[EPS EDITORIAL]

What is the size of Schrödinger's cat?

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The 2025 Nobel prize in Physics was awarded to John Clarke, Michel H. Devoret, and John M. Martinis *"for the discovery of macroscopic quantum mechanical tunnelling and energy quantisation in an electric circuit"*.

The core discovery celebrated by the 2025 Prize bridges one of the most persistent boundaries in physics: the demarcation between the quantum domain—characterised by probabilities, superposition, and tunnelling—and the classical world of everyday experience. Quantum mechanics traditionally governs phenomena at the atomic and subatomic scales. The work of Clarke, Devoret, and Martinis demonstrated unequivocally that quantum phenomena can emerge in systems large enough to be manipulated and measured directly as engineered electrical circuits.

The experiments date from the early 1980s, using Josephson junctions (an insulating interface separating two superconductors), and the tunnelling effect (see their publication *"Measurements of Macroscopic Quantum Tunnelling out of the Zero-Voltage State of Current-Biased Josephson Junction"*, *Phys. Rev. Lett.* **55**, 1908 – Published 28 October 1985). Classically, a particle like a low energy electron cannot pass the insulating barrier. In contrast, quantum mechanics permits tunnelling despite insufficient energy.

Although the early studies of quantum tunnelling focused on single particles, macroscopic systems composed of many particles can also exhibit tunnelling through the coherent dynamics of a collective quantum variable. Such coherence is normally destroyed by environmental noise. Clarke, Devoret, and Martinis demonstrated that a superconducting circuit could be sufficiently isolated to preserve macroscopic quantum coherence, enabling tunnelling of a collective degree of freedom.

Clarke, Devoret and Martinis were able to experimentally answer the question raised by A.J. Legget, himself a recipient of the Nobel Prize for Physics in 2003 for pioneering contributions to the theory of superconductors and superfluids: could a smaller version of the Schrödinger's cat thought experiment be performed in superconducting or superfluid systems? (see the publication "Prospects in Ultralow Temperature Physics", *J. Phys. Colloq.* **39** C6-1274 (1978)].

Clarke, Devoret and Martinis showed that tunnelling and energy quantisation can happen at a macroscopic level. This completely reshapes our understanding of the limits of quantum mechanics.

The work of Clarke, Devoret, and Martinis paves the way for practical applications, in particular to quantum computing, even if this is still to be made effective. Their result established the physical basis of superconducting qubits, in which information is stored and manipulated using coherent quantum states of macroscopic electrical circuits.

There are promising implementations, notably technologies based on superconducting qubits, including transmons and fluxoniums, the latter offering longer coherence, higher anharmonicity, and lower frequencies, thus allowing better stability and error control.

We may also recall that this Nobel prize is awarded during the "International Year of Quantum Science and Technology" (IYQ) – https://quantum2025.org/ – celebrating the first centenary of the invention of Quantum Mechanics and raising public awareness of the importance and impact of quantum science and applications on all aspects of life.

Once again, the Nobel prize confirms that fundamental research remains the driving force of technological revolutions: by a better understanding of the fundamental laws of physics, research opens concrete perspectives. ■

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