# Stuttgarter Physikalisches Kolloquium

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

Ansprechpartner: Dr. Michael Hirscher
E-Mail: hirscher@is.mpg.de
Telefon: 0711 - 689-1808

**Dienstag, 21. April 2015** | **17.15 Uhr** | **Hörsaal 2 D5**

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

Gastgeber: Prof. Gisela Schütz, Max-Planck-Institut für Intelligente Systeme, Telefon: 0711 - 689-1950

# Strongly interacting electrons: from Kondo effect to quantum criticality

**Hilbert von Löhneysen**
Karlsruhe Institute of Technology (KIT) Physikalisches Institut und Institut für Festkörperphysik

## Abstract

About 50 years ago, Jun Kondo explained a phenomenon in solid-state physics that at that time had been around already for three decades and had defied an explanation: the low-temperature resistance minimum in metals containing dilute magnetic impurities. His calculation showed that the minimum arises from a temperature dependent interaction of conduction electrons with those impurities, leading to an increase of the electron scattering rate towards low temperature. Today, the term *Kondo effect* entails many phenomena associated with this interaction. Around each impurity, a "local" Fermi liquid is formed.
Starting in the 70's, intermetallic compounds with a stoichiometric array of rare-earth “impurities” were investigated. In many cases, these compounds exhibit features of the Kondo effect in the dilute case. The lattice-coherent superposition of the Kondo “impurities” leads to a Fermi liquid with electronic quasiparticles of very large effective masses (up to several hundreds of the free-electron mass). These *heavy-fermion systems* can exhibit most unusual properties such as superconductivity arising from the heavy quasiparticles, or unusual types of magnetic order.
Subsequently, it was found that the transition between a magnetic and nonmagnetic ground state can be easily achieved by a non-thermal parameter such as pressure, magnetic field, or composition. These phase transitions, if of second order, reveal unusual critical properties nicknamed “non-Fermi-liquid behavior” due to the fact that the quantum energy of fluctuations becomes a relevant energy scale as the temperature is lowered toward absolute zero. Several different types of *quantum phase transitions* have been identified, as will be discussed in this talk. Examples of these quantum phase transitions will be introduced and different routes to quantum criticality will be discussed.