Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Material for: Effect of speed fluctuations on the collective dynamics of active disks

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The main paper uses numerical simulations of reduced order models, to investigate the effect of speed fluctuations on the collective dynamics of active disks. Section SI contains a description of the sample videos associated with the paper, and Section SII provides a comparison of the cluster statistics obtained using MATLAB and HOOMD simulation routines.

SI. LIST OF VIDEOS

All videos generated using OVITO [1] and recorded for $N = 400$ active disks in a periodic box of length $L = 10$. The rotational diffusion constant is $D_{\mathrm{r}} = 10^{-3}$ and $U_0 = 0.1$ in all the cases.

1. Video S1: Base case simulation indicating motility induced phase-separation in a suspension of active disks moving at a *constant* self-propulsion speed of U_0. Video sped up by a factor of 10.

2. Video S2: RS disks undergoing directional reversal in self-propulsion, i.e., $U(t) = U_0 \cos(\omega t)$, with $\omega = 5\, D_{\mathrm{r}}$. Video sped up by a factor of 10.

3. Video S3: RS disks undergoing directional reversal in self-propulsion, i.e., $U(t) = U_0 \cos(\omega t)$, with $\omega = 500\, D_{\mathrm{r}}$. Video sped up by a factor of 10.

4. Video S4: RS disks undergoing directional reversal in self-propulsion, i.e., $U(t) = U_0 \cos(\omega t)$, with $\omega = 5000\, D_{\mathrm{r}}$. Video sped up by a factor of 10.

5. Video S5: RS disks without directional reversal in self-propulsion, i.e., $U(t) = |U_0 \cos(\omega t)|$, with $\omega = 5000\, D_{\mathrm{r}}$. Video sped up by a factor of 100.

6. Video S6: PM disks without directional reversal, i.e., their speeds are drawn from a power-law distribution $P(U) \sim U^{-3/2}$ in the range $[0.1, 1000]$, at update instances governed by a Poissonian process with rate constant $\beta = 5000\, D_{\mathrm{r}}$. Video sped up by a factor of 100.

7. Video S7: PM disks without directional reversal, i.e., their speeds are drawn from a power-law distribution $P(U) \sim U^{-3/2}$ in the range $[0.1, 1000]$, at update instances

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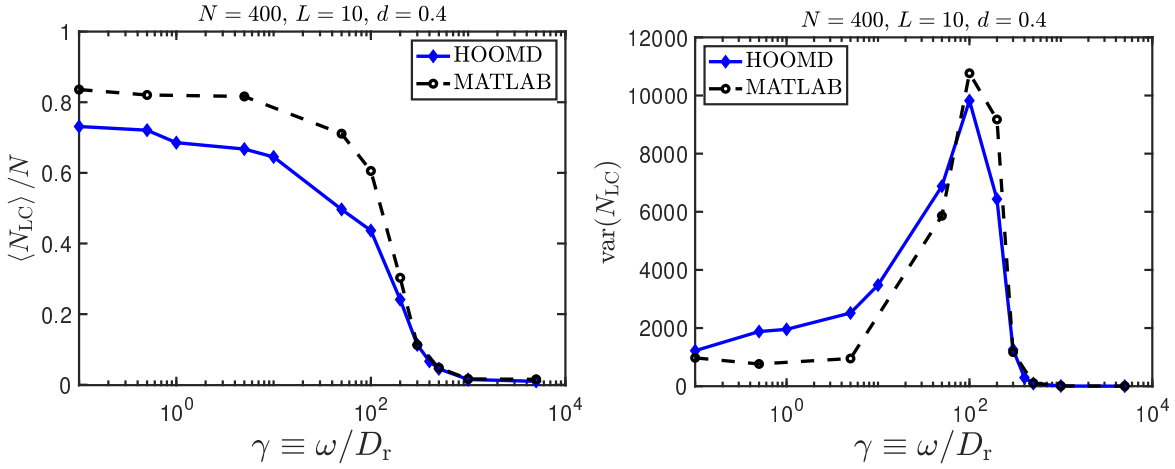
governed by a Poissonian process with rate constant $\beta = 40000\, D_{\rm r}$. Video sped up by a factor of 100.

8. Video S8: PM disks with directional reversal, i.e., their speeds are drawn from a uniform distribution in the range $[-0.1, 0.1]$, at update instances governed by a Poissonian process with rate constant $\beta = 5000\, D_{\rm r}$. Video sped up by a factor of 10.

SII. COMPARISON BETWEEN HOOMD-BLUE AND MATLAB RESULTS

The main paper contains simulation results for a collection of RS disks at a fixed area fraction of $\phi = 0.5$ and various box lengths. We have used a MATLAB code for simulating systems with $N \leq 1600$ disks. For larger sized systems, we have used a custom-written HOOMD-blue [2] script due its faster execution time. In Fig. S1, the mean and variance of the size of the largest cluster computed using HOOMD and MATLAB are compared. The mean cluster size follows the same qualitative trend for both the sets of data, and the difference in numbers could presumably be due to the differing protocols for the implementation of steric-repulsion in the two codes. The peak in the variance, however, is observed at the same frequency for results obtained using the two codes.



(a) (b)

FIG. S1. (a) Time-averaged mean and (b) variance of cluster-size for a collection of RS disks simulated using HOOMD-blue and MATLAB.

[1] A. Stukowski, Visualization and analysis of atomistic simulation data with OVITO – the Open Visualization Tool, Modelling Simul. Mater. Sci. Eng. **18**, 015012 (2010).

[2] J. A. Anderson, J. Glaser, and S. C. Glotzer, HOOMD-blue: A Python package for high-performance molecular dynamics and hard particle Monte Carlo simulations, Comput. Mater. Sci. **173**, 109363 (2020).