COHERENT GROUND AND EXCITED STATES PERMIT NEARLY PERFECT ENERGY TRANSFER IN THE B850 / B875 PHOTOSYNTHETIC COMPLEX IN RHODOPSEUDOMONAS ACIDOPHILA BACTERIA

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Abstract

The purple bacteria (Rhodopseudomonas acidophila) photosynthetic light-harvesting complex (PLHC) absorbs a photon and transfers this energy almost perfectly *at room temperature (RT)* to a Reaction Center (RC), where a charge separation occurs. While there are a number of possible light absorbers involved in this process, our focus is the B850 and B875 complexes. We propose that the dominant feature of the ground states in the B850 ring and the B875 "open chain" are pseudo one-dimensional metals due to each bacteriochlorophyll a (BChl) containing a coordinated magnesium ion, Mg(2+). The Mg ion structure undergoes a static Peierls' distortion that results in "symmetry breaking" that changes the even spacing of the Mg/BChl molecules comprising the chains to the experimentally observed Mg/BChl "dimers". A charge density waves (CDW, one for each type of the two complexes) opens an energy gap in the single-particle electronic spectrum, a lowering of the electronic energy, and coherent phonons entirely spanning the ring structures. The *ground state* CDW's seem to have two functions: the first is to form a stable optical platform and the second is to suppress radical formation and energy dissipation of the coherent excited state by creating single-particle energy gaps. After *excitation* by a photon, the B850 exciton delocalizes on a portion of the ring; a second photon can form a two-level exciton-polariton [1, 2] that could be an alternative explanation for the splitting of the B850 "exciton band". The coherent polariton formed could actively participate in "uphill" electronic energy transfer (EET) [3]. Additionally, we suggest a possible energy storage mechanism, entanglement possibilities, and experimental studies to clarify these proposals.

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