Hydrodynamics-driven phase-locking and collective motility of sessile active dumbbells

- Supplementary Information -

Urvi Mahendra Bora, Dhruba Jyoti Mech, and Mohd Suhail Rizvi

Department of Biomedical Engineering, Indian Institute of Technology Hyderabad, Kandi Sangareddy, Telangana, 502284, India.

Supplementary figures

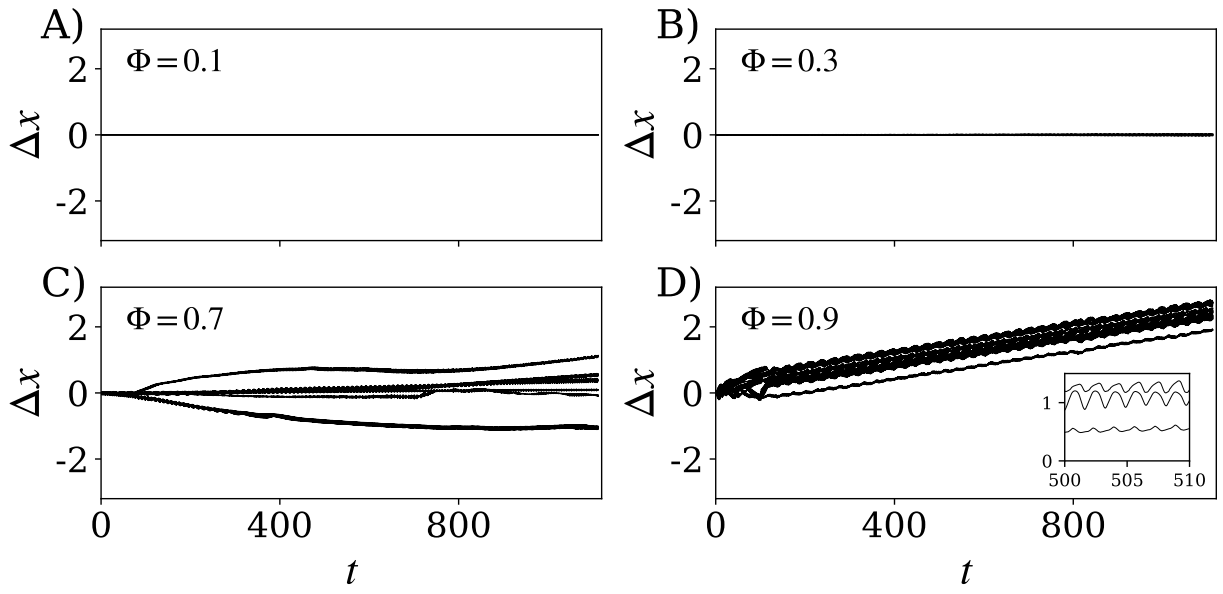

Figure S1: **Collective swimming velocity.** Displacement of representative dumbbells for suspension with (A) $\Phi = 0.1$, (B) $\Phi = 0.3$, (C) $\Phi = 0.7$, and (D) $\Phi = 0.9$. Inset in panel (D) shows the enlarged version of the same plot.

