Quantum entanglement in photosynthesis and evolution

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Recently, academic debate has been swirling around the existence of unusual quantum mechanical effects in the most ubiquitous of phenomena, including photosynthesis, the process by which organisms convert light into chemical energy.

In particular, physicists have suggested that entanglement (the quantum interconnection of two or more objects like photons, electrons, or atoms that are separated in physical space) could be occurring in the photosynthetic complexes of plants, particularly in the pigment molecules, or chromophores. The quantum effects may explain why the structures are so efficient at converting light into energy -- doing so at 95 percent or more.

In a paper in *The* Journal of Chemical Physics, which is published by the American Institute of Physics, these ideas are put to the test in a novel computer simulation of energy transport in a photosynthetic reaction center. Using the simulation, professor Shaul Mukamel and senior research associate Darius Abramavicius at the University of California, Irvine show that long-lived quantum coherence is an "essential ingredient for quantum information storage and manipulation," according to Mukamel. It is possible between chromophores even at room temperature, he says, and it "can strongly affect the light-harvesting efficiency."

If the existence of such effects can be substantiated experimentally, he says, this understanding of quantum energy transfer and charge separation pathways may help the design of solar cells that take their inspiration from nature.

More information: The article, "Quantum oscillatory exciton migration in photosynthetic reaction centers" by Darius Abramavicius and Shaul Mukamel will appear in The Journal of Chemical Physics. See: jcp.aip.org/

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