Time resolved FTIR Difference Spectroscopy for the Study of Solar Energy Conversion Processes in Photosynthetic Protein Complexes

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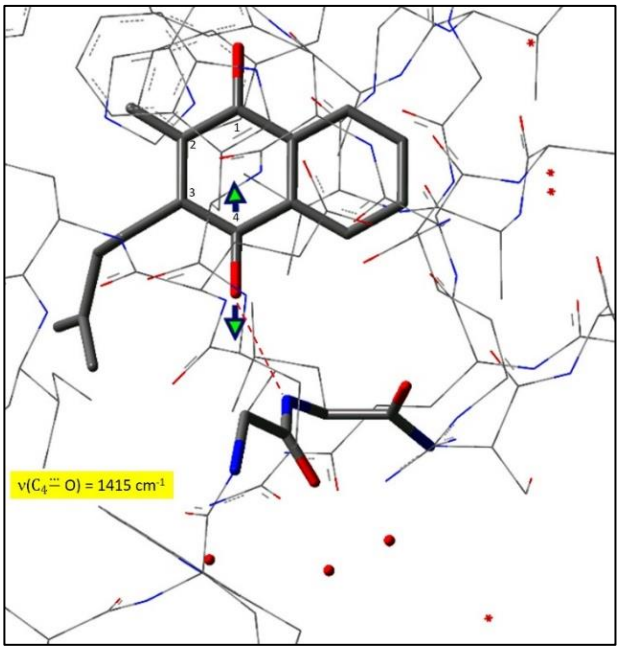
Solar energy conversion in photosystem I (PSI) is highly efficient, and in my lab several projects are underway focusing on the study of pigments involved in solar energy conversion in PSI. Here I will focus on the study of the phylloquinone (PhQ) and other non-native quinones occupying the A_1 binding site in PSI. Quinones occupying the A_1 binding site in PSI serve as intermediaries in electron transfer and are uniquely reducing. The structural details and mechanisms underlying these unique properties are not well understood.

Using time resolved FTIR and visible difference spectroscopy to study PSI with several different quinones incorporated into the A_1 binding site the bioenergetics of the electron transfer reactions that involve the quinones are elucidated.

Time resolved FTIR difference spectroscopy also allows an investigation of the molecular interactions for PhQ and other non-native quinones in the A_1 binding site, for both the neutral and anion states. Here I will present time resolved FTIR difference spectra for PSI with PhQ and several non-native quinones incorporated. From these difference spectra several "foreign minus native quinone" double difference spectra were constructed allowing us to distinguish bands in the spectra associated with the protein, and bands associated with the quinones. To further distinguish and assign bands in the spectra, measurements were also made using fully ^{13}C-labeled PSI particles with unlabeled (^{12}C) quinones incorporated. Through these isotope labeling studies and the production of several types of double difference spectra, in combination with quantum chemical calculations, the infrared absorption bands of both the neutral and anion state of PhQ and several other quinones in the A_1 binding site are identified and assigned.



Phylloquinone in the A_1 binding site in photosystem I. A vibrational mode of the anion state is indicated.