T_CSUH Bi-Weekly Seminar

Texas Center for Superconductivity
University of Houston

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Electric Field Driven Torque in Rotary Biological Motors

Friday, July 24, 2009
Room 102, University of Houston Science Center
12:00 Noon – 1:00 p.m.

Abstract

Rotary motors, including ATP synthase, V-type ATPases, and the bacterial flagellar motor, play crucial roles in living organisms. In humans and other eukaryotes, ATP synthase operates in the inner membranes of mitochondria to produce adenosine triphosphate (ATP), life's chemical currency of energy. V-type ATPases utilize the energy of ATP hydrolysis to create electrochemical potential differences (usually of protons) across diverse biological membranes. I will describe our recently proposed electric field driven torque model of ion-driven rotary motors. The model predicts a scaling law relating torque to the number of ion-carrying subunits in the rotor, the number of stators, and the ion motive force across the membrane. When the FO complex of ATP synthase is coupled to F1, the model predicts a minimum proton motive force (pmf) needed to drive ATP production by F1. By contrast the model predicts a maximum pmf against which the V1 complex of a V-type ATPase can overcome the opposing torque by V0 to pump protons back across the membrane. We are also working to develop label-free electromagnetic sensors to detect activity and possible dysfunction of mitochondrial and other enzymes. Dysfunction of mitochondrial enzymes has been implicated in type-2 diabetes, cancer, heart disease, and neurodegenerative diseases, while dysfunction of V-type ATPases has been implicated in osteopetrosis, distal renal tubular acidosis, and many other diseases. Therefore, improved understanding of such enzymes is broadly significant to human health.

Bio

Prof. Miller received his Ph.D. at the University of Illinois in 1985, where he studied the dynamics of charge density waves under the direction of John Tucker and two-time Nobel laureate John Bardeen. He was a faculty member in the Dept. of Physics and Astronomy at the University of North Carolina – Chapel Hill from 1986-1989, receiving the prestigious Alfred P. Sloan Research Fellowship in 1987. In 1989, he joined the University of Houston as a faculty member in the Department of Physics and the Texas Center for Superconductivity. Prof. Miller's research has included experiments probing the pairing state symmetry of high-T_c superconductors, applications of superconducting quantum interference devices, and studies of the electromagnetic properties of live cells and complex biological macromolecules.

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