Quantum Entanglement in Photoactive Prebiotic Systems

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Together with my collaborators I have been investigating the self-assembly of molecules that result in supramolecular bioorganic and minimal cellular systems, as well as the biochemistry of these assemblies. The self-assembly and biochemistry depend on quantum mechanics laws which induce hydrogen and Van der Waals bondings [1–3]. Therefore our work has been done through modelling based on quantum mechanical time dependent density functional theory, which also makes it possible to study quantum entanglement in such systems (TD-DFT).

In the work presented here, quantum entanglement takes the form of a quantum superposition of the active components in synthesized self-assembled and self-replicating living systems. When a quantum calculation of an entangled biosystem is made that causes one protocell photoactive biomolecule of such an entangled pair to take on a definite value (e.g., electron density redistribution tunnelling or electron spin density redistribution tunnelling), the other protocell photoactive biomolecule of this pair will be found to have taken the appropriately correlated value (e.g., electron density redistribution tunnelling or electron spin density redistribution tunnelling) in two quantum entangled excited states of this bicellular system (see Figure 1). In our simulations, the starting separation distance of the supramolecular bio systems changed during geometry optimization procedures, taking on final values that mimic those associated with real-world intermolecular interaction processes. Furthermore, the modelling indicates that quantum entanglement occurs between the prebiotic subsystems which enhances the photosynthesis of the combined systems. The enhancement occurs because two additional quantum entangled excited states are created through the simultaneous excitation of the combined system's two prebiotic kernels or. two protocells. The additional photosynthesis made possible by the quantum entanglement potentially provides a selective advantage through an enhancement of usable energy leading to faster growth and self-replication of minimal living cells [3-8], which in turn can lead to accelerated evolution.

Living systems that are self-assembled and self-replicating exist in wet and warm environments where stochastically moving supramolecular subsystems continuously generate and destroy quantum entangled states by non-equilibrium effects. While no static entanglement exists, quantum entanglement nonetheless temporarily occurs amongst the biomolecules inside the combined system or between the living subsystems, *i.e.* between two protocells or two prebiotic kernels [3, 4].

This warm quantum coherence is proposed by others as a basis for DNA stability and for the understanding of brain magnetic orientation during migration in more than 50 species of birds, fishes and insects [4]. Experimental evidence also exists for quantum-coherence as a basis for more efficient light-harvesting in plant photosynthesis [4]. Furthermore, quantum entanglement exists between supramolecules used in the sense of smell and in the microtubules of brain neurons where it gives rise to critical quantum vibrations [6].

Using quantum mechanical investigations, we have now started to design quantum entanglement molecular logical devices which hold promise for use in nano-medicine biorobots to fight molecular diseases such a cancer tumors, and against the new kinds of synthesized microorganisms and nano guns [4, 5, 8, 9]. Our current research concerns quantum entanglement investigations phenomenon in neuron synapses and neural networks.

Most important associated publications

1. Arvydas Tamulis, Mantas Grigalavicius; The emergence and evolution of life in a "fatty acid world" based on quantum mechanics; *Orig Life Evol Biosph;* **41**: 51-71, 2011.
2. Arvydas Tamulis and Mantas Grigalavicius; Molecular Spintronics Control of Photosynthesis in Artificial Cell; *Journal of Computational and Theoretical Nanoscience;* **10**: No. 4, 989-995, 2013.
3. Arvydas Tamulis, Mantas Grigalavicius and Jonas Baltrusaitis; Phenomenon of Quantum Entanglement in a System Composed of Two Minimal Protocells; *Origins of Life and Evolution of Biospheres;* **43**: 49–66.
4. Arvydas Tamulis, Mantas Grigalavicius; Quantum Entanglement in Photoactive Prebiotic Systems; *Systems and Synthetic Biology;* **8**, 117-140, 2014.
5. Arvydas Tamulis, Mantas Grigalavicius, Sarunas Krisciukaitis; Quantum Entanglement in a System Composed of Two Prebiotic Kernels with Molecular Spintronics Logic Devices for Control of Photosynthesis; *Journal of Computational and Theoretical Nanoscience;* **11**, 1597-1608, 2014.
6. Arvydas Tamulis and Mantas Grigalavicius; Quantum Mechanical Origin of Fatty Acid Life and Correlations with Anthropic Principle and Old Testament; *Quantum Matter* (of the American Scientific Publishers); **3**, 460-468, 2014.
7. A. Tamulis, L. Berteska, M. Grigalavicius, J. Baltrusaitis; Quantum Dynamics of Self-Assembly of Minimal Photosynthetic Cells; *Quantum Matter;* vol. **4**, 2015 (*in printing process*).
8. A. Tamulis, M. Grigalavicius, J. Serbenta, K. Plausinaitis; Quantum Entangled Single BioOrganic Supramolecules as Light Absorbing and Light Emitting Logical Devices; *Journal of Computational and Theoretical Nanoscience;* vol. **12**, 2015 (*in printing process*).
9. A. Tamulis, Quantum entanglement in photoactive prebiotic systems, 3rd International Conference and Exhibition on Metabolomics & Systems Biology, March 24-26, 2014 Hilton San Antonio Airport, San Antonio, USA, book of abstracts at: http://omicsonline.org/2153-0769/2153-0769_Metabolomics-2014_Accepted-Abstracts.digital/#?page=8

