P.11 Is it possible the hydrodynamic synchronization of colloidal rotors describing rigid trajectories? - an experimental proof

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The coordinated cyclic beating of eukaryotic cilia and flagella is responsible for vital functions such as motility of microorganisms and fluid transport close to various epithelial tissues. Synchronization induced by hydrodynamic interactions is a possible and potentially general mechanism behind this coordinated beating of cilia. To understand hydrodynamic synchronization, rather than a realistic beating filament description, we use here a simple model with a minimal number of degrees of freedom, based on optically driven colloidal particles that can act as micron-scale phase oscillators. This model, known as “rotors”, has been studied recently by Uchida and Golestanian, who characterized the effective potential governing the dynamical states of a couple of rotors, predicting the stable and metastable states of the system by a theoretical analysis of the coupled-oscillator equation [1,2]. Building on our work of ref [3], we report here on a combination of experiments based on two colloidal rotors driven with optical tweezers along predefined trajectories and fixed force profiles. These experiments are backed by fully stochastic Brownian Dynamics simulations -including hydrodynamic interactions through the Blake tensor- to test the coupling potential that was predicted theoretically. In particular, we explore a wide range of physical conditions which lead to in-phase (or anti-phase) synchronization for an arbitrary trajectory shape.

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