

Superconductors that work by themselves: Scientists discover new possibilities in chryoelectronics

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(Phys.org)—Scientists from the University of Tübingen, working with colleagues from Tel Aviv University and the Kiel University have proposed [1] and experimentally demonstrated [2] a new type of superconducting element – named the φ -Josephson junction. Implemented in cryogenic devices, this element will make superconducting electronic circuits work practically "by themselves" and improve functionality. The scientists have published their results in the journal *Physical Review Letters*.

A Josephson junction is a quantum mechanical device consisting of two superconductors separated by a very thin (~2nm) barrier. In spite of the barrier, and thanks to <u>quantum mechanics</u>, the superconducting electrons in one superconductor "feel" their neighbors in the other superconductor and "synchronize" with them, i.e. behave coherently. This quantum mechanical coherence on a <u>macroscopic scale</u> allows using Josephson junctions as very precise sensors of magnetic fields e.g. for medical imaging or as <u>basic elements</u> for a scalable quantum computer.

In conventional Josephson junction this "synchronization" of the <u>electron</u> <u>motion</u> takes place in-phase i.e., without a phase shift. Recently it became possible to make Josephson junctions where the electrons in two superconductors are "synchronized" anti-phase, i.e., with a phase shift of π . Then one obtains what's known as the π Josephson junction. By combining the properties of conventional and π junctions the scientists



from Tübingen, Tel Aviv and Kiel have proposed and demonstrated a Josephson junction with an arbitrary phase shift ϕ between electrons in two superconductors. The value of ϕ (0

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