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Mapping energy transfer channels in fucoxanthin–chlorophyll protein complex

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Fucoxanthin–chlorophyll protein (FCP) is the key molecular complex performing the light-harvesting function in diatoms, which, being a major group of algae, are responsible for up to one quarter of the total primary production on Earth. These photosynthetic organisms contain an unusually large amount of the carotenoid fucoxanthin, which absorbs the light in the blue-green spectral region and transfers the captured excitation energy to the FCP bound chlorophylls. Due to the large number of fucoxanthins, the excitation energy transfer cascades in these complexes are particularly tangled. Energy transfer processes and coherent phenomena in the Fucoxanthin–chlorophyll protein complex, which is responsible for the light harvesting function in marine algae diatoms, were investigated at 77 K by using two-dimensional electronic spectroscopy. Experiments performed on femtosecond and picosecond timescales led to separation of spectral dynamics, witnessing evolutions of coherence and population states of the system in the spectral region of Qy transitions of chlorophylls a and c. Analysis of the coherence dynamics allowed us to identify chlorophyll (Chl) a and fucoxanthin intramolecular vibrations dominating over the first few picoseconds. Closer inspection of the spectral region of the Qy transition of Chl c revealed previously not identified, mutually non-interacting chlorophyll c states participating in femtosecond or picosecond energy transfer to the Chl a molecule. Consideration of separated coherent and incoherent dynamics allowed us to hypothesize the vibrations-assisted coherent energy transfer between Chl c and Chl a and the overall spatial arrangement of chlorophyll molecules.

Biography

Leonas Valkunas is the author of more than 350 international publications, head of the department of Theoretical Physics at Vilnius University and Head of the Department of Molecular Compounds Physics at the Center for Physical Sciences and Technology in Vilnius. He is involved in studies of primary processes of photosynthesis such as excitation dynamics and photoinduced charge separation in various photosynthetic systems based on the spectroscopic data and using various theoretical modelling approaches.

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