Vibronic quantum coherence at ultralow temperatures in photosynthetic protein complexes

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Synthesizing quantum coherence in artificial nanosystems might be inspired by the study of the exciton dynamics in natural photoactive molecular complexes. In this talk, I will address the fundamental question under what conditions such natural systems could show dynamic quantum coherent effects. We have revisited this in a joint experimental and theoretical effort studying the quantum exciton dynamics in the Fenna-Matthews-Olson (FMO) complex by two-dimensional electronic spectroscopy at different temperatures. Our recent experimental results in a broad range down to very low temperatures reveal electronic coherence to occur on a time scale of 500 fs at 20 K. They complete earlier results obtained under ambient conditions where we have found that at room temperature, electronic coherence fades out within 60 fs. Yet, the new low-temperature data allow us to capture solid evidence of quantum coherence at ultralow temperature and to clearly disentangle electronic and vibrational dynamic coherence. The observed long-lived oscillations are due to Raman vibrational modes on the electronic ground state. The experimental data are used to establish a carefully parametrized model.