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Title: Coherent Effects in Pigment-Protein Complexes: Vibronic Renormalisation of System Parameters in Complex Vibrational Environments

The primary steps of photosynthesis rely on the generation, transport and trapping of excitons in pigment-protein complexes (PPCs). Generically, PPCs possess highly structured vibrational spectra, combining many discrete intra-pigment modes and a quasi-continuous of protein modes, with vibrational and electronic couplings of comparable strength. The intricacy of the resulting vibronic dynamics poses significant challenges in establishing a quantitative connection between spectroscopic data and underlying microscopic models. By considering two model systems, namely the water-soluble chlorophyll-binding protein of cauliflower and the special pair of bacterial reaction centers, we show how to address this challenge using numerically exact simulation methods. We demonstrate that the inclusion of the full multi-mode vibronic dynamics in numerical calculations of linear optical spectra lead to systematic and quantitatively significant corrections to electronic parameter estimation. These multi-mode vibronic effects are shown to be relevant in the longstanding discussion regarding the origin of long-lived oscillations in multidimensional nonlinear spectra.