# New 'quantum distillation' method allows measuring coherence of quantum states

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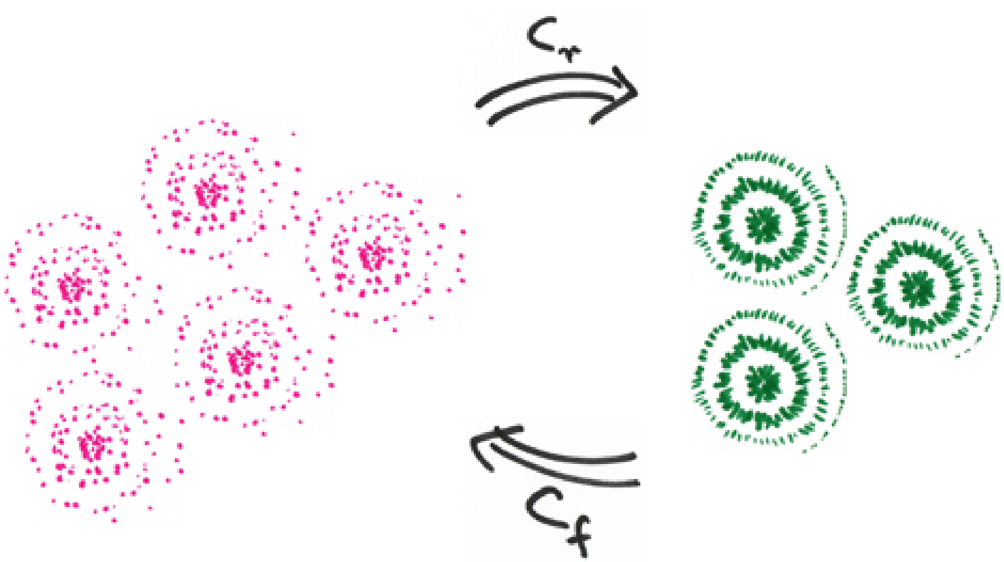


coherence

One of the main principles of quantum physics is the superposition of states. Systems exist simultaneously in different states until they are measured and the system opts for one of the possibilities. As long as the superposition lasts, the system is said to be in a coherent state. In real systems, sets of diverse elemental particles or atoms exist in a state of superposition, for example, in different positions simultaneously, with different levels of energy, or with two opposite spin orientations. These have weak coherence—the superposition is broken easily by the vibrations associated with temperature and the interactions with the environment.

In the scientific article, researchers from the Universitat Autònoma de Barcelona Department of Physics Andreas Winter and Dong Yang propose a groundbreaking method to measure the degree of coherence in any given quantum state. The researchers created simple formulas to calculate how much "pure coherence" is contained in a given quantum state by answering two fundamental questions: How efficiently can one transform the state into "pure coherence?" And how efficient is the reverse process?

"At first, the quantum state must be distilled. We must see how much coherence can be extracted from it," explains Andreas Winter. "Later, it once again forms a noisy state in which the coherence is diluted."

The distillation and dilution process allows measuring the strength of coherence of the initial state of superposition with experiments tailored to each particular case. This is an outstanding contribution to the study of quantum physics, given that "traditionally, to measure the degree of coherence of a superposition, it was necessary to measure the visibility of interference fringes, linked to standardised experiments," Winter says. "With our approach, the experiment can be adapted to every state in order to make the quantum coherence manifest itself better."

**More information:** Andreas Winter et al. Operational Resource Theory of Coherence, *Physical Review Letters* (2016). DOI: 10.1103/PhysRevLett.116.120404

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