Stochastic migrations of Marangoni surfers between two lobes of a dumbbell-shaped confinement

Supplementary Information

September 26, 2024

1 Speed Distributions of Camphor Disks

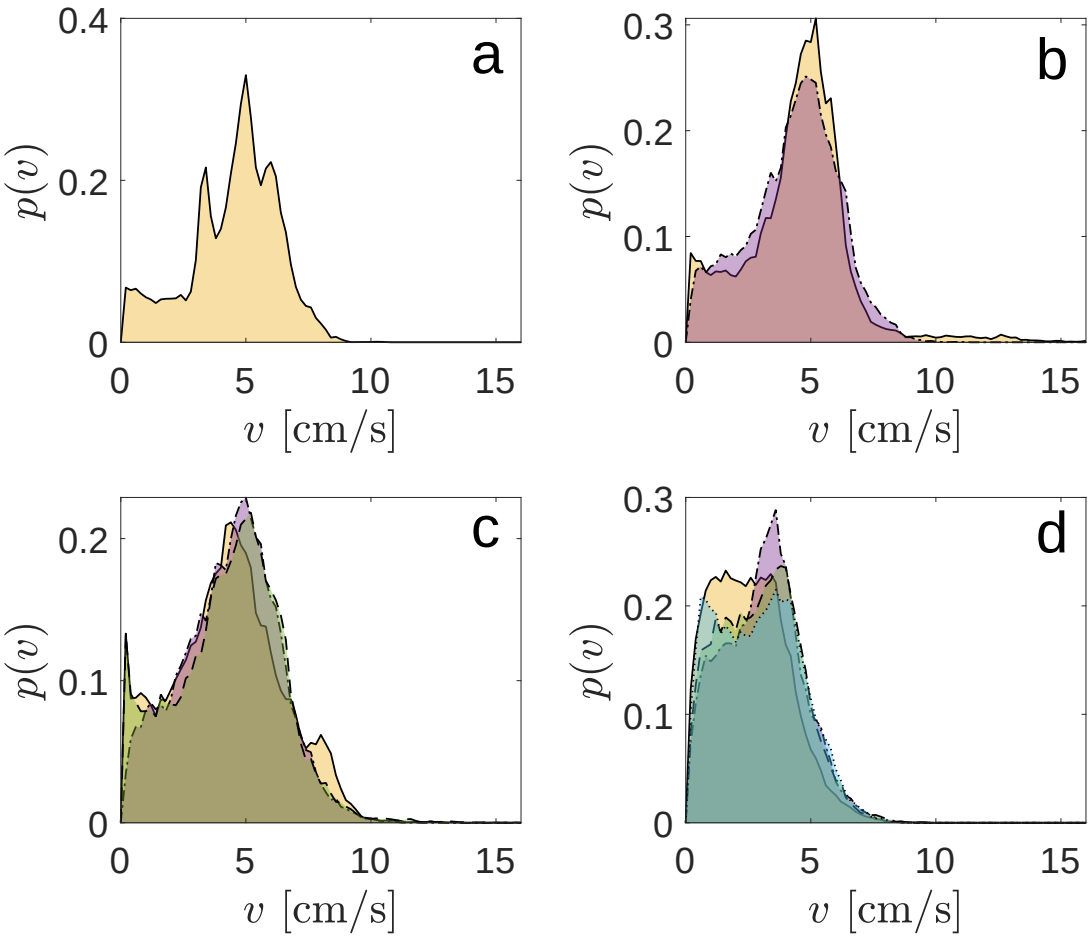

Figure 1: Speed distributions of camphor disks in all the cases presented in the current study. (a) Single-disk system (b) Two-disk system (c) Three-disk system and (d) Four-disk system. The probability distributions are averaged over at least 12 trials for each case. In general, a disk's speed distribution is bimodal. The first mode (at low speeds) corresponds to a disk's motion near the domain boundary, while the second mode (at high speeds) corresponds to motion in the bulk of the domain. All the data was sampled for 1 minute after approximately 10 minutes had elapsed since the beginning of the experiment.

