



"Hot" Schrodinger cat states created

Quantum states can only be prepared and observed under highly controlled conditions. A research team from Innsbruck, Austria, has now succeeded in creating so-called hot Schrodinger cat states in a superconducting microwave resonator. The study, recently published in *Science Advances*, shows that quantum phenomena can also be observed and used in less perfect, warmer conditions.

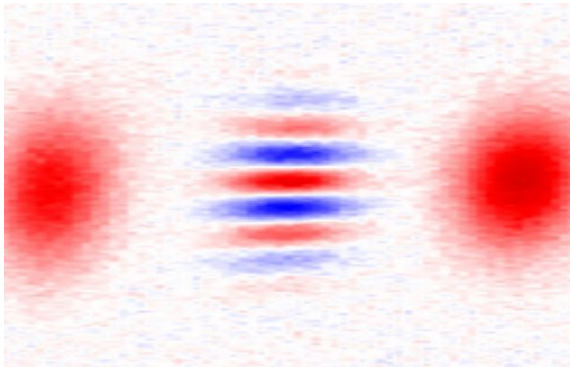
April 07, 2025

Schrodinger cat states are a fascinating phenomenon in quantum physics in which a quantum object exists simultaneously in two different states. In Erwin Schrodinger's thought experiment, it is a cat that is alive and dead at the same time. Previous experiments have focused on creating such states by cooling a quantum object to its ground state, the state with the lowest possible energy. Quantum superpositions are usually created from this well-defined state. Now, researchers led by Gerhard Kirchmair and Oriol Romero-Isart have demonstrated for the first time that it is indeed possible to create quantum superpositions from thermally excited states. i.e. Schrodinger also assumed a living, i.e. 'hot' cat in h

s thought experiment," remarks Gerhard Kirchmair from the Department of Experimental Physics at the University of Innsbruck and the Institute of Quantum Optics and Quantum Information (IQOQI) of the Austrian Academy of Sciences (OAW). "We wanted to know whether these quantum effects can also be generated if we don't start from the cold' ground state," says Kirchmair. In their study published in *Science Advances*, the researchers used a transmon qubit in a microwave resonator to generate the cat states. They succeeded in creating the quantum superpositions at temperatures of up to 1.8 Kelvin - which is sixty times hotter than the ambient temperature in the cavity. "Our results show that it is possible to generate highly mixed quantum states with distinct quantum properties," explains Ian Yang, the first author of the study. The researchers used two special protocols to create the hot Schrodinger cat states. These protocols were previously used to produce cat states starting from the ground state of the system. "It turned out that adapted protocols also work at higher temperatures, generating distinct quantum interferences," says Oriol Romero-Isart, until recently Professor of Theoretical Physics at the University of Innsbruck and research group leader at IQOQI Innsbruck and since 2024 Director of ICFO - the Institute of Photonic Sciences, in Barcelona. "This opens up new opportunities for the creation and use of quantum superpositions, for example in nanomechanical oscillators, for which achieving the ground state can be technically challenging." The states created in the experiment were characterized by measurements of the Wigner function, which makes the quantum interference visible. "Our measurements confirm that the states exhibit clear quantum features despite the high temperature," adds Thomas Agrenius, who was also involved in the study. These research findings could benefit the development of quantum technologies. "Our work reveals that it is possible to observe and use quantum phenomena even in less ideal, warmer environments," emphasizes Gerhard Kirchmair. "If we can create the necessary interactions in a system, the temperature ultimately doesn't matter." The study was funded by the Austrian Research Fund FWF and the European Union.

Reference:

Hot Schrodinger Cat States. Ian Yang, Thomas Agrenius, Vasilisa Usova, Oriol Romero-Isart, Gerhard Kirchmair. *Science Advances* 2025 DOI: 10.1126/sciadv.adr4492



Researchers generated highly mixed quantum states with distinct quantum properties. Credit: IQQOI Innsbruck.