



BIG energy seminar series

Addressing the scale and complexity of the global energy challenge.



Dynamics of photosynthetic light harvesting: from ultrafast energy transfer to single-molecule conformational fluctuations

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Location: Caruthers Biotechnology Building, A115 (East Campus)

Abstract:

In photosynthetic light harvesting, organisms simultaneously achieve two seemingly opposite goals: 1) they convert photoenergy to chemical energy with near unity quantum efficiency; and 2) they safely dissipate excess photoenergy to avoid photodamage. Part of how photosynthetic organisms balance these two goals is through dynamics occurring on timescales spanning more than fifteen decades. To explore these processes, we perform two sets of experiments to access two distinct timescales. On a femtosecond to picosecond timescale, the remarkable quantum efficiency is achieved by energy rapidly transferring through networks of pigment-protein complexes in order to reach a central location to initiate photochemistry. However, how the pigment-protein complexes produce this directional energy flow remains poorly understood. In a first set of experiments, we use 2D electronic spectroscopy to map out the rates and mechanisms of energy transfer through the most ubiquitous pigment-protein complex from higher plants, LHCII. We determine energy moves through LHCII via two parallel pathways that consist of energy transfer steps ranging from tens of picoseconds down to previously unresolved sub-100 fs steps. On a millisecond to second timescale, the protein fluctuates between different functional conformations, which appear as an averaged value in ensemble measurements. The structure of these conformational states, as well as how they impact the excited state manifold, has not been determined. In a second set of experiments, we use a non-perturbative, solution-phase single-molecule technique, the Anti-Brownian Electrokinetic (ABEL) trap, to circumvent this ensemble averaging. In this way, we determine and characterize the conformational dynamics for LH2, the bacterial pigment-protein complex analogous to LHCII. These experiments reveal that LH2 complexes exhibit a photoactivated, reversible switch to a state with increased quenching of photoenergy, thus exhibiting a previously unknown photoprotective strategy. In this talk, the results presented will illustrate how the combination of these two sets of experiments, 2D spectroscopy and single-molecule spectroscopy, provides an approach to elucidate the sophisticated molecular machinery that underlies photosynthetic light harvesting.

Bio:

Dr. Gabriela Schlau-Cohen uses single-molecule spectroscopy and ultrafast spectroscopy to investigate the primary steps of photosynthesis. Her work involves developing techniques to explore the structure-function relationships in photosynthetic proteins that underlie the efficiency and adaptability of natural light harvesting. Currently, she is a CMAD Postdoctoral Fellow at Stanford University working with Prof. W.E. Moerner. Dr. Schlau-Cohen did her doctoral research under the direction of Prof. Graham Fleming, and received her PhD in Physical Chemistry in 2011 from the University of California, Berkeley, where she was an AAUW American Fellow. She received her B.S. in Chemical Physics in 2003 from Brown University.

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