SYNERGISTIC TWO-PHOTON ABSORPTION ENHANCEMENT IN PHOTOSYNTHETIC LIGHT HARVESTING

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The grand scale fixation of solar energies into chemical substances by photosynthetic reactions of light-harvesting organisms provides Earth's other life forms a thriving environment. Scientific explorations in the past decades have unraveled the fundamental photophysical and photochemical processes in photosynthesis. Higher plants, green algae, and light-harvesting bacteria utilize organized pigment-protein complexes to harvest solar power efficiently and the resultant electronic excitations are funneled into a reaction center, where the first charge separation process takes place. Here we show experimental evidences that green algae (*Chlorella vulgaris*) *in vivo* display a synergistic two-photon absorption enhancement in their photosynthetic light harvesting. Their absorption coefficients at various wavelengths display dramatic dependence on the photon flux. This newly found phenomenon is attributed to a coherence-electronic-energy-transfer-mediated (CEETRAM) photon absorption process of light-harvesting pigment-protein complexes of green algae. Under the ambient light level, algae and higher plants can utilize this quantum mechanical mechanism to create two entangled electronic excitations adjacently in their light-harvesting networks. Concerted multiple electron transfer reactions in the reaction centers and oxygen evolving complexes can be implemented efficiently by the coherent motion of two entangled excitons from antennae to the charge separation reaction sites. To fabricate nanostructured, synthetic light-harvesting apparatus, the paramount role of the CEETRAM photon absorption mechanism should be seriously considered in the strategic guidelines.