Revealing the lowest states and excitation dynamics in bacterial photosynthetic reaction centers

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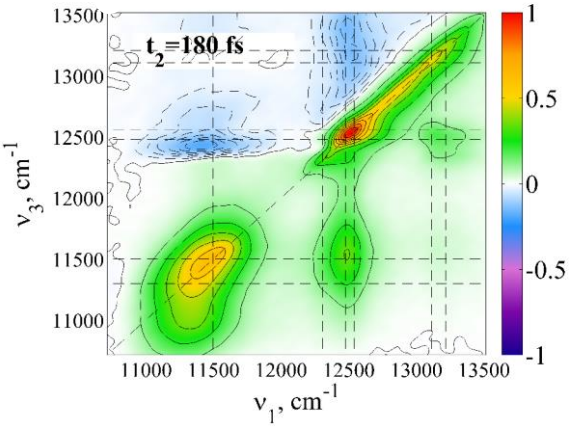
Light-harvesting complexes in photosynthetic organisms absorb sunlight and transfer energy to reaction centers (RCs), where the primary charge separation takes places. Notably the general structural arrangement of RCs is preserved throughout photosynthetic organisms and therefore many functional features of RCs are expected to be similar. In all of the RCs the primary electron donor is the special pair of chlorophyll-type molecules. It is tentatively assumed that the lowest-energy state is the special pair exciton state often coupled to a putative charge transfer state. However, despite numerous spectroscopic RC studies carried out over the decades, uncertainties remain regarding the lowest functional states in photosynthetic RCs.



Absorptive 2D spectrum of the purple bacteria RC at 77K

To study the lowest states in bacterial photosynthetic RC we used two-dimensional electronic spectroscopy (2DES) at cryogenic temperatures, which provides high spectral and time resolution. Mapping the spectral signatures in two dimensions and following their evolution in time enables unraveling otherwise congested transitions and excitation dynamics. We employed 2DES at 77 K to investigate the lowest states and their dynamics of the Q- type RC from purple non-sulfur bacteria [1] and FeS-type RC from green sulfur bacteria [2,3]. The picture that we uncover is more complex than what was thought before, as we observe functional involvement of additional low energy states.

References:

[1] A. Vermeglio, G. Paillotin, BBA **681**, 32 (1982).

[2] G. Hauska, T. Schoedl, H. Remigy, G. Tsiotis, BBA **1507**, 260 (2001).

[3] J. Dostal, J. Psencik, D. Zigmantas, Nat. Chem. **8**, 705 (2016).