Nanoscale Diffusion Studies of Lipid Membranes

National High Magnetic Field Laboratory

Advanced Magnetic Resonance Imaging & Spectroscopy User Facility, University of Florida

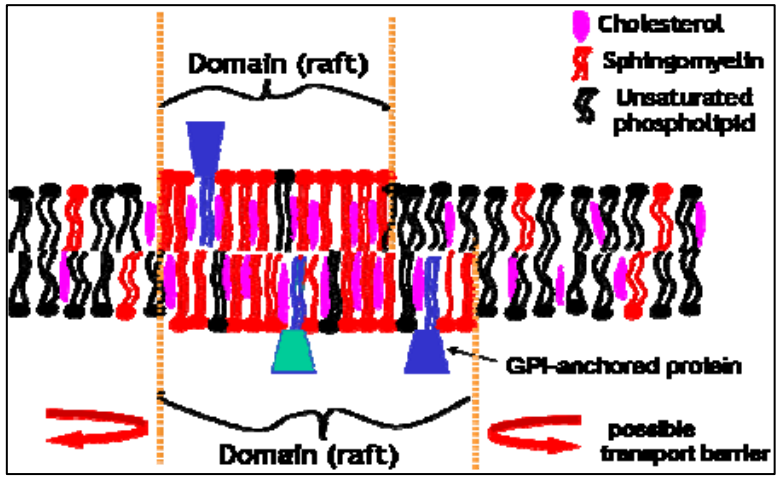
Chemical Engineering

We have developed a new NMR experimental option for studies of lateral diffusion in lipid membranes on the nanoscale, *viz.* high field (17.5 T) and high gradient (up to 30 T/m) pulsed-field-gradient NMR.

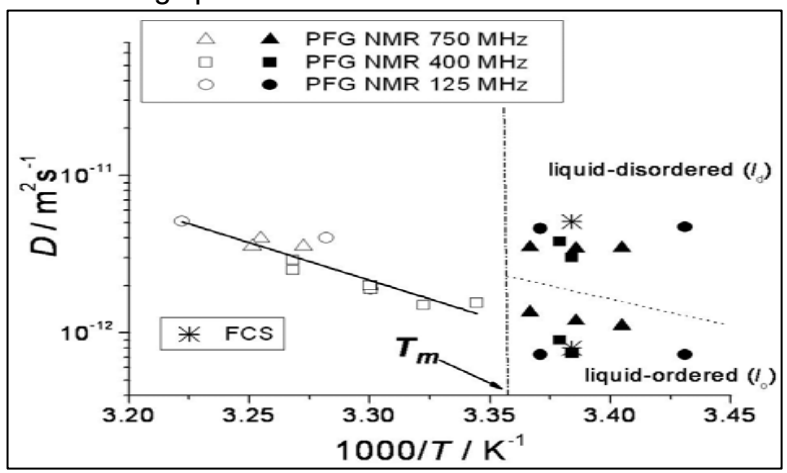
The heterogeneous organization of the cell membrane, specifically the formation of nanosized membrane domains (rafts), is believed to play a role in important cell functions. Studies of lateral lipid transport in membranes over relevant length scales (~100 nm) allow for the characterization of the domain structural and transport properties. Initial findings were recently published.

Ulrich, K.; Sanders, M.; Grinberg, F.; Galvosas, P. and Vasenkov, S., ***Langmuir***, **24**, 7365-7370 (2008)

Ulrich, K.; Sanders, M. and Vasenkov, S., ***Mag. Res. Imag.***, **25**, 493-496 (2007).



Schematic of organization of a biological membrane illustrating lipid raft formation.



Lipid diffusivities as a function of inverse temperature. Below 25°C, the bilayer forms two phases including a liquid-ordered (raft) phase and surrounding disordered environment.

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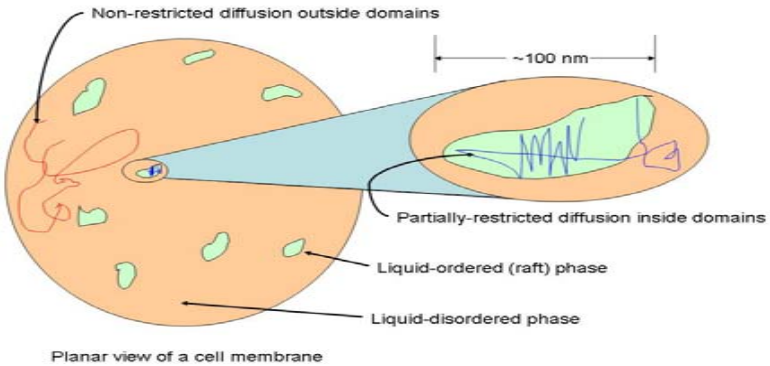
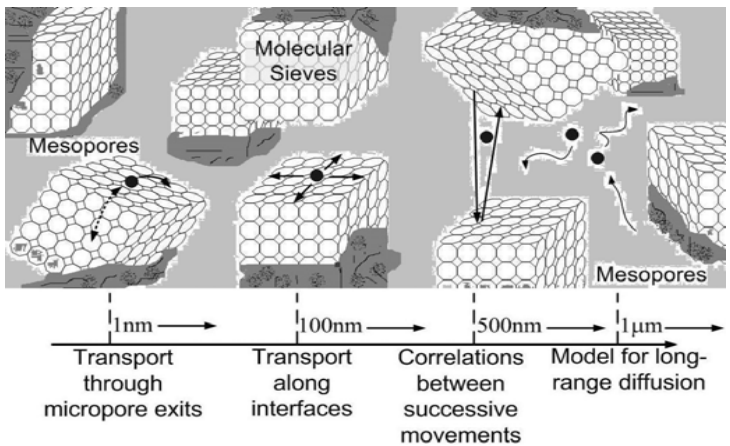


Self-diffusion of lipids that form the cell membrane. Lipids inside domains have a lower diffusivity than lipids in the surrounding environment and are often restricted by domain boundaries.



Different types of gas transport contributing to the overall, long-range molecular diffusion in hierarchical porous materials.

The introduction of pulsed-field-gradient (PFG) NMR at high field strengths with high gradients at AMRIS allows for the measurement of nanoscale diffusion in various types of complex systems. Training in this technique has been provided for two other groups and a technical manual outlining experimental procedures will be developed for the facility's future use. This will serve to enhance infrastructure for research and education at the Magnet Lab.

Members of this group currently serve as mentors to high school and minority undergraduate students. The work with minority students was recognized by two awards from the American Chemical Society Petroleum Research Fund in 2007 and 2008.