DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

PHYSICS SOCIETY OUTREACH LECTURE

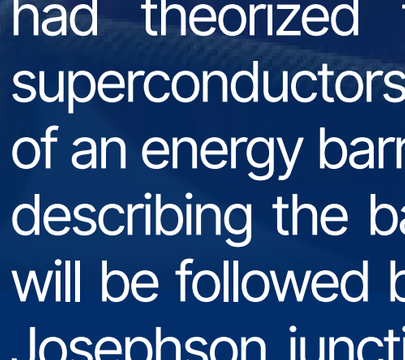
2025 PHYSICS NOBEL PRIZE: DISCOVERY OF MACROSCOPIC QUANTUM MECHANICAL TUNNELLING AND ENERGY QUANTIZATION IN AN ELECTRIC CIRCUIT

Abstract

The 2025 Nobel prize in physics was awarded to John Clarke, Michel Devoret and John Martinis for the discovery of macroscopic quantum mechanical tunnelling and energy quantization in an electric circuit. The experiments were conducted when Martinis was a doctoral student and Devoret was a postdoc in Clarke's lab in the university of California at Berkeley (USA).

These experiments were performed [1-3] in early 1980's with a device known as a Josephson junction, in which two superconductors are separated by a thin insulating barrier. Anthony Leggett [4] had theorized that at extremely low temperatures, macroscopically distinct states of the superconductors could exhibit the quantum mechanical behavior of tunneling: jumping from one side of an energy barrier to another, something not possible in classical physics. In this talk, I shall begin by describing the basic phenomena and the physics of superconductivity and Josephson effect. This will be followed by a discussion on the quantum behavior of the macroscopic phase-difference in a Josephson junction and its observability at extremely low temperatures (below 50 mK) in devices carefully isolated from noise sources. The experiment by the Noble laureates will then be described together with their novel isolation method using copper-powder filter for eliminating the interference from ambient electromagnetic noise. Finally the results, interpretation and later consequences including superconducting quantum-bits of these experiments will be discussed.

Speaker



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1. Martinis, J. M., Devoret, M. H., Clarke, J. Phys. Rev. Lett. 55, 1543(1985).
2. Devoret, M. H., Martinis, J. M. & Clarke, J. Phys. Rev. Lett. 55, 1908(1985)
3. Martinis, J. M., Devoret, M. H. & Clarke, J. Phys. Rev. B 35, 4682 (1987).
4. Caldeira, A. O. & Leggett, A. J. Phys. Rev. Lett. 46, 211 (1981).

ALL ARE CORDIALLY INVITED

Tuesday, February 17, 2026 at 5:00 PM
(Refreshments at 4:45 PM)

Lecture Hall Complex(L-16)