New Metrology for Characterization of Nanomagnetic MRI Contrast Agents

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Magnetic resonance imaging (MRI) is a relatively new and powerful biomedical imaging tool. Due to its noninvasive nature and multiple modalities, it is fast becoming a dominant biomagnetic imaging technique. Nanomagnetic contrast agents are designed to manipulate local nuclear magnetic resonance (NMR) properties in the human body. Nuclear precession and relaxation are then imaged, with MRI, to obtain tissue-specific functional and dynamic information. We are developing new metrology and analysis based on a combination of electron paramagnetic resonance (EPR) and NMR that utilizes a superconducting quantum interference device (SQUID) detection of the change in magnetic moment due to the resonant rf irradiation. Prior to this work, absolute values of the EPR were difficult to obtain. We use this metrology to provide a quantitative probe of the physics behind the interactions of the electronic spin moment (using EPR) of the contrast agent with the nuclear spin moment (using NMR) of the water proton nuclei. We will present results on the single molecule magnet Fe_8 that shows great promise as a new class of superparamagnetic contrast agent with a size less than 1.5 nm.