Photogalvanic phenomena in superconductors and hybrid superconducting systems

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In this talk we consider the peculiarities of the photogalvanic phenomena, photon drag and inverse Faraday effects in superconductors and hybrid superconducting structures. Our theoretical study is based on the time – dependent Ginzburg – Landau (TDGL) theory with a complex relaxation constant which provides the simplest description of the mechanisms of the second-order nonlinear effects in the electrodynamic response and related mechanisms of generation of dc photocurrents, magnetic moment, Abrikosov vortices and switching between different current states under the influence of electromagnetic wave of various polarization.

In particular, we suggest a phenomenological theory of photogalvanic phenomena in superconducting materials and structures revealing the diode effect. Starting from a generalized GL model accounting for the quadratic nonlinearity in the relation between the supercurrent and superfluid velocity, we show that the electromagnetic wave incident on the superconductor can generate a nontrivial superconducting phase difference between the ends of the sample. Being enclosed in a superconducting loop, such a phase battery should generate a dc supercurrent circulating in the loop and provoke the switching between the loop states with different vorticities.

We develop a phenomenological description of the photon drag phenomenon and resulting dc supercurrents induced by microwave radiation incident on a superconductor surface. We consider both the case of a plane wave and structured light, characterized by a certain angular momentum m. The photocurrents and magnetic fields are shown to be determined both by the helicity of light and its orbital momentum m.

The effect of photoinduced switching between vortex states according to the above mechanisms provides a convenient tool for superconducting optofluxonics allowing one to manipulate the magnetic flux trapped inside the loop which is promising for applications in the devices of the rapid single flux quantum (RSFQ) logics.

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