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Ferromagnetic Swimmers - Devices and Applications JOSHUA HAMILTON, PETER PETROV, C. PETER WINLOVE, ANDREW GILBERT, MATTHEW BRYAN, FEODOR OGRIN, University of Exeter — Microscopic swimming devices hold promise for radically new applications in lab-on-a-chip and microfluidic technology, diagnostics and drug delivery etc. We propose a new class of autonomous ferromagnetic swimming devices, actuated and controlled solely by an oscillating magnetic field. Experimentally, these devices (3.6 mm) are based on a pair of interacting ferromagnetic particles of different size and different anisotropic properties joined by an elastic link and actuated by an external time-dependent magnetic field. The net motion is generated through a combination of dipolar interparticle gradient forces, time-dependent torque and hydrodynamic coupling. We investigate the dynamic performance of a prototype (3.6 mm) of the ferromagnetic swimmer in fluids of different viscosity as a function of the external field parameters and demonstrate stable propulsion over a wide range of Reynolds numbers. Manipulation of the external magnetic field resulted in robust control over the speed and direction of propulsion. We also demonstrate our ferromagnetic swimmer working as a macroscopic prototype of a microfluidic pump. By physically tethering the swimmer, instead of swimming, the swimmer generates a directional flow of liquid around itself.

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