Walther-Meißner-Seminar

Walther-Meißner-Institut, Seminar Room 143

Date: **Friday, 20 Januar 2017, 13:30 h**

Speaker: **Dr. Toni Helm**

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Title: **Microstructuring single-crystalline quantum materials**

Abstract:
One major challenge for investigating quantum materials is the size and shape of real-life single crystals. Another hurdle to experiments is that most of the interesting physics occurs on length scales much smaller than the actual sample dimensions. To uncover and understand the physics of microscopic crystals, experiments are pushed to their limits in terms of setup dimensions and resolutions. An alternate pathway to quantum materials is the fabrication of microstructured devices from their bulk directly.
We use Focused Ion Beam (FIB) micromachining to create microstructures from single crystals. Our research focuses on the mesoscale regime, i.e. the typical sizes of our structures are in the range of 0.1-100 micrometer. This range covers most of the relevant length scales in quantum materials such as coherence lengths in superconductors, domain sizes in quantum magnets or the mean-free-path in clean metals. Very recently, FIB micromachining has proven extremely successful helping to reveal new physics in rather simple compounds: For example, micro-wires of the highly conductive Delafossite metal $PdCoO_2$ show evidence for a hydrodynamic electron flow similar to water [1] or the Dirac semimetal Cd_3As_2 is found to host topologically protected surface states [2].
In this talk, I will introduce the audience to our approach and its potential to uncover new physics in exotic materials. I will show examples demonstrating how to gain direct access to the magnetotransport anisotropy of metallic materials. With the help of FIB microstructures we discovered a subtle transition above T_c in the quasi one-dimensional superconductor $Ta_4Pd_3Te_{16}$ setting the scene for superconductivity [3]. As a second example, I will discuss how microstructures of the frustrated Shastry Sutherland antiferromagnet Yb_2Pt_2Pb provide insights on its electronic and magnetic structure.

[1] P.J.W. Moll, et al., *"Evidence for hydrodynamic electron flow in $PdCoO_2$"*, Science **351**, 1061 (2016).
[2] P.J.W. Moll et al., *"Transport evidence for Fermi-arc-mediated chirality transfer in the Dirac semimetal Cd_3As_2"*, Nature **535**, 266 (2016).
[3] T. Helm et al., *"Thermodynamic Anomaly Above the Superconducting Critical Temperature in the Quasi One-Dimensional Superconductor $Ta_4Pd_3Te_{16}$"*. arxiv:1610.07226 (2016),

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