Coherent Optical Spectroscopy of Semiconductors

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This tutorial will discuss techniques and applications of femtosecond photobiology. First, ultra-short pulse generation, detection and measurement techniques are briefly reviewed. Then, several examples of ultrafast dynamics in biological systems will be discussed. Ultrafast spectroscopy has provided new information about the dynamics and function of many biological systems. As examples we will discuss the energy and electron transfer processes in photosynthetic and artificial light-energy converting systems and investigate reactions of retinal chromophores in proteins used by nature in energy converting and signaling systems.

Ultrashort pulses for dynamics in biology. Reactions forming the functional basis of biological systems are elementary chemical reactions like energy and charge transfer, bond breaking and forming, isomerizations, proton transfers, etc. The direct study of these reactions in real time frequently requires sub-100 femtosecond time resolution. Widely tunable and low-intensity pulses are often advantageous in order to facilitate the study of sensitive biological systems absorbing light over a broad range of wavelengths. How ultrashort-pulse Ti:Sapphire technology can be used to accomplish this will be discussed.

Photosynthetic energy conversion. Energy and electron transfer reactions are the basis of the photosynthetic light-energy converting processes. The availability of structural information to atomic resolution of many photosynthetic pigment-protein complexes has made it possible to study in great detail the dynamics and function of these systems. Topics of current interest that will be discussed are: The nature of light excitations in photosynthetic antenna proteins; the mechanism of energy relaxation and transfer in antenna proteins and how it is related to the function of the proteins will be examined and compared with a model dye system.

A light-driven cationization reaction is extensively used by nature in several pigment-protein light-energy conversion (bacteriorhodopsin, photosynthetic yellow protein) and signaling (rhodopsin and phytochrome). The nature of the primary photomodulation and how it is related to the function of the proteins will be examined and compared with a model dye system.

References: