# On the physical nature of the quantum Zeno effect

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Most of the experimental evidence for the existence of the quantum Zeno effect is a manifestation of the fundamental properties of quantum physics – its time reversal noninvariance.

The quantum Zeno effect was invented by theorists. “Frequent measurement slow the evolution of a quantum system, hindering transitions to states different from the initial one. This phenomenon, known as the quantum Zeno effect (QZE) … , is a consequence of general features of the Schrodinger equation, that yield quadratic behavior of the survival probability at short times …” [1]. It is usually defined as ”the inhibition of transitions between quantum states by frequent measurements” [2]. There is also somewhat supernatural definition: ”It describes the situation that an unstable particle, if observed continuously, will never decay” [3].

The quantum Zeno effect is extremely widely mentioned and discussed in the scientific literature. Mostly by theorists. At the same time, the physical nature of the effect is not discussed. The authors limit themselves to mathematical modeling or references to the collapse of the wave function.

In contrast, there are few experimental works. Their results are mostly inconclusive. Several works with atoms and ions are highlighted here, which are most often referred to as experimental proof of the existence of the quantum Zeno effect [2, 4, 5]. These are really very high-quality and spectacular experimental results, which outwardly are very similar to the manifestation of the Zeno effect.

However, these experiments have another, quite physical explanation. Earlier in [6], a rather vague attempt was made to give such a physical explanation. Now, apparently, it is time to concretize it. The fact is that the "measurement" does not hinder the decay of the initial quantum state of the system, but facilitates the return of the quantum system to the initial state. All this is due to the fact that the differential cross section of the quantum process reversed to the initial state can be very large (several orders of magnitude greater than that of the forward process). This is a consequence of the nonequivalence of forward and reversed processes in quantum physics [7].

This nonequivalence also implies that the quantum system has some kind of memory about its initial state. Memory manifests itself through the inequality of differential cross-sections of forward and reversed processes. This memory looks like the physical equivalent of entropy. Memory can accumulate (be buried, be hided, weakens). As a result, the differential cross-section of the reversed process decreases. Repeated "measurements" contribute to the regeneration, "refreshment" of this memory.

The effects studied in [2, 4, 5] are a consequence of four-photon mixing, as a result of which the quantum system returns to its initial state. Such quantum processes are very widespread in nonlinear optics. They underlie such effects as electromagnetically induced transparency [8], photon echo, coherent population trapping, laser-induced molecular alignment [9] and others.

For a detailed experimental study of all these effects, it is necessary to measure the differential cross sections of forward, reversed, and partially reversed quantum processes. It cannot be said that this is a very difficult problem. But to begin such work, physicists (first of all, theorists) must recognize at last the fact of the nonequivalence of forward and reversed processes in quantum physics. And this is a really big problem. Moreover, this is not a physical problem. For many years, we have more than enough direct and indirect experimental evidence of the nonequivalence of forward and reversed processes in quantum physics (its time reversal noninvariance) [7, 10, 11].

Thus, the quantum Zeno effect is probably the same myth and sophism as the original Zeno arrow paradox. We have long needed a paradigm shift in quantum physics and the beginning of a conscious experimental study of the noninvariance of time reversal in it [12].

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