

"Lighting Up" NMR and MRI

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Synopsis

The enhanced signals of laser-polarized gases allow novel applications of NMR and MRI in chemistry, biology, and medicine over distance scales from nanometers to meters. Two recent experiments use polarized atoms in "functionalized" molecular biosensors, and permit the observation of NMR and MRI in ultralow magnetic fields. Novel methodologies also allow "ex-situ," and even "remote," detection of magnetic resonance, making it possible to obtain enhanced information about samples, objects or subjects that are immobile or otherwise inaccessible to traditional methods of magnetic resonance spectroscopy and imaging in biomedicine.

The enhanced signals of laser-polarized gases allow novel applications of NMR and MRI in chemistry, physics, materials science, biology, and medicine. Examples will be presented of developments and applications of laser-polarized and detected NMR and MRI over distance scales from nanometers to meters. Recent experiments will be described in which polarized atoms and molecules have been used as molecular sensors to investigate the hydrophobic surfaces and interiors of macrocyclic molecules and proteins, and as "functionalized" biosensors of molecular targets. The use of optical pumping and detection also opens an exciting new frontier in the possibility of "Zero-Field" NMR and MRI. Using laser polarization and novel detectors, spectra and images have been obtained without the need for high field magnets normally required for MRI. The detectors are incorporated into a novel ultralow-field MRI instrument, making it possible to obtain bright MRI pictures and NMR spectra in environments similar to the earth's natural magnetic field, thousands of times weaker than those of traditional MRI magnets. Finally, novel recent experiments will be described in which magnetic resonance is detected "ex-situ" or "remotely" in order to obtain enhanced information about samples, objects or subjects that are immobile or otherwise inaccessible to traditional methods of magnetic resonance spectroscopy and imaging in biomedicine.