On the physical nature of the superposition of states in quantum physics.

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The note is devoted to the necessity of experimental study of differential cross sections of forward and reversed quantum processes.

Quantum physics claims that in the microworld there are quantum states and the transition from one state to another occurs by a jump. This is on the one hand.

On the other hand, the fundamental principle of quantum mechanics is the concept of a superposition of states, that is, a superposition of alternative (mutually exclusive) states or the existence simultaneously in several states. An important consequence of quantum superposition is quantum entanglement – a quantum mechanical phenomenon in which different parts of a quantum system are interdependent.

Obviously, from a physical point of view, these two approaches contradict each other. But physicists have long been accustomed to this. For many years, finding a mathematical description of quantum phenomena is more important task than explaining their physical nature. Impressive results have been achieved here. However, the debate about the physical interpretation of these mathematical descriptions seems endless.

Is it possible to remove this physical contradiction? It is important to note here that the superposition of quantum states is not a real state of things - it is a mathematical description. What is the physical equivalent of the concept of the superposition of quantum states?

In our opinion, the key to understanding the physical nature of the concept of quantum superposition of states lies in the field of symmetry of quantum processes.

Mathematicians have the concept of unitary transformations that are mostly used in quantum mechanics. This is the basis of the still widespread view that all laws of physics are symmetrical in time [1-5]. However, the reversal of time is an anti-unitary transformation. Therefore, one would expect that the physical laws in the quantum world would be asymmetric in time. Thermodynamics also prompts such an assumption.

Surprisingly, but for many years we have a number of direct and many indirect experimental proofs of the nonequivalence of forward and reversed processes in quantum physics (in nonlinear optics) [6]. Differential cross sections of forward and reversed quantum transitions differ by many orders of magnitude. This is the real physical basis of all nonlinear optics.

The nonequivalence of forward and reversed processes in quantum physics presupposes the existence of a quantum system's memory of its initial state. Without such a memory, it would not be able to distinguish a forward process from a reversed one. This memory is the physical equivalent of the concept of quantum superposition of states. **So, a quantum system is always in one concrete quantum state, but it has a memory of previous states.** This memory also looks like the physical equivalent of entropy.

As a result, we have the following physical definition: *a superposition of quantum states (entanglement) is the memory of a quantum system about its initial state, which manifests itself through the inequality of differential cross sections of forward and reversed processes.* The question of the storage, accumulation of quantum memory (entropy) and its possible nonlocality remains open and needs experimental study.

It is obvious that in order to study the memory of quantum systems, experimental study of differential cross sections of forward and reversed quantum transitions (processes) is necessary. This is not a very difficult task. However, for many years I cannot convince our experimenters to begin such work.

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