2 Dwell-time Distributions of Configurations

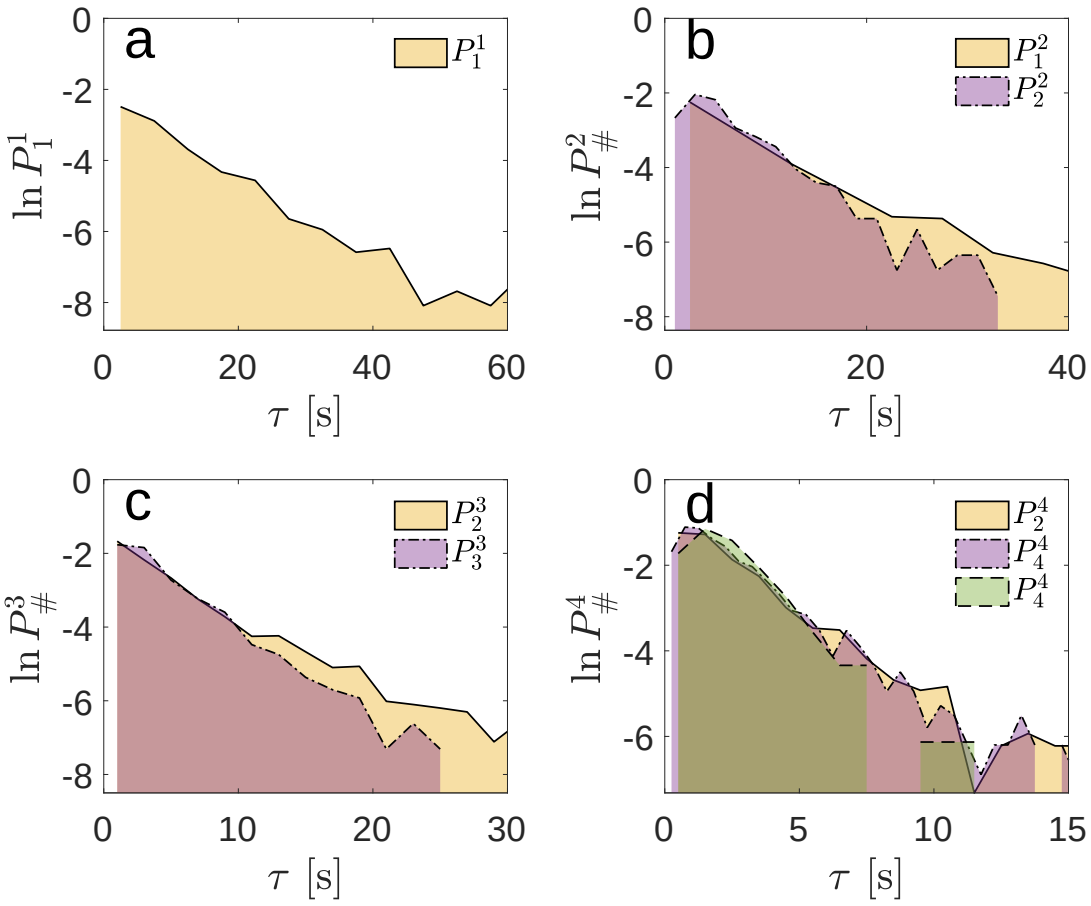

Figure 2: Dwell-time distributions of various configurations in all the cases presented in the current study. (a) Single-disk system (b) Two-disk system (c) Three-disk system and (d) Four-disk system. The probability distributions are averaged over at least 12 trials for each case. In general, all the distributions exhibit non-exponential features, evident from the non-linearity of $\ln P$ vs. τ curves.

