Superconducting strip could become an ultra-low-voltage sensor

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Researchers studying a superconducting strip observed an intermittent motion of magnetic flux which carries vortices inside the regularly spaced weak conducting regions carved into the superconducting material. These vortices resulted in alternating static phases with zero voltage and dynamic phases, which are characterised by non-zero voltage peaks in the superconductor. This study, which is about to be published in EPJ B[1], was carried out by scientists from the Condensed Matter Theory Group of the University of Antwerp, Belgium, working in collaboration with Brazilian colleagues.

Superconductors, when subjected to sufficiently strong magnetic fields, feature vortices that carry quantized amounts of magnetic flux, although the natural tendency of superconductors is to expel such flux. The authors relied on the Ginzburg-Landau theory to study the dynamic of the nanometric- to millimetric-scale-width superconducting strip, which was subjected to a magnetic field applied at a right angle and a current applied alongside its length.

Typically, weakly acting superconducting regions are natural impediments for the passage of electrical current. However, the authors found that they also work as efficient pathways for vortices to enter and exit the superconducting strip. The increasing magnetic field also increases the density of mutually repelling vortices, which stimulates vortex motion across the strip in the presence of an external current. At the same time, the barrier for vortex entry and exit on the strip boundaries is also dependent on the magnetic field. This interplay of magnetic-field-dependent barriers and vortex-vortex interaction results in an on/off vortex motion in increasing magnetic fields.

Due to the simple geometry of the strip, these results can be confirmed experimentally in magnetoresistance measurements. These findings could be applicable in gate devices used to control various modes of on/off states in electrical systems which operate in specific windows of temperature, applied magnetic field, current and voltage.

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