ENERGY AND ELECTRON TRANSFER IN PHOTOSYNTHESIS INVESTIGATED WITH MÖSSBAUER SPECTROSCOPY.

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Higher plants, algae and some species of bacteria transform and store solar energy in the form of energy-rich organic molecules. This process is called photosynthesis. The energetic compounds are further used in growth and reproduction of living organisms. In oxygen-producing organisms, water is used as a reductant. The invention of the water splitting enzyme has changed the anaerobic atmosphere into its present molecular rich composition. The presence of O_2 has decided on the direction of life evolution on the Earth.

There are two cooperating photosynthetic reaction centers in the thylakoid membranes: photosystem I (PSI) and photosystem II (PSII). These centers are complex systems of proteins containing many redox components active in an electron and energy transfer in the photosynthetic process. Especially interesting is PSII, which provides electrons and protons extracted from water to the electron and proton chain in oxygenic photosynthesis. Although, recent X-ray studies have given a better insight into the structure of photosystem II, the function of some PSII redox cofactors is not known. For example, the role of cytochrome b_{559} containing heme iron and of the non-heme iron of the iron-quinone complex is still not recognized. Cytochrome b_{559} has been suggested to participate in the cyclic or in the side path electron flow through photosystem II. These mechanisms could be responsible for its protection against photoinhibition and energy dissipation in PSII. Even more enigmatic is the action of the non-heme iron.

Mössbauer spectroscopy has been shown to be a powerful method to study valence, spin and dynamic properties of a probing atom, in our case the isotope ^{57}Fe. This spectroscopy allows to monitor diamagnetic states, which are not available by the EPR method. Mössbauer recoil-free fraction gives information on the vibrational and collective motions of the probing iron atoms and the whole matrix, respectively. The problems how the spin and valence states of the heme and non-heme iron in photosystem II as well as the rigidity of the whole system influence the linear electron transfer within PSII will be discussed. Molecular mechanism of energy dissipation by cytochrome b_{559} during photoinhibition on the donor and acceptor side of PSII will be presented.

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