SC3.6 - Probing photosynthetic energy transfer at the quantum/classical border

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Quantum mechanics diverges from the classical description of our world when very small scales or very fast processes are involved. It is relevant when explaining the properties of matter and its interactions with energy on the scale of a few hundreds of atoms. At room temperature, this scale is similar to the dimensions of proteins or complexes of proteins, ranging from 1-100 nm. Unlike classical mechanics, quantum effects cannot be easily related to our everyday experience and the result of quantum behavior are often counterintuitive to us. Nevertheless, the dimensions and time scales of the photosynthetic energy transfer processes puts them close to the quantum/classical border, so bringing them into the range of measurable quantum effects. One of these effects, quantum coherence (the ability of energy to travel through multiple paths simultaneously), was suggested to play a role in photosynthesis. Our work on energy transfer in the phycobilisome antenna of desert crust cyanobacteria suggests that effects on the quantum classical border may play a role in controlling the efficiency of energy transfer in the hydrated (active) and desiccated (inactive) states[1,2]. Based on these data and on research performed by other groups in the field, we suggest that photosynthetic processes can take advantage of the sensitivity of quantum effects to the environmental "noise" as means of tuning Exciton Energy Transfer efficiency.

1. Bar Eyal, L. et al. Changes in aggregation states of light-harvesting complexes as a mechanism for modulating energy transfer in desert crust cyanobacteria. Proc. Natl. Acad. Sci. 114, 9481–9486 (2017).

2. Bar-Eyal, L. et al. An easily reversible structural change underlies mechanisms enabling desert crust cyanobacteria to survive desiccation. Biochim. Biophys. Acta - Bioenerg. 1847, 1267–1273 (2015).