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Protein dynamics tunes energy levels for efficient light harvesting in photosynthesis

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Photosynthetic antenna complexes can serve as role models for bioinspired artificial solar cells. Light harvesting and excitation energy transfer in photosynthesis is relatively well understood at cryogenic temperatures up to ˜100 K (see e.g. [1] and references therein), where crystal structures of several photosynthetic complexes including the major antenna complex of green plants (LHC II) are available at nearly atomic resolution [2,3]. The situation is much more complex at higher or even physiological temperatures, because spectroscopic properties typically undergo drastic changes at about 120 –150 K.
Recently, we have addressed this problem using a combination of quasielastic neutron scattering (QENS) and optical spectroscopy on native LHC II and mutants lacking individual pigment molecules. Absorption difference spectra of mutant LHC II reveal spectroscopic changes at ˜80 K for individual chromophores. The complementary QENS data indicate an onset of conformational protein motions at about the same temperature. This finding suggests that excited state positions in LHC II are affected by protein dynamics. In more detail, this would mean that at cryogenic temperatures the antenna system is trapped in a certain protein conformation. At higher temperature, however, a variety of conformational substates with different spectral position may be thermally accessible. This finding implies that pigment-protein interactions „fine-tune"electronic energy-levels of LHC II for efficient excitation energy transfer to the reaction center at physiological temperatures.

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