3 Motion Trajectory of a Camphor Disk

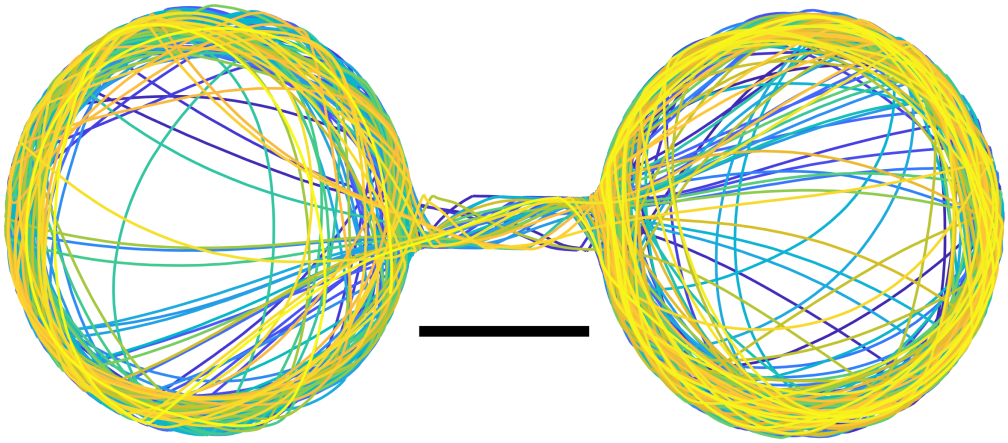

Figure 3: A ten-minute-long motion trajectory of a disk in a dumbbell-shaped confinement. Color variation (blue to yellow) indicates time evolution. A camphor disk, due to its translational and rotational degrees of freedom, has features typical of a chiral active particle. For example, the above trajectory demonstrates the "wall-hugging" nature of chiral active particles. Scale bar: 2.5 cm

4 Procedure for Curve Fitting of Survival Probalities

We used the Curve Fitting Toolbox of MATLAB® to perform the fitting procedure.

A stretched exponential has the following form.

$$f(t) = A \exp\left[-(\alpha t)^{\beta}\right] \tag{1}$$

Where, β is the stretching exponent, and usually $\beta \in (0, 1)$

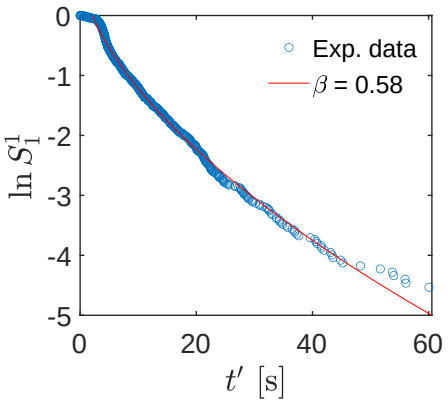

Figure 4: Survival probability S_1^1 and the corresponding fit to a stretched exponential is shown in solid red line. The plot is annotated with the correpsonding stretching exponent, β.

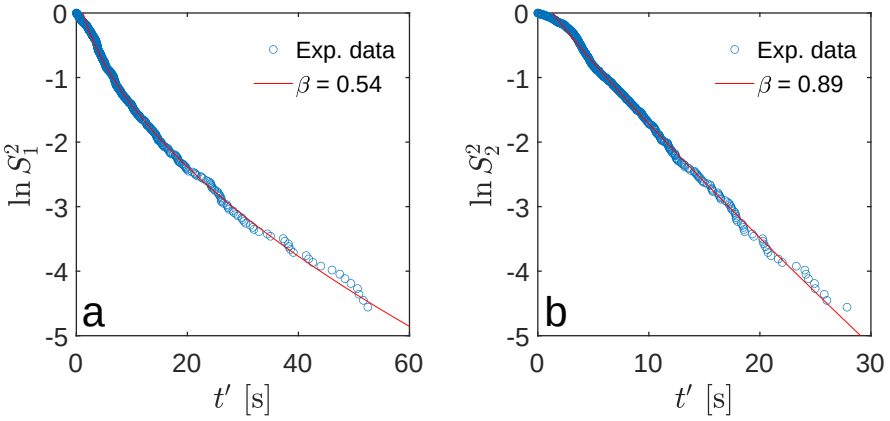

Figure 5: Survival probabilities S_1^2, S_2^2 and the corresponding fits to a stretched exponential are shown in solid red lines. The plots are annotated with the correpsonding stretching exponent, β.

