TT 79: Correlated Magnetism – Transport

Time: Thursday 11:30–12:45 Location: HSZ/0103

TT 79.1 Thu 11:30 HSZ/0103

Spin Dynamics Approach to Thermal Hall Conductivity — •Ignacio Salgado-Linares[1,2], Alexander Mook[3], Léo Mangeolle[1,2], and Johannes Knolle[1,2,4] — [1]Technical University of Munich, TUM School of Natural Sciences, Physics Department, TQM, 85748 Garching, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Schellingstr. 4, 80799 München, Germany — [3]Department of Physics, Johannes Gutenberg University Mainz, 55128 Mainz, Germany — [4]Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom

In recent years, the thermal Hall effect has emerged as a powerful tool for probing topological phenomena of magnetic systems. At low temperatures, the thermal Hall transport of long-range ordered magnets can be described in the framework of linear spin-wave theory (LSWT). However, how to treat regimes with increased thermal fluctuations or non-linearities beyond LSWT is an outstanding question. Therefore, within this project, we developed a novel numerical technique to extract the thermal Hall transport properties, which intrinsically includes non-linear effects. In particular, we use semi-classical spin dynamics simulations to compute thermal currents in the Kitaev model in a field. The results are expected to shed new light on the topological thermal transport in Kitaev spin liquid candidate materials.

TT 79.2 Thu 11:45 HSZ/0103

Extrinsic contribution to bosonic thermal Hall transport — •Léo Mangeolle[1,2] and Johannes Knolle[1,2,3] — [1]Technical University of Munich, TUM School of Natural Sciences, Physics Department, 85748 Garching, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Schellingstr. 4, 80799 München, Germany — [3]Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom

Bosonic excitations like phonons and magnons dominate the low-temperature transport of magnetic insulators. Similar to electronic Hall responses, the thermal Hall effect (THE) of charge neutral bosons has been proposed as a powerful tool for probing topological properties of their wavefunctions. For example, the intrinsic contribution of the THE of a perfectly clean system is directly governed by the distribution of Berry curvature. However, disorder is inevitably present in any material and its contribution to the THE has remained poorly understood. Here we develop a rigorous kinetic theory of the extrinsic side-jump contribution to the THE of bosons. We show that the extrinsic THE is always relevant for bosonic systems and can be of the same order as the intrinsic one but sensitively depends on the type of local imperfection. We study different types of impurities and show that a THE can even arise as a pure impurity-induced effect in a system with a vanishing intrinsic contribution. We discuss the importance of our results for the correct interpretation of THE measurements and provide a ready-to-use formula for comparison to experimental data.

TT 79.3 Thu 12:00 HSZ/0103

Giant thermopower changes due to secondary gradients of electronic properties — •Ulrike Stockert[1,2,4], Judith Grafenhorst[1], Sarah Krebber[3], Kristin Kliemt[3], Cornelius Krellner[3], and Elena Hassinger[4,1,2] — [1]Technische Universität Dresden, 01062 Dresden, Germany — [2]MPI for Chemical Physics of Solids, 01187 Dresden, Germany — [3]Physikalisches Institut, Goethe-Universität Frankfurt, 60438 Frankfurt/M, Germany — [4]Institute for Quantum Materials and Technologies, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

The diffusion thermopower S_{diff} of conventional metals and semiconductors is typically small, being of the order of 10-100 μV/K. It arises from changes of the number and velocity of mobile charge carriers with temperature T due to the energy dependence of the density of states and the T dependence of the Fermi distribution. In simple models for the thermopower, these changes are assumed to be weak, and the materials behave homogeneous. However, if electronic properties as the chemical potential or the charge-carrier mobility exhibit strong T dependencies, any temperature gradient induces also significant gradients of these properties. In our presentation we will show that such a secondary gradient of the electrical conductivity σ may induce giant values of the diffusion thermopower. Using a simple drift-diffusion model and allowing explicitly for gradients of σ, we are able to predict the correct magnitude, shape, and field dependence of the thermopower. Our results open a new route to large thermopower values via gradients of electronic properties.

TT 79.4 Thu 12:15 HSZ/0103

Observation via spin Seebeck effect of macroscopic magnetic transport from emergent magnetic monopoles — •Nan Tang[1], Josef Willsher[2], Stephan Glamsch[3], Aisha Aqeel[3], Ludwig Scheuchenpflug[1], Michael Schulze[4], Christoph Liebald[5], Daniel Rytz[5], Christo Guguschev[4], Manfred Albrecht[3], Roderich Moessner[2], and Philipp Gegenwart[1] — [1]Experimentalphysik VI, Universität Augsburg, Augsburg, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [3]Experimentalphysik VI, Universität Augsburg, Augsburg, Germany — [4]Leibniz-Institut für Kristallzüchtung (IKZ), Berlin, Germany — [5]EOT GmbH-Coherent, Idar-Oberstein, Germany

Magnetic monopoles, elusive in high-energy physics, have been realised as emergent quasiparticles in solid-state systems, where topological defects act as effective magnetic charges. They have been proposed in diverse platforms, including skyrmion lattices, chiral magnets, soft ferromagnets, and artificial nanomagnets, yet their role in magnetic transport has remained unconfirmed. Here, we demonstrate such transport via the spin Seebeck effect in the insulating pyrochlore $Dy_2Ti_2O_7$. A thermal gradient applied perpendicular to a [111]-oriented magnetic field yields a spin Seebeck voltage showing a dominant peak at monopole proliferation, alongside a secondary feature and frequency-dependent behavior. These results establish a direct link between monopole dynamics and magnetic transport in an insulator and provide a route to probing fractionalized excitations and spintronic functionalities.

TT 79.5 Thu 12:30 HSZ/0103

Unconventional Magnetotransport and Magnetic Anisotropy in van der Waals Ferromagnet Fe_4GeTe_2 — •Riju Pal[1,2,3], Joyal J. Abraham[1,2], Buddhadeb Pal[3], Suchanda Mondal[4], Prabhat Mandal[3,4], Atindra Nath Pal[3], Bernd Büchner[1,2,5], Vladislav Kataev[1], and Alexey Alfonsov[1] — [1]Leibniz IFW Dresden, D-01069, Germany — [2]Institute for Solid State and Materials Physics, TU Dresden, D-01062, Germany — [3]S. N. Bose National Centre for Basic Sciences, Kolkata, 700106, India — [4]Saha Institute of Nuclear Physics, Calcutta, 700064, India — [5]Würzburg-Dresden Cluster of Excellence ctd.qmat, Dresden, D-01062, Germany

Magnetic van der Waals (vdW) materials, with their intrinsic two-dimensionality and tunable exchange interactions, magnetocrystalline anisotropy, and electron correlations, are promising candidates for realizing non-trivial magnetic states. Combining transport measurements and electron spin resonance (ESR) spectroscopy, we studied the quasi-2D vdW ferromagnet Fe_4GeTe_2, which has a near-room-temperature $T_C \sim$ 270K and an unusual spin-reorientation transition near $T_{SR} \sim$ 120K. Transport experiments reveal two electronic transitions near T_{SR} and $T_Q \sim$ 40-50K marked by sign reversal in Hall effect and magnetoresistance. ESR study further quantifies the non-trivial temperature evolution of magnetic anisotropy, with characteristic temperatures coinciding with those found in transport studies, indicating strong magneto-electronic coupling relevant for spintronic applications.