Overview of the quantum biology session at the 19th IUPAB congress and 11th EBSA congress

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Alexandra Olaya-Castro (UCL) and Martin Plenio (University of Ulm) are among the pioneers of quantum biology (Al-Khalili and McFadden 2014). In her presentation, Olaya-Castro describes the current research on photon and electron counting statistics of single photosynthetic complexes to show the potential of these techniques in unveiling quantum effects in molecular systems.

Plenio argues, in his talk, that bio-molecular systems are mechanical objects that exhibit vibrations at a broad range of frequencies extending into the infrared (Chin et al. 2013). In pigment–protein complexes, this has the remarkable consequence that electronic motion is coupled to these vibrations and may lead to a prolongation of electronic coherence, as well as enhanced transport and charge separation (Huelga and Plenio 2013). Experiments are now beginning to achieve the unambiguous demonstration of these effects and recent studies in organic photovoltaics have not only observed vibronic coupling but also demonstrated that it is essential for efficient charge separation.

Rienk van Grondelle (VU Amsterdam) has developed theoretical tools to understand complex spectroscopic data. Using multi-dimensional electronic spectroscopy, he recently showed that ultrafast charge separation is driven by specific molecular vibrations that allow electronic coherences to stay alive. He proposed a molecular model for photoprotection and demonstrated that the major plant light harvesting

complex operates as a nanoswitch, controlled by its biological environment. These results, of utmost importance for our understanding of photosynthesis, inspire technological solutions for artificial and/or redesigned photosynthesis, as a route towards sustainable energy production (Scholes et al. 2011).

Leonor Cruzeiro points out that protein aggregates are thermodynamically more stable than the native state, suggesting that the latter cannot be the global free energy minimum. Her simulations indicate that the native state is just one of the many kinetic traps that each protein may fall into. She proposes that the nascent chain of all proteins is helical and that the first step of folding *in vivo* is a local impulse in a specific amide I group.

Michael Green (City College of New York) and his group have carried out large-scale quantum molecular dynamics calculations on particle transport across cell membranes. These results are consistent with the motion of protons as a key to opening and closing the channels. He argues that the application of quantum calculations in biophysics is of significant importance.

Pierre-André Cazade (University of Limerick) discusses his group's multi-scale modelling of large biomolecular complexes, such as cellulosome, a complex biological nanomachine composed of multiple proteins connected by flexible linker regions. Their work exploits the latest developments in out-of-equilibrium simulation methods, accelerated sampling and analysis methodologies to extract relevant information from very large datasets.

Compliance with ethical standards

Conflict of interest Jim Al-Khalili declares that he has no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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