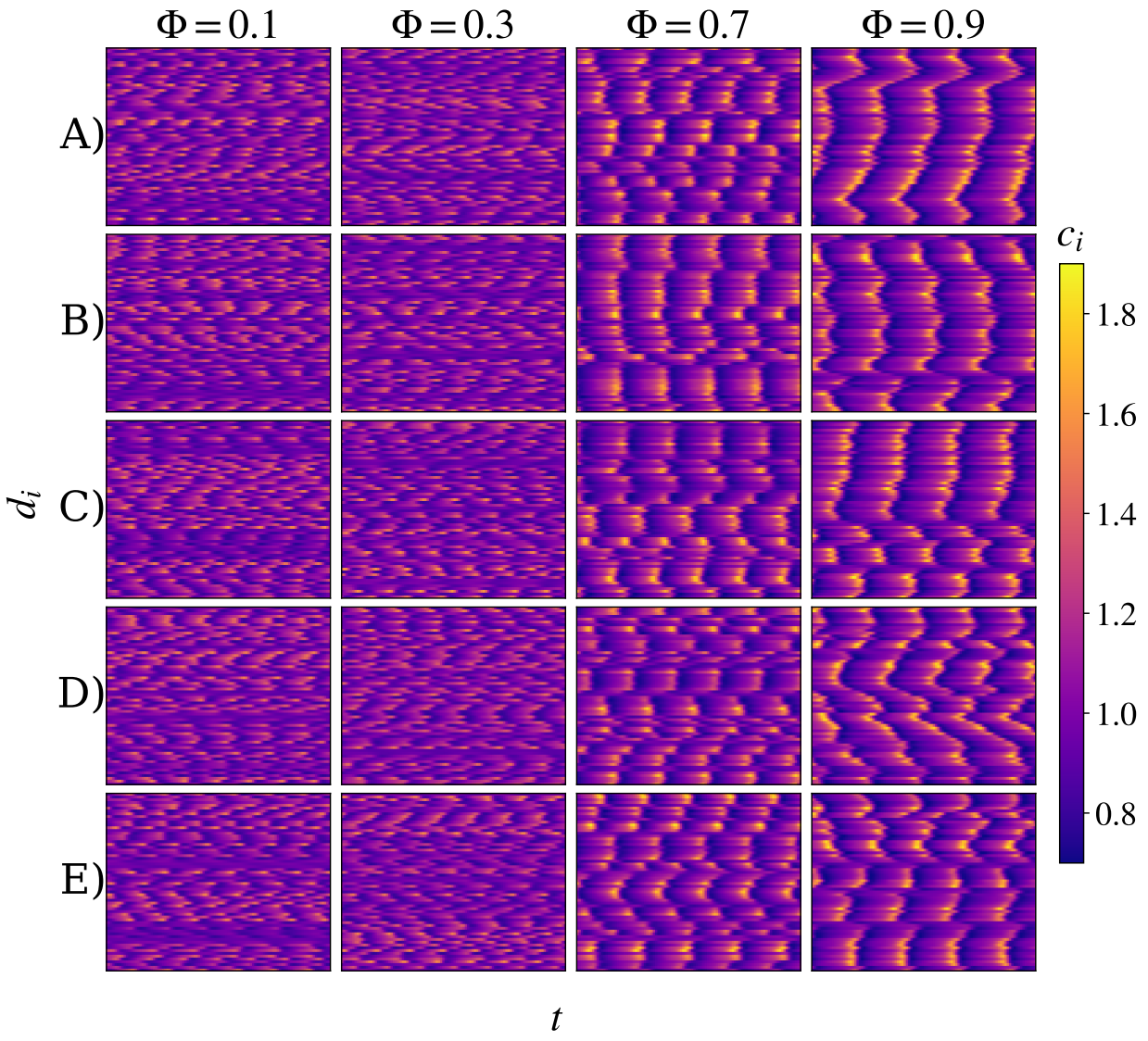

Figure S2: **Steady state dynamics.** Representative kymographs showing the concentration of bound myosin in the dumbbells for five different realizations of the suspensions.

