. S2. The critical normalized density ρ^* for the I-N transition decreases with decreasing H/D_r with constant $f = 30\text{Hz}$ and $\Gamma = 4$, where $H/D_r = 20$ (○), 14 (▽), 8 (□), and 4 (◇). Lines show the linear least squares fit of the data in the transition region (see Material and Methods).

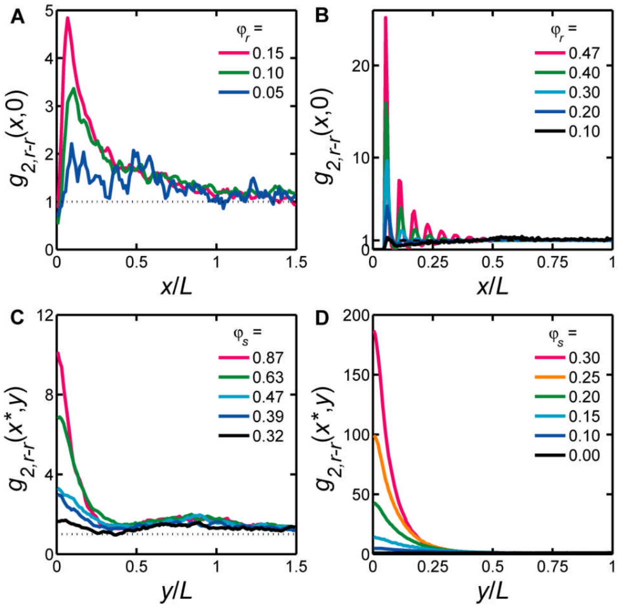

Fig. S3. Rod-rod correlation functions $g_{2,r-r}\left(x,y\right)$. The $g_{2,r-r}\left(x,0\right)$ function from the midpoint of a rod in the direction perpendicular to its long axis for granular experiments with $\varphi_s = 0.47$ (*A*), and Monte Carlo simulations with $\varphi_s = 0.10$ (*B*). The $g_{2,r-r}\left(x^*,y\right)$ function parallel to a rod's long axis for granular experiments with $\varphi_r = 0.10$ (*C*) and Monte Carlo simulations with $\varphi_r = 0.20$ (*D*), where x^* is the maximum in the correlation function from $g_{2,r-r}\left(x,0\right)$. The smaller peak in (*C*) (occurring between $0\ . < 6y/\ L < 2\ \ 5$) indicates a preference for orthogonal aggregate-aggregate associations in granular experiments. For granular experiments (*A* and *C*), data was smoothed by a moving average filter with a span of 3 points. The material presented is as close to a direct comparison as possible between the pair correlations in the experiments and simulations, as is seen by the striking similarity in the plots. Comparisons with exactly the same rod and sphere area fractions are not feasible due to limitations in the granular experiments. Specifically, quasi-2D experiments require a higher concentration of spheres to achieve aggregation in rods (see manuscript). In addition, the appearance of non-equilibrium patterning prevents comparison with higher rod area fractions (see manuscript).

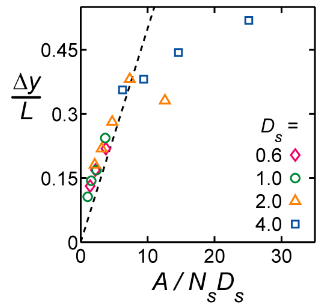

Fig. S4. Rod slip shows universal scaling behavior. Same data as Fig 4*C*, now collapsed when plotted versus a scaling parameter derived from AO theory by incorporating sphere-sphere excluded volume through the parameter $\tilde{A}$ in eqn [20].