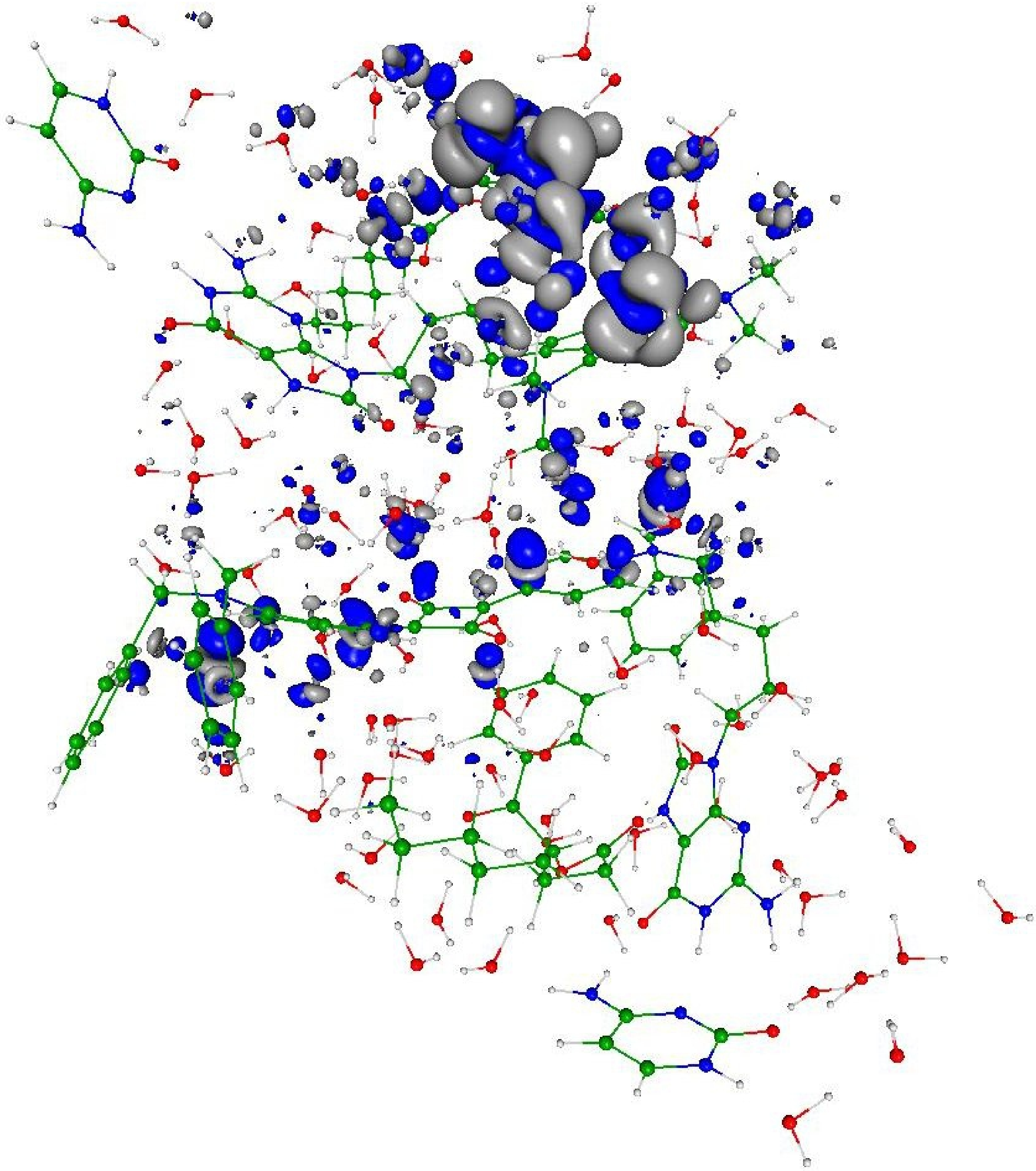

Figure 1: The enclosed figure shows the quantum entanglement phenomenon occurring in 2 self-assembled protocellular subsystems, *i.e* in two prebiotic kernels [3]. The quantum TD-DFT based modelling indicates that the 2 subsystems become closely associated to the point where photoexcited electron charge redistribution tunnelling occurs from one protocell to the other resulting in an exchange of energy and information. Carbon atoms and their associated covalent bonds are shown as green spheres and sticks, hydrogens – light grey, nitrogens – blue, oxygens – red. Electron cloud holes are indicated by the dark blue colour while the transferred electron cloud location is designated by the grey colour signifying electron charge tunnelling.

The electron charge density redistribution tunnelling is associated with the 6^{th} (467.3 nm) excited state which quantum entangled with 4^{th} (471.2 nm) excited state. The transition in the 6^{th} (467.3 nm) excited state is mainly from squarine molecule of the first subsystem situated at the bottom of bicellular system to precursor of fatty acid (pFA) of the second subsystem (at the top), with a little from the 1,4-bis(N,N-dimethyl-amino)naphthalene (at the top-right) to the same pFA molecule of the second subsystem (at the top). Due to the elementary transition is with a small weight in the 4^{th} excited state, exist small quantum entangled electron transition from squarine molecule in the first subsystem to the pFA molecule in the second subsystem. Despite that the oscillator strengths associated with the quantum entangled excitations in 4^{th} and 6^{th} states are relatively small, this phenomenon allows to operate with information and energy transfer from one subsystem to another and *vice versa*.

The nonlinear quantum interactions compress the overall molecular system resulting in a smaller gap between the HOMO and LUMO electron energy levels which allows enhanced redistribution of photoexcited electrons densities from the squarine sensitizer and the (1,4-bis(N,N-dimethylamino)naphthalene) to the pFA molecule resulting in its cleavage. The new fatty acid joins the existing minimal cell thus increasing it in size. After reaching some critical size, the minimal cell should divide (i.e. self-replicate) into two separate smaller minimal cells.