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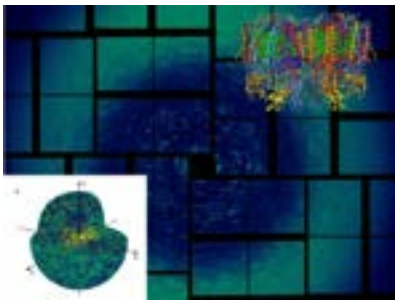
Dynamics of biomolecules "In Action" studied with X-ray free electron lasers

Petra Fromme
Arizona State University, USA

Biomolecules are highly dynamic; however, most structures only provide a static picture of the molecule. Serial Femtosecond Crystallography (SFX) provides a novel concept for structure determination, where X-ray diffraction "snapshots" are collected from a fully hydrated stream of nanocrystals, using femtosecond pulses from high energy X-ray free-electron lasers (XFELs), where diffraction is observed before destruction takes effect. The first proof of concept of serial femtosecond crystallography was achieved using Photosystem I, a larger membrane protein complex involved in Photosynthesis as a model system. The structure of non-damaged biomolecules can now be determined, unraveling their function at the atomic scale that include important human membrane-bound receptors. SFX opens a new avenue for determination of protein dynamics, with the goal of molecular movies of biomolecules "in action". First experiments on the proof of principle for time resolved serial femtosecond nanocrystallography have been performed on proteins in Photosynthesis, where first snapshots of steps in water splitting reaction have been observed. A new concept based on continuous X-ray diffraction extends resolution beyond Bragg diffraction and allows for direct phasing of X-ray diffraction data. TR-SFX studies extend to atomic resolution where the first steps in photosensing were recently revealed at a time scale of femtoseconds using the photoactive yellow protein. This pioneering work paves the way for the determination of molecular movies of the dynamics of membrane proteins "at work" in the future. The talk will close with a progress report on the development of compact femto and attosecond X-ray Sources at DESY (AXSIS) and at ASU (CXLS and CXFEL) , which will provide unique new opportunities to study the ultrafast dynamics of reactions in photosynthesis with a combination of X-ray diffraction, X-ray spectroscopy and ultrafast optical spectroscopy.



Biography

Petra Fromme received her masters at the Free University in Berlin in Biochemistry (1985) and then received her doctorate in Chemistry at the Technical University in Berlin (1988) where she then became a professor in 1992. During this time she developed and pursued her fascination with understanding the function of membrane proteins by investigating and determining their atomic structures. In 2002, Dr. Fromme joined Arizona State University as a Professor of Chemistry and Biochemsitry where she has worked with distinguished colleagues from around the world to pioneer a new technique for imaging proteins using extraordinarily powerful x-ray lasers that has the capability to make movies of these fascinating proteins in action.

pfromme@asu.edu

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