Noise is not necessarily detrimental to quantum devices

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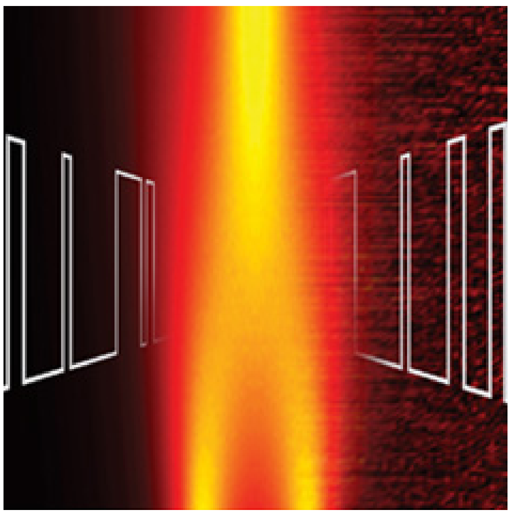

The researches of the Aalto University and the University of Oulu have succeeded to simulate a phenomenon called motional averaging, which demonstrates that in certain conditions externally-induced fast fluctuations in energy can help stabilize the state of the system. The study shows that noise is not necessarily detrimental to the functioning of quantum devices such as superconducting quantum bits, but under certain circumstances noise can even improve their characteristics.

The researchers also demonstrated that quantum coherence is maintained in certain hybrid states that are combinations of the states of the atom and those of the modulating field. This could lead to novel ways of realizing so-called quantum gates, that is, the elementary operations of future quantum computers. The research was published in the scientific journal *Nature Communications* at the end of January.

"In natural set-ups, like in liquids or gases, the energy fluctuations of atoms can be modified only indirectly, for instance, by changing the temperature. We have recreated this phenomenon in an electrical circuit that artificially mimics an atom," says doctoral researcher Matti Silveri from Oulu University.

"On a fundamental level, one can see this phenomenon as a way to go around the restrictions imposed by the energy-time uncertainty relation," adds docent Sorin Paraoanu from Aalto University.

The measurements were conducted by applying a combination of microwave electronics and cryogenic techniques to a superconducting quantum circuit, where the energy fluctuations of the artificial atom were induced and controlled externally by a random signal generator. The research is a first step in the direction of emergent quantum technologies, based on the principles of quantum mechanics. Circuits such as those studied by the team are expected to perform simulations of quantum many-body phenomena enabling, for example, predictions of the properties of materials to an accuracy which is currently not available.

More information: Link to the published article in Nature Communications 4, 1420 (2013).

Provided by Aalto University