PHYSIKALISCHES KOLLOQUIUM

Wintersemester 2024/25

Das Kolloquium findet (soweit nicht anders angegeben) **jeweils montags um 16:15 Uhr in Präsenz im Röntgen-Hörsaal** des Physikalischen Instituts, Hubland Campus Süd, Universität Würzburg **und online via Zoom statt**.
Zugangsdaten siehe https://www.physik.uni-wuerzburg.de/aktuelles/veranstaltungen-aus-der-physik/physikalisches-kolloquium/

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Vorstellungsvortrag im Rahmen des Habilitationsverfahrens

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Magnetic Topological Insulators: From Fascinating Transport Physics to Applications in Metrology

Abstract

The quantum anomalous Hall effect (QAHE), first observed in a magnetic topological insulator Cr/V-doped (Bi, Sb)2Te3 [1], holds promise as a disruptive innovation in quantum metrology, for its potential to define a new generation of quantum standards of resistance [2,3]. Indeed, one of the goals of modern metrology is to combine various standards into a so-called “quantum electrical metrology toolbox”, a single measurement apparatus that can perform quantum resistance, voltage and current metrology. Conventional quantum standards of resistance rely on the integer quantum Hall effect for their operation. The large external magnetic field needed to establish the quantum Hall effect makes a quantum standard of voltage (based on the AC Josephson effect) inoperable [4]. This is where QAHE can save the day and enable the combined standards [5]. Metrologically relevant precision of QAHE quantization has already been demonstrated [2,3] under very challenging experimental conditions (extremely low temperature and low electrical current). The effect will need to be made significantly more robust to enable mainstream metrology applications. In this talk I will present results that give us confidence this is possible [6,7].

In this context, it is important to understand the physics that drive transport in magnetic topological insulators. The combination of novel magnetic properties and topological transport creates a platform for the emergence of fascinating and fundamental physics. These include: An evolution from conventional electrodynamics to the axion scaling of the QAHE as the thickness of the topological layer is varied from the 2D to 3D regime [8,9]. Magnetic fluctuations that follow switching statistics consistent with that of macroscopic quantum tunneling of magnetization, which can be observed when the device size is reduced to a regime (some 200 nm) where the dynamics from a single magnetic domain can be singled out [10]. Anomalous Hall effect signals showing evidence for the coexistence of two ferromagnetic orders in the system [11], with qualitatively the same signals often being misinterpreted in the literature as evidence for the topological (or skyrmion) Hall effect.

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[5] L. K. Rodenbach et al., ArXiv:2308.00200 (2023).
[6] K. M. Fijalkowski et al. Nature Communications 12, 5599 (2021).
[7] K. M. Fijalkowski et al. Nature Electronics 7, 438-443 (2024).
[8] S. Grauer, K. M. Fijalkowski et al., Physical Review Letters 118, 246801 (2017).
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Für die Dozentinnen bzw. Dozenten der Fakultät

Prof. Dr. Porod, Prof. Dr. Hinkov, Dr. Leisegang, Dr. Ünzelmann, Hr. Baumbach