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PROCEEDINGS

Energetic Benefits for Two Swimmers in a Circular Runway

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ABSTRACT

The coordinated motion by multiple swimmers is a fundamental component in fish school. Fish swimming in a certain formation (tandem, side by side, diamond and phalanx etc.) can gain substantial energetic benefits. However, the question whether the non-straight swimming behaviors such as milling structure in other collective patterns can also gain energetic benefits remains to be explored. Based on a series of simulations on two self-propelled swimmers, we provide a viewpoint for the energetic benefits of milling pattern in collective behaviors. The trajectory and velocity of both swimmers are controlled by a PID approach. First, we demonstrate that the influence of the circumferential effect on the optimal phase, as well as the energy saving resulting from the benefits of both propulsion and turning. Then, we study the radial effect in terms of energetic benefits. In the milling pattern, the swimmers on the inside can get a certain energetic benefit (-8%) easily, while their peers on the outside have to be close enough ($\leqslant$ 0.1BL) to the inner one with a proper phase to gain the energetic benefit (-14%). Whatever the radial spacing becomes larger or lies in an unmatched phase, the swimming of the outer ones tend to be more laborious (+16%). It is found that the swimmers that keep the matched phase and minimum radial effect obtain the largest energetic benefits (-26%). The present results indicate the energetic benefits by swimmers even in a milling pattern, in which the position difference dominates the extent of benefit.

KEYWORDS

Biological fluid dynamics; biomimetic propulsion; collective swimming

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