

Field-controlled thermal spin transport in rutile-type altermagnets

Thursday, 24 September 2026 17:00 (20 minutes)

The magnon-driven transport properties of a two-dimensional model of a d -wave altermagnet are investigated. As a case study, we consider a rutile with easy-planar anisotropy (e.g., NiF_2), where the sublattice magnetization vectors lie within the xy -plane in the equilibrium state. An external magnetic field is applied perpendicular to this plane, along the z -axis. The model Hamiltonian accounts for anisotropy, Zeeman interaction, and the complex structure of the Heisenberg exchange, including ferromagnetic, antiferromagnetic, and specific altermagnetic exchange contributions.

We computed the spectrum of spin waves and found that altermagnetism renders magnons chiral, as in the case of the easy-planar g -wave altermagnets [1]. The altermagnetically-induced magnon magnetic moment is k -dependent, and its distribution over the 1st Brillouin zone possesses d -wave symmetry for each magnon branch. The latter results in a magnon-driven spin current in response to an applied temperature gradient, similar to that in easy-axial d -wave altermagnets [2]. The corresponding tensor of the thermal spin conductivity $\sigma_{\alpha\beta}$ was derived from the transport Boltzmann equation within the relaxation time approximation. The direction of the spin current is determined by the direction of the temperature gradient relative to the crystallographic axes (Fig. 1). An important finding of this research is the possibility of controlling the spin conductivity by the applied magnetic field. We observe that at low temperatures, the conductivity is governed by the lowest-energy magnon mode, and its temperature dependence follows a T^2 -law. However, for high temperatures, $\sigma_{\alpha\beta}$ is temperature-independent, and its value and sign are determined by the magnetic field. The field-controlled spin conductivity highlights the potential for tunable magnonic and spin-caloritronic devices, providing a robust mechanism for controlling spin and heat currents at the nanoscale.

Fig. 1. Temperature dependencies of σ_{xy} for different values of the reduced magnetic field $b = B_z/B_{\text{sf}}$, where B_{sf} is the critical spin-flip field.

This work was supported by the German Federal Ministry of Research, Technology and Space (BMFTR) through the GU-QuMat project (01DK24008).

[1] V.P. Kravchuk, et al., *Phys. Rev. B*, **112**, 144421 (2025).

[2] K.V. Yershov, et al., *Phys. Rev. B*, **110**, 144421 (2024).

Primary author: Dr GUSIEVA, Yuliia (G.V. Kurdyumov Institute for Metal Physics of the NAS of Ukraine)

Co-authors: KRAVCHUK, Volodymyr (Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine); Dr YERSHOV, Kostiantyn (Institute for Theoretical Solid State Physics, Leibniz Institute for Solid State and Materials Research Dresden)

Presenter: Dr GUSIEVA, Yuliia (G.V. Kurdyumov Institute for Metal Physics of the NAS of Ukraine)

Track Classification: QUANTUM MATERIALS