Macroscopic active particles driven by light

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The self-organization of bird flocks, the formation of human stampedes, the motion of molecular motors, or the collective cell migration can all be considered ensembles of self-propelling active particles. The study of such ensembles is getting increased interest [1] due to the broad range of its applications in physics, biology, chemistry, and robotics. It has been observed that, regardless of the type of particles in question, active systems share certain properties at the group level. Accordingly, several models have been developed to describe the emergence of collective behavior [2, 3].

In self-propelled particles, some kind of energy is converted into directed mechanical motion. Indeed, the energy can come from the particle itself (e.g. bird flocks), or from an external source, acting locally or at the boundary (e.g. moving or shaking boundaries in the case of granular systems). In our work, we focus on the response to a stimulus, called taxis. We present novel, macroscopic self-propelled agents excited by light.

The agents are small robots called Hexbugs [4] with photovoltaic cells mounted on their top (see Fig. 1 right). Using this configuration the behavior of the agents can be influenced by changing the light intensity. Fig. 1 shows the sketch of the experimental setup, while Fig. 2 represents the trajectories of four particles obtained with homogeneous illumination.

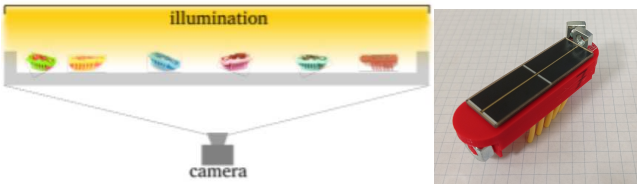

Fig. 1. Left: Sketch of the experimental setup. Right: Hexbug with a 3D printed cover holding the photovoltaic cell.

On the one hand, the macroscopic size of the particles allows us to explore the limit case of more sophisticated microscopic systems and isolate the contribution of some physical variables regarding the emergence of collective motion.

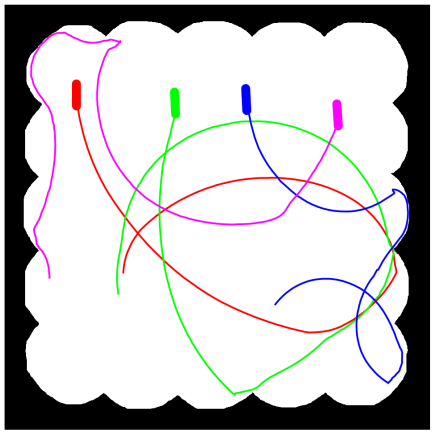

Fig. 2. Sample particle trajectories recorded with homogeneous illumination.

On the other hand, using a fully controllable illumination panel, we are able to change the illumination intensity spatially and temporally. E.g. by imposing spatial gradients of activity, we aim studying the diffusion, mixing, and clustering of the particles.

In this poster, we present the first results about the collective behavior of the photosensitive agents.

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