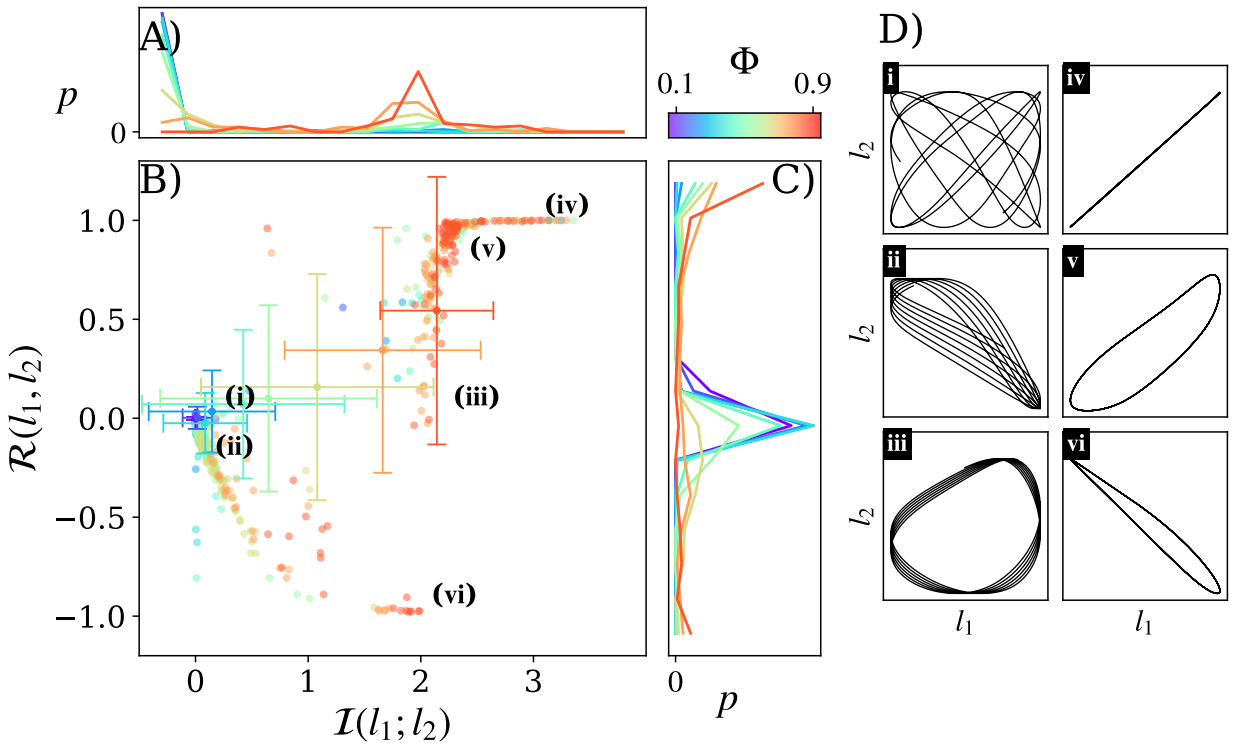

Figure S3: **Signatures of phase locking in dumbbell lengths.** (A-C) Mutual Information $\mathcal{I}(l_1; l_2)$ and correlation $\mathcal{R}(l_1, l_2)$ between bound myosin concentrations in two dumbbells at fixed separations, obtained from numerical simulation with multiple randomized initial conditions. In (B) circular markers represent different realizations of the dumbbell pair. The markers with the error bars represent average values of $\mathcal{I}$ and $\mathcal{R}$ for different Φ. (A) and (C) show probability distributions of $\mathcal{I}(l_1; l_2)$ and $\mathcal{R}(l_1, l_2)$ for different Φ values, respectively. In (A-C) panels, colors represent different Φ values as shown in the colorbar. (D) Representative examples showing steady state phase dynamics of bound myosin in two dumbbells for the marked $\mathcal{I} - \mathcal{R}$ values in panel (B).

Supplementary movie

Movie S1: Video showing hydrodynamic phase separation and collective motility at high suspension density. The color of each dumbbell denotes the size of the cluster it belongs to. Vertical lines in the bottom panel indicate initial confinement boundaries.

Supplementary source codes

- **Source code S1:** `SageMath` notebook for analytical calculation of hydrodynamics driven motion of two dumbbells with differing characteristics.
- **Source code S2:** `SageMath` notebook for analytical calculation of hydrodynamics driven motion of two identical dumbbells.