Supplementary Information (SI) for Soft Matter.

Supplementary material for "Obstacle-enhanced spontaneous oscillation of confined active granules"

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1. Mean squared displacement (MSD) of an active granular particle

To visualize the self-propelling character of the active dumbbell-shaped particle, Fig. S1 shows the MSD of the granular dumbbell along its long axis as a function of time, which is equivalent to a one-dimensional motion. The parabolic time dependence of the MSD indicates that the granular dumbbell experiences a self-propulsion along its long axis.

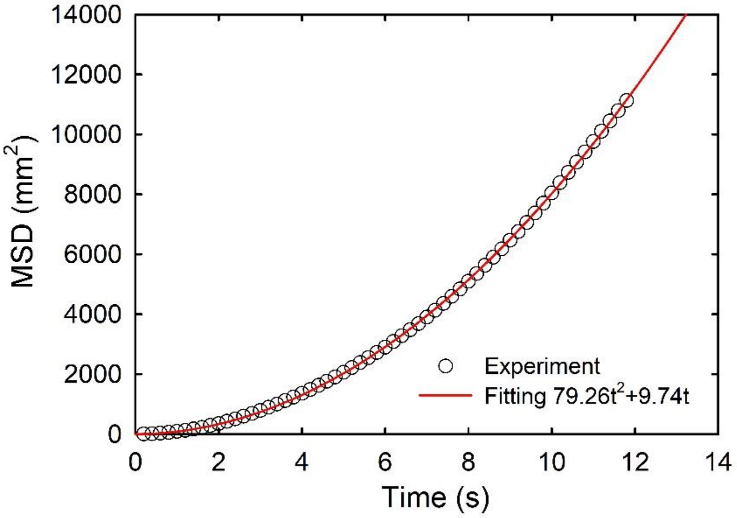

Fig. S1. MSD of an isolated granular dumbbell along its long axis. Here, the vibrating frequency $f = 80Hz$ and dimensionless acceleration $\Gamma = 4g$. The solid line refers to a fitting with a quadratic function.

2. Videos

Movie S1. Self-propelled particles confined in two chambers **without** obstacles inside generate spontaneous number oscillation with unsatisfactory periodicity. The parameters in this oscillation: vibrating frequency $f = 80Hz$ and vibrating strength $\Gamma = 4g$, channel length $L = 12$ in unit of one self-propelled particle, channel width $w = 1.25$, where the channel width w is normalized by the diameter d_b of the large ball on the self-propelled particle, and the total particle number $N = 80$.

Movie S2. Self-propelled particles confined in two chambers **with** obstacles inside generate spontaneous number oscillation with satisfactory periodicity. In the control experiment, all other conditions maintain the same.

3. The orientation distribution of particles near the channel opening with and without obstacles

We discuss the orientation distribution of particles near the channel opening with and without obstacles. First, we draw a semicircle centered around the midpoint of the opening, with a radius equal to the distance from the top of the obstacle to the opening, as shown by the yellow semicircle in Fig. S2(a) and Fig. S2(b). The purple arrow is parallel to the channel and points towards the opening. We then record the angle between the long axis direction of each particle (i.e. the direction of self-propulsion, indicated by the red arrow) within this semicircle, and the purple arrow. We perform 200 statistical measurements under both conditions, with and without obstacles, to obtain the probability distribution of $\Delta\theta$, as shown in Fig. S3. It can be seen that the peak of the probability distribution curve shifts to the left after adding the obstacle, and the probability of angles greater than 90° is almost zero. This also confirms the rectification effect of obstacles on the movement direction of particles near the opening.

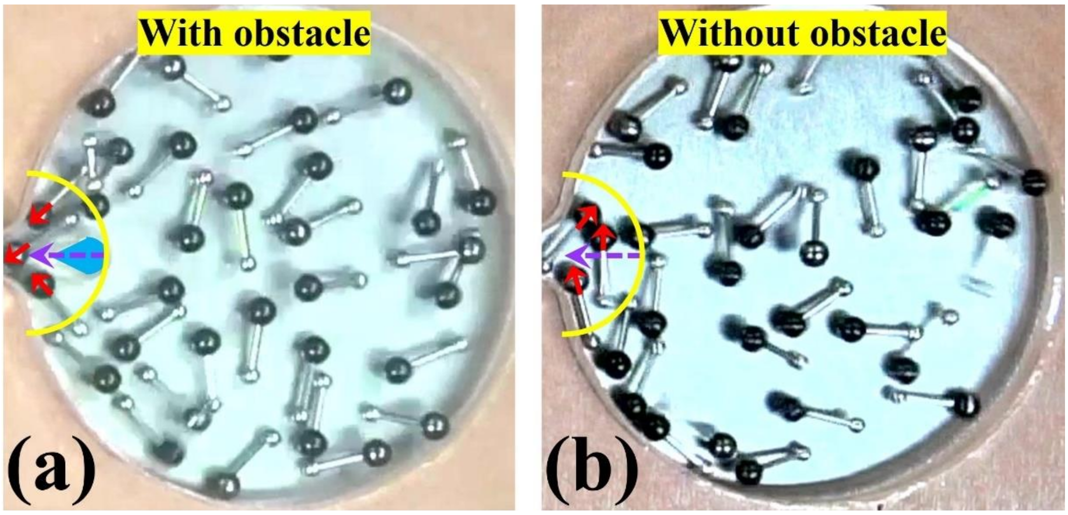

Fig. S2. Orientation of particles near the opening (indicated by a yellow semi-circle) (a) with the obstacle. (b) Without the obstacle.

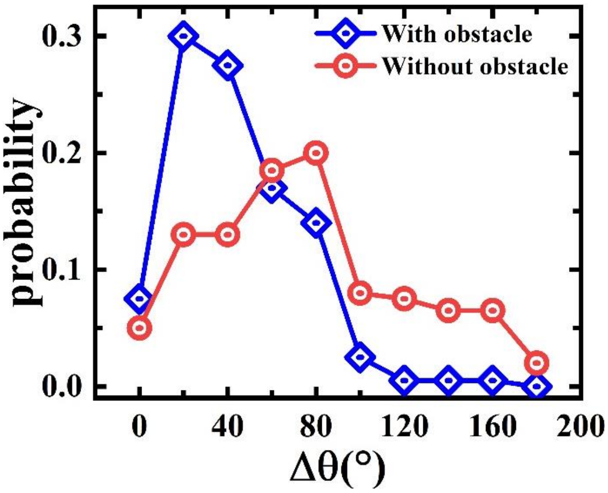

Fig. S3. Distribution of orientation angles between particles near the opening under conditions with and without obstacles.