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 quantum mechanics, 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 macroscopic scale allows using Josephson junctions as very precise sensors of magnetic fields e.g. for medical imaging or as basic elements for a scalable quantum computer.

In conventional Josephson junction this "synchronization" of the electron motion 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