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Detecting Protein Dynamics in Various Time Scales by Neutron Scattering

XIANG-QIANG CHU, Department of Physics and Astronomy, Wayne State University, Detroit, MI 48201

Proteins undergo sophisticated changes in space and time, in order to keep the cells functioning. These motions are believed to ultimately govern the biological function and activities of the protein. Various tools are used to study the protein dynamics, such as NMR spectroscopy, Raman spectroscopy and Infrared spectroscopy. Among these, neutron scattering provide exceptional tools for studying the structures and dynamics of protein in real time at the molecular level. In our recent research, quasi-elastic neutron scattering (QENS) experiments were carried out to study the protein dynamics by using a "state-of-the-art" backscattering spectrometer at the world's largest neutron source at Oak Ridge National Lab (ORNL). As a result, an exotic logarithmic decay in the relaxational dynamics of proteins is observed in the time range of 10ps to 1ns. This is the first experimental observation of logarithmic behavior in protein relaxation. In addition, using a direct time-of-flight Fermi chopper neutron spectrometer (SEQUOIA) at ORNL, we obtained a full map of the milli-eV phonon-like excitations in the fully deuterated protein. The Q range of the observed excitations corresponds to the length scale of about 2.5 to 3 Å, which is close to the length scales of the secondary structures of proteins (4-5 Å) and reflects the collective intra-protein motions. These observations and further investigation using neutron scattering can reveal important macromolecular behavior that cannot be otherwise measured by other techniques.