NMR at very low temperatures: An approach to millisecond-scale structure determination and micron-scale imaging

Jaekyun Jeon, Hsueh-Ying Chen, Kent Thurber, Wai-Ming Yau, and Robert Tycko
Laboratory of Chemical Physics, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, MD 20892-0520, USA

I will discuss two ongoing projects, both involving nuclear magnetic resonance (NMR) and dynamic nuclear polarization (DNP) at temperatures below 30 K. In the first project, we use rapid mixing and rapid freezing to trap transient intermediates in biochemical processes such as protein folding, ligand binding, and oligomerization, on time scales of several milliseconds. The resulting frozen solutions are examined by DNP-enhanced magic-angle spinning NMR. Preliminary results for the folding/oligomerization process of the 26-residue peptide melittin will be presented. In the second project, we use sensitivity gains from low temperatures and DNP, together with microcoil circuitry, to improve the spatial resolution of magnetic resonance imaging (MRI), with the goal of reaching isotropic resolution below one micron. I will describe the technology we have developed for these projects, as well as recent contributions to our understanding of DNP mechanisms and nuclear spin relaxation processes that influence the success of these projects.