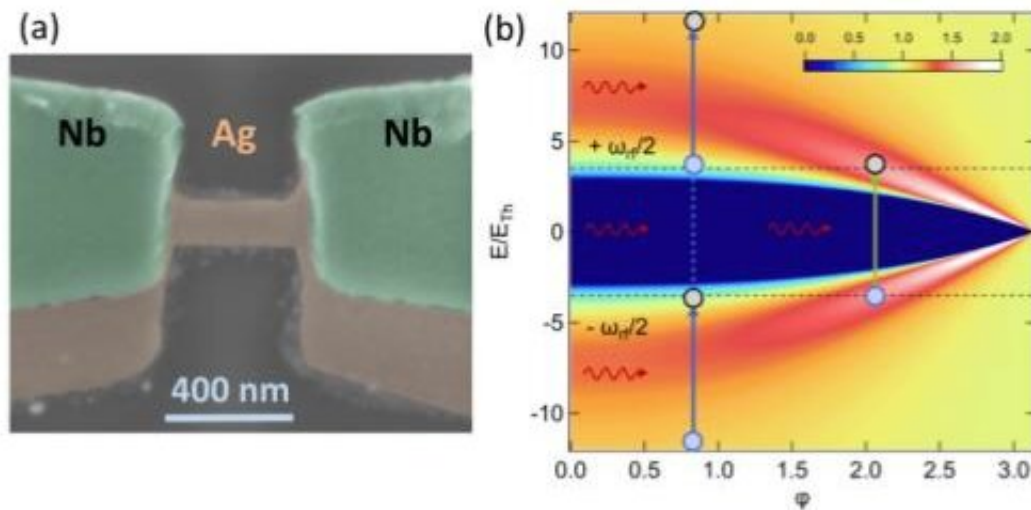


Non-adiabatic dynamics of strongly driven diffusive Josephson junctions

December 5 2019



(a) Scanning electron micrograph of the measured Superconductor(Nb)/Normal metal (Ag)/ Superconductor(Nb) Josephson junction. (b) Color-coded sketch of the normalized energy-phase dependent density of states of a long diffusive SNS junction. Full (dashed) vertical arrows represent the high (low) probability inelastic transitions. Grey (blue) circles represent electron-like (hole-like) quasiparticles. Credit: University of Jyväskylä/Pauli Virtanen

Understanding how microwave absorption changes the transport properties of diffusive Josephson junctions is at the forefront of interest in the quantum transport community. It is especially relevant for current efforts to address the current-phase relation in topological Josephson junctions, and more generally, the microwave transport in quantum

devices.

Researchers from the University of Paris-Saclay, the University of Regensburg (Germany) and the University of Jyväskylä; (Finland) have delivered a combined experimental and theoretical work revealing the profound nature of quantum [transport](#) in strongly driven diffusive Josephson junctions. Results are published in *Physical Review Research* in October.

At sufficiently low temperatures, superconductors cannot absorb microwave radiation of energy smaller than the superconducting energy gap D . In Josephson weak links, where two superconductors (S) are weakly coupled through a long diffusive metallic wire (N), radiation can be absorbed in N because the induced gap in the density of states or minigap is considerably smaller than D .

The researchers have studied the out-of-equilibrium dynamical state induced by the absorption of high frequency microwave photons in diffusive superconductor-normal metal-superconductor (SNS) junction. To characterize this state, the researchers pioneered a harmonic-resolved ac-Josephson spectroscopy technique to access the harmonic content of the current-phase relation under [microwave](#) radiation.

With this approach, which does not require specialized on-chip circuitry, they could see that a strong anharmonicity of the current-phase relation arises under illumination, especially at high frequency when inelastic transitions across the induced minigap are favored. This novel regime goes well beyond the standard Eliashberg theory and is understood because of the modifications of the supercurrent-carrying Andreev spectrum induced by non-adiabatic transitions.

These findings shed light on the complex mechanisms involved in irradiated mesoscopic superconductors and has important implications in

Andreev-based quantum computing prospects.

More information: J. Basset et al, Nonadiabatic dynamics in strongly driven diffusive Josephson junctions, *Physical Review Research* (2019).
[DOI: 10.1103/PhysRevResearch.1.032009](https://doi.org/10.1103/PhysRevResearch.1.032009)

Provided by University of Jyväskylä

Citation: Non-adiabatic dynamics of strongly driven diffusive Josephson junctions (2019, December 5) retrieved 26 April 2024 from <https://phys.org/news/2019-12-non-adiabatic-dynamics-strongly-driven-diffusive.html>

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