Quantum biology and nanobiophysics: Examples in the context of photosynthesis

Quantum biology and nanobiophysics are emerging research fields with a broad scope of scientific and technological applications. Nanobiophysics uses the principles of physics to better characterise and understand the complex molecular machines found in living organisms. Life operates at the nanoscale, using remarkable molecular machines called proteins to exhibit almost all functions in the "factory" known as the cell. The hot and wet environments in which proteins are embedded hardly bring to mind complex quantum mechanics. Yet, non-trivial quantum effects play a vital role in photosynthesis and are thought to be important in various other processes of life. Proteins can bind various molecules to perform different biological functions. The light-harvesting proteins of photosynthetic organisms bind a dense arrangement of chromophores – light-sensitive molecules that enable the light-harvesting proteins to rapidly transport the absorbed solar energy to the reaction centre where it is converted with a near-unity quantum efficiency into a more stable form. At the same time, these proteins function as smart, finely regulated nanoswitches, capable of switching between different biological functions by exhibiting only subtle structural changes.

In this presentation I will briefly introduce quantum biology and nanobiophysics and give a few examples of our latest research on photosynthetic light-harvesting proteins.