Sonderforschungsbereich 1277
Emergent Relativistic Effects in Condensed Matter - From Fundamental Aspects to Electronic Functionality

SFB-Kolloquium

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Thema: Towards a Theory of the Magnetic Properties of the MIT in Doped Semiconductors

Abstract

Doped semiconductors are well known to show a metal-insulator transition (MIT) as function of dopant concentration or pressure. Although this MIT has been long known as a paradigm of quantum phase transitions and has been intensively studied, it remains only partially understood. While the transition seems to be driven by disorder, similar to an Anderson MIT, there is strong experimental evidence that the complete theory of the MIT requires to take into account both correlations and disorder. This makes the derivation of its critical properties one of the most important challenges in condensed matter theory. We outline a comprehensive theory of physical properties of doped semiconductors in the vicinity of metal-insulator transitions incorporating the following facts: a) The MIT in doped semiconductors is a second order quantum phase transition with a diverging correlation length, when coming from the metallic side and a diverging localization length on the insulating side of the transition. b) Since the critical state is multifractal a comprehensive theory of physical properties at the MIT has to take into account the full distribution function of electron wave function intensities. c) The wave function intensities at the MIT are power law correlated in energy and in space. Building on these facts we review the theory of magnetic properties of doped semiconductors and Refs. therein, and the effect of magnetic moments on the position and the critical properties of the MIT giving rise to finite temperature MITs (Kondo-Anderson Transitions). In this context we review recent numerical results on the Anderson-Hubbard model. We also review further consequences like the exponentially enhanced Orthogonality Catastrophe and its Effects on Relaxation and the X-ray edge singularity at the MIT. These results might be of relevance for a wide range of doped materials such as topological insulators, topological superconductors and on the superconductivity in doped semiconductors such as doped SrTiO3 where there are indications that multifractality and magnetic moments are crucial for the understanding of the doping dependence of the critical temperature.

Gastgeber: Dr. Paul Wenk