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Motion-Reversal Transitions in Self-Assembled Colloidal Walkers

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— Nature has created a variety of designs in order to move fluids and transport objects within living organisms. At microscopic scales (in the region of micrometers) two motifs are common: flagella and cilia. Within the cell, however, molecular motors with nanometer dimensions transport small sized vesicles. Here, we describe a novel approach that combines properties from two systems: cilia and molecular motors, to create self-assembled colloidal walkers. These walkers are assembled by superparamagnetic beads in the presence of a rotating homogeneous magnetic field, and are able move in a given direction due to the presence of surfaces which provide an effective friction. The motion is somewhat reminiscent of a person doing cartwheels on ice, where the friction is not high enough to avoid slip, but overall one can attain directed motion in one direction. Interestingly, the motion of the center of mass of these walkers is a non-monotonic function along one cycle of revolution. By exploiting this non-monotonicity, we show that motion reversal is possible in this systems if one carefully controls the friction properties of the surface as well as the confining "gravitational" field that maintains the beads near the surface. Our results our important in understanding the motion of micron scale organisms and may be useful in the development of virtual microfluidic platforms.

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