SE-05-01

Hyperpolarized solution-state NMR spectroscopy via quantum resources

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Abstract

Nuclear spin hyperpolarization provides a promising route to overcome the challenges imposed by the limited sensitivity of NMR spectroscopy. The current leading approach for hyperpolarizing nuclear spins, dissolution DNP, requires deep cryogenic temperatures (~1K) and long polarization buildup times (~1 hour) thus limiting the applicability of hyperpolarization. In this talk I will present our alternative method for enabling nuclear hyperpolarization of a wide range of molecules at room temperature and under a minute utilizing quantum resources - optically polarizable electron spins in crystals and singlet states in gaseous hydrogen molecules.

We demonstrate that utilizing the quantum resource a molecule of choice can be sufficiently polarized to serve as a “polarization source”. Mixing a high enough concentration of the polarization source molecule into the solution enables polarization of an extremely wide range of analytes via the intermolecular nuclear Overhauser effect (NOE), and achieves enhancements up to 2600 in benchtop NMR spectrometers.

I will discuss the recent advances achieved by using various polarization sources, the ongoing development for making the system widely accessible to the NMR community and potential “killer applications” of the technology.