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PD en Ciencia y Tecnología Cuántica

ARTIFICIAL LIFE IN QUANTUM TECHNOLOGIES

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We have designed a quantum protocol for the realization of Artificial Life in an experimental quantum platform. Our framework allows to mimic a natural selection scenario where the living units, or individuals, are able to self-replicate, mutate, age, displace, interact and finally die. The challenge is to provide a model for the evolution of individuals that when scaled to a big number of units is able to reproduce specific behaviors of a complex interacting ecosystem. This problem has been addressed in the classical regime in famous creations as “The Game of Life”, “Tierra” or “Avida” among others, which originated the research field of Computational Artificial Life that has already produced several applications in the study of animate matter. The novelty of our model is that the encoding of information and the physical processes that realize the time evolution are quantum. In particular, we employ qubits as registers for individuals and quantum gates as building blocks for the natural selection processes. A qubit is a reduced effective description of a physical system, which can only be measured in two physical states labeled by $|0\rangle$ and $|1\rangle$, but is allowed to exist in any linear superposition of them. In the model, each individual is composed by two qubits, representing the genotype and the phenotype, where the genotype is the register for the information that is inherited and transmitted while the phenotype accounts for the expression of the individual within the environment. The individuals displace randomly along a two dimensional spatial grid and interact when they share the same location. Together with the development of the model, we have analyzed the feasibility of a possible experiment in a selection of the most controllable quantum platforms. We show that current technological resources could be enough to support the realization of our “Quantum Artificial Life”.