SUJET DE STAGE

Challenging collective behavior of fish: evacuation through two doors

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Context:

The self-organization of groups of individuals is a fascinating phenomenon that can be found in everything from a cycling peloton to flocks of starlings to herds of sheep. The collective behavior of fish is an astonishing example of coordinated movement that emerges spontaneously on a large scale despite limited communication between individuals.

In the team, we have first proposed a model, purely orientational, which shows the gain in rheotaxis performance (alignment with respect to a flow) in the presence of collective interactions[1]. We have investigate the behavior of a group of fish in a crowded environment and showed a transition linked to a social-interaction screening[3]. More recently, we have challenged the collective behavior by forcing the fish school to pass through a bottleneck [2]. This experiment revealed that, unlike humans, fish still respect social distance upon emergency evacuation which renders the evacuation more efficient.

The experiments are performed with groups of small aquarium fish, *Paracheirodon innesi*, also known as neon fish.

Objective:

In the evacuation through a bottleneck[2], the fish flow is well fitted to the same law as for air bubbles exiting through a bottleneck. To go further and reveal cognitive effects, we want to repeat the evacuation experiments but with two openings. By varying the opening size and the distance between them, we aim at characterizing the gregarious instinct of fish. Indeed, preliminary experiments have shown that the flow is not larger with two openings rather with one, and that the two openings are not used independently. The intern will perform experiments with fish and perform correlation analyses of the fish exits. He/she will contribute to the modeling and interact regularly with the rest of the team.

Team :

This internship topic is part of a larger interdisciplinary project. We are working in collaboration with P. Peyla (LIPhy) for the numerical modeling, T. Métivet (INRIA) for the numerical integration of the hydrodynamics, E. Bertin (LIPhy) for statistical physics modeling and C. Graff (LPNC) for ethology.

Keywords : biological physics, active matter, collective effects, image analysis (Python)

[1] Larrieu et al. Collective orientation of an immobile fish school and effect on rheotaxis. Phys. Rev. E 2021.
[2] Larrieu et al. Fish evacuate smoothly respecting a social bubble. Scientific Reports 2023
[3] Ventéjou et al, Collective behavior of a fish schools in a crowded environment. (In preparation)