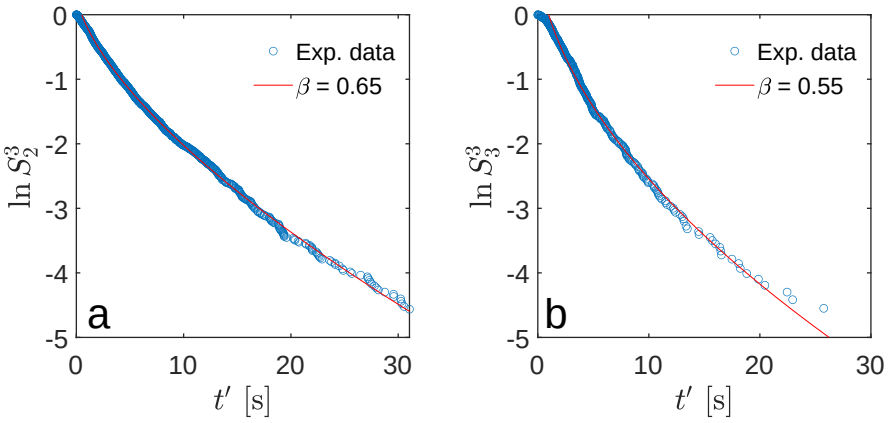

Figure 6: Survival probabilities S_2^3, S_3^3 and the corresponding fits to a stretched exponential are shown in solid red lines. The plots are annotated with the correpsonding stretching exponent, β.

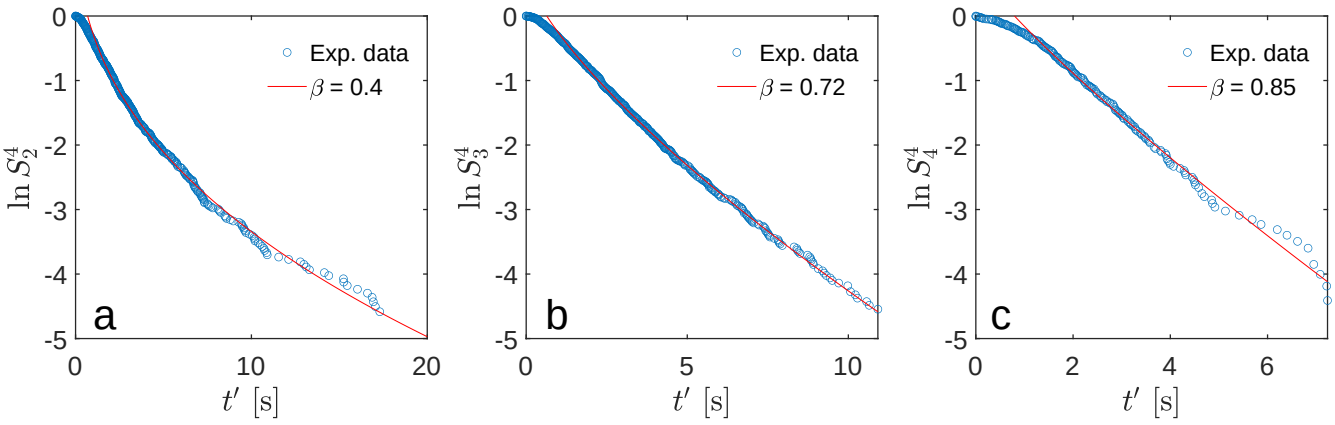

Figure 7: Survival probabilities S_2^4, S_2^4 and S_2^4 and the corresponding fits to a stretched exponential are shown in solid red lines. The plots are annotated with the correpsonding stretching exponent, β.