MA 3: Spin-Dependent Phenomena in 2D

Time: Monday 9:30–10:15 Location: H43

MA 3.1 Mon 9:30 H43

Noncollinear magnetism in a monolayer of two-dimensional $\mathbf{CrTe_2}$ — •Nihad AbuAwwad[1,2], Manuel dos Santos Dias[2,1], Hazem AbuSara[3], and Samir Lounis[1,2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA, 52425 Jülich, Germany — [2]Faculty of Physics, University of Duisburg-Essen, 47053 Duisburg, Germany — [3]Department of Physics, Birzeit University, PO Box 14, Birzeit, Palestine

The discovery of two-dimensional (2D) van der Waals magnets opened unprecedented opportunities for the fundamental exploration of magnetism in quantum materials. Recently, thin $CrTe_2$ films were demonstrated to be ferromagnetic up to room temperature, with an intriguing dependence of the easy axis on the thickness of the material [1,2]. Using first principles, we show that the charge-density waves characterizing a single $CrTe_2$ give rise to spiral magnetism through the emergence of the Dzyaloshinskii-Moriya interaction (DMI). Utilizing atomistic spin dynamics, we perform a detailed investigation of the complex magnetic properties pertaining to this 2D material impacted by the presence of various types of charge density waves. Also, we study the electronic and magnetic properties of heterostructures consisting of a single $CrTe_2$ monolayer interfaced with either Graphene or hBN.
–Work funded by the Palestinian-German Science Bridge (BMBF–01DH16027) and SPP 2244 (project LO 1659/7-1).
[1] Zhang *et al.*, Nat. Commun. **12**, 2492 (2021); [2] Meng *et al.*, Nat. Commun. **12**, 809 (2021).

MA 3.2 Mon 9:45 H43

Electric-field control of the DMI in magnetic heterostructures — •Donya Mazhjoo, Gustav Bihlmayer, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany

The use of external electric fields can extend the exploration of spintronic devices with a tunable Dzyaloshinskii-Moriya interaction (DMI) by allowing control of the interfacial DMI. Moreover, the magnetocrystalline anisotropy energy (MAE) changes as function of electric field intensity. By using density functional theory as implemented in the Fleur-code [1], we investigated the electric field effects on graphene (Gr) covered Co/Pt(111) heterostructures. Experiments show evidence of a sizable DMI at the Gr/Co interface which partially compensates the spin-orbit coupling induced DMI at the Co/Pt interface [2], which could make these structures susceptible to electric fields. To stimulate their influence, we sandwiched the film between two electrodes of opposite polarity. The self-consistent spin-spiral calculations were performed with these changed boundary conditions and spin-orbit effects were included in first order perturbation theory for the DMI and self-consistently for the MAE. We demonstrate that external fields lead to modulation of the spin-orbit induced quantities that allow a tuning of properties like domain wall widths or skyrmion radii. Support from the FLAG-ERA JTC 2019 grant SOgraphMEM is gratefully acknowledged.
[1] https://www.flapw.de
[2] F. Ajejas et al. Nano Lett. 2018, **18**, 5364-5372

MA 3.3 Mon 10:00 H43

Spinon induced drag in quantum spin liquid heterostructures — •Raffaele Mazzilli[1], Alex Levchenko[2], and Elio Koenig[1] — [1]Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart, Germany — [2]Department of Physics, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA

Several quantum spin liquid candidate materials, such as $\alpha RuCl_3$ and $1T\text{-}TaSe_2$, are exfoliable, so that it is possible to investigate 2D samples which avoid the manifestation of bulk properties that might disrupt the quantum spin liquid phase. In this phase the material is a Mott insulator and therefore it is impenetrable to direct electric probes such as charge currents. Despite this, in this work we propose an experimental setup that will allow to use non-local electrical probes to gain information on the transport properties of a gapless quantum spin liquid. The proposed setup is a spinon induced drag experiment, that consists in interfacing two metallic films separated by a layer of a quantum spin liquid. A current is injected in one of the two layers (active layer) and a voltage is measured on the second (passive) metallic film. The overall momentum transfer mechanism is a two-step process mediated by the Kondo interaction between the local moments in the quantum spin liquid and the spins of the electrons. We calculate, both for a U(1) and a Z_2 spin liquids, the drag resistivity in the framework of the linearized quantum Boltzmann equation derived from the Keldysh formalism. In this framework the three layers are out of thermodynamic equilibrium. We further confront the results obtained with the equilibrium case and with the results of standard Coulomb drag.