Magnetic Relaxometry as Applied to Sensitive Cancer Detection and Localization

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Abstract

Background: Here we describe superparamagnetic relaxometry (SPMR), a technology that utilizes highly sensitive magnetic sensors and superparamagnetic nanoparticles for cancer detection. Using SPMR, we sensitively and specifically detect nanoparticles conjugated to biomarkers for various types of cancer. SPMR offers high contrast *in vivo*, as there is no superparamagnetic background, and bones and tissue are transparent to the magnetic fields.

Methods: In SPMR measurements, a brief magnetizing pulse is used to align superparamagnetic nanoparticles of a discrete size. Following the pulse, an array of superconducting quantum interference detectors (SQUID) sensors detect the decaying magnetization field. NP size is chosen so that, when bound, the induced field decays in seconds. They are functionalized with specific biomarkers and incubated with cancer cells *in vitro* to determine specificity and cell binding. For *in vivo* experiments, functionalized NPs are injected into mice with xenograft tumors, and field maps are generated to localize tumor sites.

Results: Superparamagnetic NPs developed here have small size dispersion. Cell incubation studies measure specificity for different cell lines and antibodies with very high contrast. *In vivo* animal measurements verify SPMR localization of tumors. Our results indicate that SPMR possesses sensitivity more than 2 orders of magnitude better
than previously reported.

Keywords (Index Terms) — Cancer; magnetic relaxometry; nanoparticles; SQUID.