A new idea “nugget” from FOCUS:

**FOCUS polarized xenon project**

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Laser polarized xenon has the potential to greatly impact NMR quantum computing and information research. FOCUS researchers are working on two ideas in this area: 1) magnetization transfer to nuclei of molecules that are useful for NMR computation; and 2) development of laser polarized xenon qubits.

Magnetization transfer among nuclear spins within a molecule and between solvent and solute molecules is well established in NMR. Signal increases of tens to a hundred have been realized, but the efficiency of polarization transfer is still less than 1%! This is because the energies of the xenon spin flip and the target nucleus spin flip are mismatched. Our near term goal for the magnetization transfer project is to enhance the polarization of target nuclei with efficiency approaching 100%. We have started with thermally polarized xenon experiments in our 14 T NMR system. At the same time, we are completing a new xenon polarizer and developing techniques for NMR experiments in the 14 T system with laser polarized xenon.

Ultimately we would like to produce polarization of 10% or more of nuclear spins of small molecules such as Chloroform, which has two spins. This is of great interest, because the polarization is essentially a parameter that quantifies the entanglement of the spins in such a system. We could thus have a knob on the entanglement to investigate fundamental issues that arise in consideration of NMR based quantum information applications.

The use of laser polarized xenon as qubits is a FOCUS seed funding project that follows from our work on xenon bound to proteins. We propose to produce highly polarized nuclear spins (129-Xe) and arrange them on a substrate as a register of interacting nuclear spins. Proteins are interesting as substrates, because xenon binds to hydrophobic sites that are in principle distinguishable.

For example, x-ray scattering of crystallized myoglobin shows four distinct xenon sites. We have studied xenon in myoglobin in liquid solution (necessary for high resolution NMR) in our 14 T NMR, but found that the four sites are not spectrally distinct, presumably due to the rapid exchange of xenon atoms among the sites. The search continues for suitable substrates including investigation of the possibility of synthesized cage molecule complexes.