

*Xenon, Liquid Crystals, and SPIONs:  
Tools for Enhancing Sensitivity and Information Content in NMR and MRI*

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**Abstract**

Nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) embody some of the most powerful spectroscopic and diagnostic techniques available to scientists, engineers, and physicians. Nevertheless, NMR suffers from a number of drawbacks that in some circumstances, can dramatically limit its applicability to potential applications. For example, the low nuclear spin polarization achieved even in the largest magnets results in low detection sensitivity compared to other methods. Furthermore, while MR spectra and images can be enormously informative, even greater spectral information content and brighter, more physiologically-relevant contrast are often desired. The first part of this Seminar will concern ongoing work in our Group to use hyperpolarized substances (e.g. laser-polarized xenon, LPXe) and liquid crystal matrices to enhance the detection sensitivity and information content of NMR, with application to the solution study of weak intermolecular interactions—including those that hold together host-guest inclusion complexes. Additionally, the physics of spin-exchange optical pumping (SEOP)—how LPXe is generated—will be briefly reviewed, and results from our ongoing collaboration with Michael Barlow (U. Nottingham, UK) to study SEOP under conditions of high resonant laser flux and high Xe densities will be discussed. The latter portion of the seminar will concern our Group's collaboration with Prof. Yong Gao (SIUC) to investigate a novel class of dendron-functionalized SPIONs (SuperParamagnetic Iron Oxide Nanoparticles) as “molecular-switch” MRI contrast agents capable of encoding local environmental changes onto the MR relaxation behavior of the water molecules that surround them—potentially enabling pH mapping *in vivo*, among other possibilities.