Supplementary Information: A surfactants reaction model for reciprocating motion of a self-propelled droplet

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Descriptions of movies

- **exp_uni.avi**
  An experimental real time movie of a droplet moving unidirectionally. $s = 35$ mM.
- **exp_rec.avi**
  Same as exp_uni.mp4, but in a reciprocating mode of motion. $s = 21$ mM.
- **sim_uni.avi**
  A simulation movie of a particle in a unidirectional mode of motion. $\hat{a}_1 = 16.0$, $\hat{a}_2 = 8.0$, and $\hat{a}_3 = 1.0$.
- **sim_rec.avi**
  Same as sim_uni.mp4 but in a reciprocating mode of motion. $\hat{a}_1 = 64.0$, $\hat{a}_2 = 20.0$, and $\hat{a}_3 = 1.0$.
- **dist_uni.avi**
  A simulation movie of concentration distribution together with normalized surface tension force acting on a particle in a unidirectional mode of motion. $\hat{a}_1 = 16.0$, $\hat{a}_2 = 8.0$, and $\hat{a}_3 = 1.0$. In the movie, c_1 is ES concentration, c_2 is SDS concentration, and F is $\hat{F}_\gamma/\hat{a}_4$.
- **dist_rec.avi**
  Same as dist_uni.mp4, but in a reciprocating mode of motion. $\hat{a}_1 = 64.0$, $\hat{a}_2 = 20.0$, and $\hat{a}_3 = 1.0$.

The effect of nonlinear reaction

In the main text, we assumed the simplest possible reaction between ES and SDS, $-a_2c_1c_2$. But if ES molecules are dissolved in micelles of SDS, the reaction should be nonlinear. Our previous work (Fig. 6 in [19]) suggests that a ES molecule reacts with four SDS molecules. In this case, the reaction term should be $-a_2c_1c_2^4$. We tested this reaction term and constructed bifurcation diagrams as shown in the Fig. 1. The results suggest that the effect of the nonlinear reaction is only to shift the position of bifurcations, and that the essential features of phenomena remain.

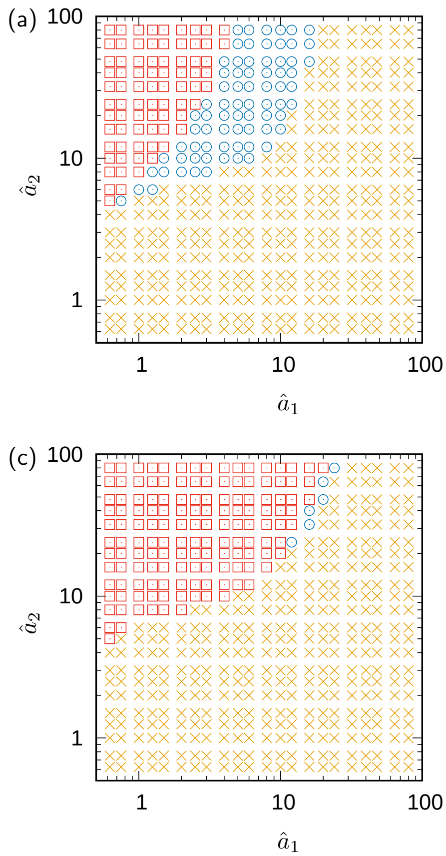

Figure 1: Bifurcation diagrams constructed under a nonlinear reaction, $-a_2c_1c_2^4$ instead of $-a_2c_1c_2$. Crosses, circles, and squares, respectively represent unidirectional motions, reciprocations, and stationary states. (a) $\hat{a}_3 = 1.0$. (b) $\hat{a}_3 = 2.0$. (c) $\hat{a}_3 = 4.0$. (d) $\hat{a}_3 = 8.0$.