www.physik.uni-stuttgart.de/aktuelles/kolloquium

Stuttgarter Physikalisches Kolloquium

Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme
Fachbereich Physik, Universität Stuttgart

Ansprechpartner: Andreas Schnyder
E-Mail: A.Schnyder@fkf.mpg.de
Telefon: 0711 689-1553

Login data will be announced by e-mail and on the colloquium webpage.

Dienstag, 15. Dezember 2020	**16.15 Uhr**	**Online-Vortrag**

Stuttgarter Max-Planck-Institute, Heisenbergstraße 1, 70569 Stuttgart-Büsnau

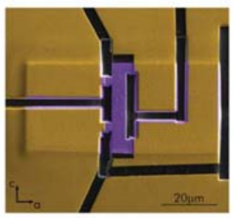
When quantum meets clean: the unusual metallic transport in delafossites

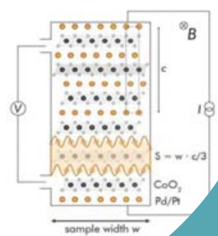
Philip Moll
EPF Lausanne

Abstract

The layered metals $PdCoO_2$ and $PtCoO_2$ have recently turned into a testbed for ideas of quantum mechanics on the mesoscopic scale. The conductivity is exclusively due to orbitals in the Pd/Pt layer. These single-electron-metals are well described by a cylindrical Fermi surface with almost negligible warping that reflects the strong anisotropy of the in-plane to out-of-plane hopping terms. Consistently, a large resistivity anisotropy of $\frac{\rho_c}{\rho_a}\sim 5000$ is observed and quantum oscillations match well ab-initio calculations of the Fermi surface. The origin of the novel physical phenomena discovered in this at first glance trivial metal lies in its extreme cleanliness. The crystals grow as thin platelets virtually free of defects and, in particular, free of stacking faults unlike many electronically layered materials. Accordingly, transport mean-free-paths of >20µm at low temperatures in this oxide and coherent interlayer transport below 400K are routinely observed.

This crystalline perfection, in combination with recent advances in Focused Ion Beam microstructuring, have turned this material into a testbed of quantum mechanics in the unusual limit of weakly yet coherently coupled layers. I will focus here on two recent observations, boundary symmetry breaking and h/e oscillations. The first part concerns the well-known fact that the resistivity tensor in a hexagonal symmetry must be isotropic in the plane perpendicular to the rotational axis. This property of infinite crystals is naturally broken by the finite size of any real crystal, yet boundary effects are typically undetectable. Here we show by micromachining transport bars in the quasi-ballistic limit that one can observe and quantify an emergent mesoscale in-plane anisotropy – demonstrating that the electronic symmetry in the microbars is indeed lowered. The second part concerns the out-of-plane transport in µm-sized pillars. This previously inaccessible regime of quantum transport shows a necessary breakdown of quasi-classics and a transition to a new type of quantum coherent transport that should be generic to ultra-clean layered materials. This regime is well described by transport of fully delocalized electron waves that are transferred from plane-to-plane. The natural area of this quantum process is given by the atomic interlayer distance, and hence the transport is strongly modulated by the number of flux quanta between adjacent planes.





C. Putzke et al., Science 368, 1234 (2020); M.D. Bachmann et al. Nat. Comm. 10:5081 (2019)