Nuclear magnetic resonance (NMR) spectroscopy in the solid state is a powerful approach to determine atomic-resolution structure and motion in systems for which the molecules do not rapidly tumble. Our research focuses on application of solid-state NMR to problems in membrane fusion, bacterial inclusion bodies, and inorganic materials.

**Membrane Fusion:** Fusion between cells and cellular components has an essential role in living organisms for such significant physiological processes as egg fertilization and synaptic transmission in the nervous system. Membrane fusion is also an important step in HIV and influenza viral infection of human cells and is mediated by proteins in the viral membrane that bind to the target cell membrane during infection. We are using solid-state NMR to determine the conformations, membrane locations, and oligomerization states of the membrane-bound HIV and influenza viral fusion proteins and using these data to develop an atomic-resolution structural model of fusion protein-induced membrane fusion.

**Bacterial Inclusion Bodies:** Proteins for fundamental research or therapeutic purposes are usually produced by putting the DNA which codes for the protein into E. coli bacteria, culturing the bacteria to high densities, and then inducing production of the “recombinant” protein. Most of the recombinant protein is usually sequestered in non-crystalline solids in the bacterial cytoplasm that are termed “inclusion bodies” and which are viewed negatively by researchers because typical solubilization protocols for inclusion bodies are denaturing with the subsequent requirement of refolding whose success is variable and dependent on the specific protein. Because there is little molecular-level structural information on inclusion body protein, we are carrying out solid-state NMR studies with a particular emphasis on inclusion bodies in whole bacterial cells. One overall goal is development of non-denaturing solubilization protocols for inclusion body protein.

While doing this research, students learn a variety of skills which could include peptide synthesis, protein expression and purification, design and repair of NMR equipment, NMR theory and pulse sequence development, and computer simulation. Our research is benefiting from the enhanced sensitivity and resolution of the 900 MHz NMR spectrometer at MSU.

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**Nuclear Magnetic Resonance of Biological Systems**

**Professor**

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**Selected Publications**


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(Top) Normal E. coli cell. (Bottom) E. coli cell that has produced recombinant protein. The dark regions in the bottom panel are inclusion bodies.