Quantum effect at biological system

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ABSTRACT

Biological processes are the series of events or molecular functions vital for a living organism to live. Studying biological processes helps scientists learn more about human health and the etiology of diseases, and paves the way towards personalized medicine. Analysis of biological processes has been mostly based on the Newtonian equation of motions. However, the Newtonian methods are unable to determine the mechanisms of biological cells and biological networks, particularly, they fail to explain how biological systems interact with the environment.
Quantum mechanics, the physics of the microscopic worlds, has profound capabilities in explaining biological processes. In addition, biological processes are usually highly nonlinear, and therefore, chaos theory can be applied to model the nonlinear behaviors in these processes. The combination of chaos theory and quantum mechanics provide a unique opportunity to investigate biological systems at the edge of chaos, the region between order and disorder.
In the present work, we aim to study coherence - decoherence occurrence in biological systems, a symmetry breaking process at the edge of chaos [1].

Keywords: *biological system, chaos theory, coherence, decoherence, topology*

1. INTRODUCTION

Entanglement and (de-)coherence arguably define the central issues of concern in present day quantum information theory. In state-of-the-art experiments, ever larger numbers of quantum particles are entangled in a controlled way, and ever heavier particles are brought to interfere. Moreover, entanglement is no more considered as just an important resource for quantum information processing, but it allows for a better characterization of “complex” quantum systems, realized, e.g., in engineered, interacting many-particle systems. Thus, there is a permanent and in many respects enhanced need for a deeper understanding of – and fresh approaches to – quantum entanglement, notably in high-dimensional quantum systems. Equally so, entanglement being a consequence of the quantum mechanical superposition principle for composite systems, we need a better understanding of the environment-induced destruction of coherent superposition states and of those interference phenomena that may survive the action of a noisy environment. Quantum systems display properties that are unknown for classical ones, such as the superposition of quantum states, interference, or tunneling.

1.1 Coherence

In physics, coherence means a property of waves – coherent waves are able to interfere as they have a constant phase relation.
Physicists distinguish between two types of coherence:
Spatial (transverse) coherence
Temporal (longitudinal, spectral) coherence
In order to observe interference patterns both types of coherence must exist.

Some light sources such as lasers already have a high spatial and temporal coherence due to their design. For some years such sources are also available for atoms; they are based on Bose-Einstein condensates and are able to emit coherent matter waves. However, for large molecules we often have to work with incoherent thermal sources. In the case of such sources, say, the wave functions of two molecules leaving the source from two far apart regions of the oven nozzle do not have a pre-defined phase relation to each other.