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Quantum Entanglement and Cellular Automata

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Abstract.-Here I propose a new perspective to analyze the thorny problem posed by the continuous creation and destruction of natural quantum entanglements anywhere in the universe and at any point in its history.

Keywords: Entangled particles, quantum decoherence, cellular automata.

1. Discussion

The production of entangled particles has occurred and continues to occur continuously in our observable universe. The same can be said of the physical interactions that break it down. We are therefore justified in considering any pair of such entangled particles at any moment in the long history of the universe. Let these two entangled particles be, for example, two photons γ_1 and γ_2 separated by a distance of, for example, one light-year. Suppose that at a certain instant t the photon γ_1 undergoes a natural physical interaction that causes its spin to collapse (quantum decoherence), for example to the value of +1. At that very instant t, the spin of γ_2 also ceases to be in a superposition of states and takes the value of -1. The problem raised here has nothing to do with the transmission of information or the presence of observers, but rather with **physical causality**. This is because photon γ_2 does not undergo any physical interaction that could produce this change in the state of its spin, a change that occurs at precisely the same instant t at which the photon γ_1, located one light-year away, undergoes the actual physical interaction that causes the change in its spin state. We therefore have two simultaneous changes, one of which appears to be **acausal**.

I am not convinced by the explanations that different interpretations of quantum mechanics give to these facts. First, I eliminate all those in which rational observers play a relevant role, because I am considering natural superpositions and decoherences that occur without the presence of rational observers at any moment in the long history of the universe (in most of which rational observers did not even exist). C. Everett's interpretation of multiple universes seems excessively crude and unsightly to me: it would be a potentially infinite waste of universes to explain a simple physical interaction, billions of which appear to be continuously occurring in our universe. Only the Broglie–Bohm's hidden variable theory could have some connection with the suggestion proposed below [1].

In my opinion, cellular automata theory could serve as an initial theoretical tool for constructing a finitist and discrete model of the universe and its evolution: each cell of the automaton would be an indivisible unit of the discrete physical space[1] (qusit, quantum space unit) whose state is updated in each successive indivisible unit of a discrete time (qutit, quantum time unit), updating being understood as the simultaneous application of the rules of the automaton to each of its cells, an update that affects at the same time (in the same qutit) all qusits containing entangled and non-entangled objects.

Naturally, the purpose of this brief discussion is simply to suggest a new (perhaps not so new [2]) line of research into the problem posed by the continuous creation and destruction of quantum entanglements throughout the history of the universe. This line of research would also solve the old **problem of change** posed by the pre-Socratics, which remains unresolved and has been completely forgotten by modern physics ([4, 3, 5]).

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