CONDENSED MATTER SCIENCES SEMINAR

Professor Victor Yakovenko

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Host

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Title

A sharp interband optical absorption peak due to time-reversal-breaking superconductivity

Friday, September 25th, 2026

1st Floor – B101

15:00-16:00

Abstract

A sharp optical peak in the ac Hall conductivity \sigma_{xy}(\omega) was found theoretically in [1] and clarified in [2] for a tight-binding model on the honeycomb lattice of the chiral (d+id)-wave superconductivity that breaks time-reversal symmetry. The peak originates from vertical optical transitions between the lower and upper bands of the Dirac cones, activated in \sigma_{xy}(\omega) by the time-reversal-breaking superconductivity. The frequency of the peak is \omega=2\mu, where \mu is the Fermi energy measured from the Dirac point, which is typically much greater than the superconducting gap 2\Delta. Optical transitions are strictly forbidden in clean single-band superconductors, but are permitted in multi-band superconductors. The peak is sharp (narrow in frequency) due to the particle-hole symmetry of the Dirac spectrum. Its spectral weight is in agreement with the Lange-Kotliar magneto-optical sum rule for \sigma_{xy}(\omega). It also implies the appearance of a persistent loop-current pattern reminiscent of Haldane's model. These results can be applied to various layered superconductors. An experimental observation of a sharp optical peak, emerging in superconducting state in \sigma_{xy}(\omega) at the frequency \omega=2\mu (tunable by gating), would be a strong indicator of spontaneous time-reversal symmetry breaking.

[1] P. M. R. Brydon, D. S. L. Abergel, D. F. Agterberg, and V. M. Yakovenko, "Loop currents and anomalous Hall effect from time-reversal symmetry-breaking superconductivity on the honeycomb lattice", PRX 9, 031025 (2019), https://doi.org/10.1103/PhysRevX.9.031025

[2] A. S. Alzahrani and V. M. Yakovenko, "Loop currents in Haldane's model and in time-reversal-breaking superconductors", https://arxiv.org/abs/2608.22083