Model of Biological Quantum Logic in DNA

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Abstract

The DNA molecule has properties that allow it to act as a quantum logic processor. An electron or its quantum state can be coherently conducted or quantum teleported longitudinally along the coherence provided by the pi stacking of the nucleotide bases of the DNA molecule. (Rieper, et al., 2011) As an electron or its quantum state is conducted or teleported longitudinally along the DNA molecule it is simultaneously subject to an electron spin filtration effect that is brought about by interaction of the helicity of the DNA molecule with the spin of the electron (Göhler, et al., 2011), and this provides the means for selective deposition of an individual electron, or the reading of an individual electron state, into a specific individual nucleotide quantum gate as determined by the electron spin direction and the coherence distance along the DNA molecule. Quantum logical operations in DNA occur via a quantum logic gate capability in each nucleotide that is provided by a logically and thermodynamically reversible Szilard engine function (Mihelic, 2012) of the deoxyribose moiety through which coherent electron spin is held in an enantiomeric symmetry between the C2-endo and C3-endo enantiomers in the nucleotide. The symmetry break that provides for quantum decision in the system is determined by the spin direction of an electron that has an angular orbital momentum that is sufficient to overcome the energy barrier of the double well potential separating the C2-endo and C3-endo deoxyribose enantiomers. The energy barrier of that double well potential (Levitt, et al., 1978) is appropriate to the Landauer limit of the energy necessary to randomize one bit of information, thereby enabling chirality determination by electron spin at an energy level appropriate to quantum logical operation. The individual nucleotide quantum gates are held in coherent concatenation through the pi stacking interactions of the nucleotide bases in the DNA molecule, and longitudinal coherence distances can be affected by deoxyribose enantiomeric selection that can bring about a change in the orientation of the nucleotide's base by a change in the N-glucosidic bond angle. The crystalline nature of the DNA molecule allows for extended temporal coherence of the system through its precisely designed nanospace which limits the degrees of freedom upon which entropic factors such as temperature or solvation can have any effect, and within which inherently fault-tolerant topological quantum logic operations can take place.

References

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