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**Geometrically Confined Spin Vortices: from Fundamental Physics to Biomedical Applications**

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The magnetic ground state of magnetically soft thin film ferromagnets in confined geometries (on the micrometer scale) consists of a curling spin configuration, known as a magnetic vortex state. We have recently demonstrated that the magnetic vortex microdisks can be successfully used as multifunctional magnetic carriers for biomedicine [1]. In particular, we will report on successful interfacing of ferromagnetic nanomaterials with a spin vortex ground state and biomaterials (antibody, whole cell). Namely, the gold-coated lithographically defined microdisks with an Fe-Ni magnetic core were biofunctionalized with anti-human-IL13a2R antibody for specifically targeting human glioblastoma cells. When an alternating magnetic field is applied the vortices shift, leading to the microdisks oscillation that causes a mechanical force to be transmitted to the cell. Cytotoxicity assays, along with optical and atomic force microscopy studies, show that the spin vortex-mediated stimulus creates two dramatic effects: (a) membrane disturbance and compromising, and (b) cellular signal transduction and amplification, leading to robust DNA fragmentation and, finally, programmed cell death [2]. The experiments reveals that by employing biofunctionalized magnetic vortex microdisks the magnetic fields of low frequency of a few tens of Hz and of small amplitude of $< 100$ Oe applied during only 10 minutes was sufficient to achieve $\sim$90% cancer cells destruction.

[1] E. A. Rozhkova, et al., J. Appl. Phys. Vol. 105, (2009) 07B306.
[2] D.-H. Kim, et al., Nature Materials, vol. 9, pp. 165 - 171 (2010).