Colloquium on Solid-State Physics

Department of Physics
WS 2022/23

Thursday, 3rd November 2022, 17.15 h
Lecture Hall III, Department of Physics, Garching

Supercurrent diode effect and magnetochiral anisotropy from Rashba and valley-Zeeman spin-orbit coupling

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Abstract:

A superconducting condensate is made out of pairs of electrons --the Cooper pairs-- described by the same macroscopic wavefunction ψ, which plays the role of order parameter in the Ginzburg-Landau approach. In the ordinary case, electrons in a Cooper pair have opposite momentum and are in a spin singlet state. This intimate relation between spin and orbit is the one that both fulfills the Pauli principle and maximizes the phase space for the scattering process leading to the attractive interaction. It is thus not surprising that, in the presence of spin-orbit interaction (SOI), extra-ordinary phenomena emerge as, e.g., unconventional pairing, topological phases, Ising superconductivity, helical condensates, etc.

In this talk, I shall discuss how SOI, in the presence of an in-plane magnetic field, leads to nonreciprocal supercurrent and magnetochiral effects in Josephson junctions with Rashba-type SOI. Using a simple model based on Andreev bound states in the normal weak-link, we can quantitatively reproduce the experimental results. In plain films, the most striking signature of Rashba SOI is the anisotropic squeezing of Abrikosov vortices. We show that this is the first direct experimental evidence of the elusive Lifshitz invariant. Finally, we turn to NbSe2, a superconducting 2D material. We show that valley-Zeeman-type SOI can produce a supercurrent rectification too, but in this case with the magnetic field directed out-of-plane.

There will be coffee, tea, and cookies in front of the lecture hall at 17.00 h