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In-Person & Virtual Section Meeting

Friday, March 3, 3:30 PM

318 Cox Science Bldg, University of Miami, Coral Gables

or Join by Zoom Meeting

https://miami.zoom.us/j/93097611271?pwd=WUViQ3lRUEtmT3JJUWFCelFPUmtoZz09

Meeting ID: 930 9761 1271, Passcode: 758529

Clifford Russell Bowers, PhD

Professor of Chemistry, University of Florida and Affiliate of the National High Magnetic Field Lab, Tallahassee

Merging Spin Physics and Catalysis Science: NMR Sensitivity Enhancement by Homogeneous and Heterogeneous Hydrogenation Catalysis

Abstract: Nuclear Magnetic Resonance (NMR) spectroscopy underpins many important applications ranging from molecular structure determination to medical magnetic resonance imaging (MRI). Unfortunately, NMR is also a notoriously insensitive form of spectroscopy, in part due to the weak interaction of nuclear magnetic moments with the applied magnetic field. Inducing hyperpolarization of nuclear spins in the molecule of interest (i.e., tricking them into thinking they are at zero Kelvin) can help overcome the sensitivity problem. Indeed, a 100,000-fold increase in the NMR sensitivity for ^{13}C signal relative to the conventional, thermally polarized NMR signal of the same room temperature sample. In a clinical MRI scanner operating at 1.5 T, the available gain is 783,000 (!) Parahydrogen, the metastable singlet spin isomer of dihydrogen, represents an inexpensive source of nuclear spin order, yet the pure state is invisible to NMR. Chemical hydrogenation reaction, either reversible or irreversible, provides a means for conversion of parahydrogen spin order to NMR/MRI observable hyperpolarization of order unity. This talk will present examples of how we have combined homogeneous catalysis or heterogeneous catalysis with coherent or adiabatic spin dynamics to tease-out the pure singlet spin order from parahydrogen. Not only can this approach provide access to the fundamental steps of hydrogenation, there's also excellent potential for application to molecular MRI for disease detection and monitoring by imaging of metabolic fluxes. I will present our vision and progress toward batch and flow chemistry processes for parahydrogen enhanced biomedical imaging.

Russ Bowers is a pioneer of hyperpolarization methods for sensitivity-enhanced NMR. Recent research in the Bowers lab has focused on the use of heterogeneous catalysis to convert the pure nuclear spin order inherent to parahydrogen into NMR observable hyperpolarization, which can result in NMR signal enhancements of more than four orders of magnitude. One of the most exciting recent breakthroughs in the Bowers lab is the SWAMP effect (Surface Waters are Magnetized from Parahydrogen), where the protons of liquid water and alcohols are hyperpolarized by simply bubbling parahydrogen through a suspension of Pt-Sn intermetallic nanoparticles in the earth's field. The SWAMP effect illustrates how the ingenious manipulation of the principles of quantum mechanics and thermodynamics can lead to transformative discoveries. Such is the guiding theme of the research program. The Bowers lab and offices are located within the UF Physics Building. He is affiliated with the National High Magnetic Field Laboratory, the UF Center for Condensed Matter Sciences, and the Center for Chemical Physics.