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Research Article

On Macroscopic Quantum Phenomena in Biomolecules and Cells: From Levinthal to Hopfield

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In the context of the macroscopic quantum phenomena of the second kind, we hereby seek for a solution-in-principle of the long standing problem of the polymer folding, which was considered by Levinthal as (semi)classically intractable. To illuminate it, we applied quantum-chemical and quantum decoherence approaches to conformational transitions. Our analyses imply the existence of novel macroscopic quantum biomolecular phenomena, with biomolecular chain folding in an open environment considered as a subtle interplay between energy and conformation eigenstates of this biomolecule, governed by quantum-chemical and quantum decoherence laws. On the other hand, within an open biological cell, a system of all identical (noninteracting and dynamically noncoupled) biomolecular proteins might be considered as corresponding spatial quantum ensemble of these identical biomolecular processors, providing spatially distributed quantum solution to a single corresponding biomolecular chain folding, whose density of conformational states might be represented as Hopfield-like quantum-holographic associative neural network too (providing an equivalent global quantum-informational alternative to standard molecular-biology local biochemical approach in biomolecules and cells and higher hierarchical levels of organism, as well).

1. Introduction

On Macroscopic Quantum Phenomena. Initially, *quantum mechanics* appeared as a theory of *microscopic physical systems* (elementary particles, atoms, and molecules) and phenomena at small space-time scales; typically, quantum phenomena are manifested at dimensions smaller than 1 nm and time intervals shorter than 1 μs. However, from the very beginning of the quantum mechanical founding the question of its *universality* was raised, that is, the question of general validity of the quantum-physical laws for *macroscopic phenomena*, usually treated by the methods of classical physics. In the history of quantum physics, and especially quantum mechanics, this question has been temporarily put aside for very different reasons, being considered as a difficult scientific problem. The situation is additionally complicated by the existence of different schools of quantum mechanics, arguing about physical-epistemological status of the so-called *collapse (reduction) of the wave function*. In this respect the situation is not much better today, and it can be said freely that the problem of universal validity of quantum mechanics is still open [1–15]. To this end, Primas [16] emphasizes the following.

"If we consider quantum mechanics as *universally valid* in the atomic, molecular, mesoscopic and engineering domain,