Vision based transition in collective dynamics of a fish school under illuminance variations

B. Lafoux[a*], R. Godoy-Diana[a] et B. Thiria[a]

a. Laboratoire de Physique et Mécanique des Milieux Hétérogènes (PMMH, UMR 7636), CNRS, ESPCI Paris–PSL University, Sorbonne Université, Université Paris-Cité, F-75005

∗ baptiste.lafoux@espci.fr

We highlight experimentally the role of vision on the cohesive motion of a large school of red-nose tetras (*Hemigrammus rhodostomus*). Our setup allows groups of around 50 fish to swim freely in a wide rectangular tank (140 × 100 cm), while progressively altering their visuals abilities by means of a controlled illumination ($\bar{E} \in [0, 1]$).

The 2D trajectorie of each fish is tracked from images captured by an overhead camera. The collective nature of the motion is described through the polarization $\mathcal{P}$ and milling $\mathcal{M}$ parameters, which capture respectively global alignment and rotation. We also measure distances of interest in the school (average distance and nearest-neighbour distance).

For low light exposure, fish are unable to school and we observe no order. The group configuration quickly changes to a temporary state of strong alignment, and then switch to a robust "vortex" structure (see Figure 1). We observe that the level of alignment is correlated with the the light intensity to which the fish are subjected, allowing us to analyze the transition between swarming, polarization and milling.

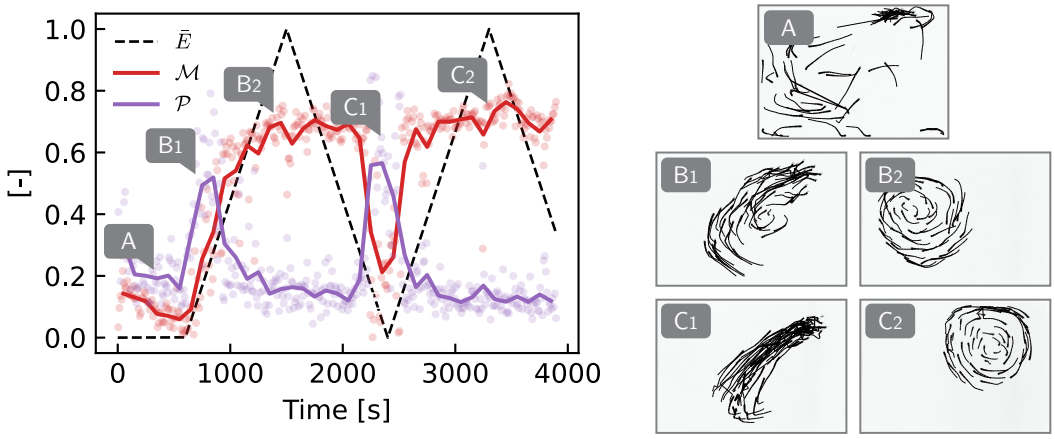

Figure 1: **(left)** Experimental time signal of the milling $\mathcal{M}$ and polarization $\mathcal{P}$ parameters for a group of 53 fish undergoing variations of the global illuminance ($\bar{E}$, normalized) over a 1h time period. **(right)** Trajectories snapshots showing the different phases of the school, exhibiting the strong correlation between organization level and available visual cues.