Discussion quantum criticality

Initial presentation: Qimiao Si (Rice)

Outset: unified perspective on heavy fermions and iron pnictides

heave fermions: quantum critical point between AFM phase and Fermi liquid that often triggers a SC phase in its vicinity;
first indication: anomalous spin dynamical scaling in CeCu(5.9)Au(0.1); possible explanation via joint suppression of T_N AND a Kondo destruction scale as a function of control parameter, along with a sudden Fermi surface reconstruction (in the T->0 limit) phenomenologically reproducible from a Kondo lattice problem
divergent mass at the critical point suggests a 2nd order phase transition despite a Fermi surface jump;

Pepin: diverging mass not as apparent from the FL side as from the AFM side -

Si: small range of control parameter variation

A consequence of Fermi surface jump would be a change in the Hall coefficient which yields a crossover behavior for finite temperature
Connecting low temperature and high temperature phenomena:
Claim by SI: high temperature regime should host finite spectral weight of the small FS from the AFM side at lower T and from the FL side at lower T.
Main point of discussion: Is ARPES measurement supporting the reconstructed Fermi surface phenomenology?

Zwicknagl: Larger T range has to be considered in order to support the claim that the observed spectral weight at larger k is in accordance with a quantum critical regime

Si: High temperature measurement sees single impurity Kondo effect (Kondo resonance at T0) which is the starting point to break it at lower T.

Superconductivity near heavy fermion QCPs CeRhIn5: Tc/TF = 0.1, CeCu2Si2: Tc/TF = 0.05; Global phase diagram of HFs: what kind of QCPs might there be? Maybe unconventional lattice will trigger more, such as Shastry-Sutherland lattice Yb2Pt2Pb, kagome lattice CePdAl

Si: Could pnictides be reconciled by quantum critical behavior? J.G. Analytis et al. Nat. Phys. 2014 finds a divergent effective mass from the SC/FL side to smaller doping for isovalent BaFe2(As(1-x)P(x))2

Contribution by Hilbert von Löhneysen:

Sr(1-x)Ca(x)RuO3
Replace Sr by Ca: suppress ferromagnetic ordering
Anomalously small dynamical exponent z=1.8 ! (d=3)
Hertz: z=3 for ferromagnet, z=4 for disordered ferromagnet
HERE: disorder seems to reduce z
tentative explanation (courtesy of Jörg Schmalian): strong coupling between critical fluctuations and incoherent quasiparticles: local fluctuations may lead to a local gap in the Stoner continuum, leading to less damping of fluctations, i.e. smaller z

Roser Valenti: why is this material the first time that this behavior is seen?
von Löhneysen: ARPES is often done, but not the measure for thermodynamic phase transition, but not useful for determining the critical behavior; thermodynamic measurements simply have not been done as often
Hirschfeld: Local Stoner criterion - is that residual magnetism associated with the impurity?
Fradkin: Schmalians idea relates to localization, and not to Hertz theory
Thomale: Maybe v. Löhneysens observation is helpful to tell apart localized moment from itinerant ferromagnets in general?

Contribution by R. Fernandes

BaFe2(As(1-x)P(x))2:
Only evidence from pnictides for possible quantum critical fluctuations: penetration depth gives a very interesting behavior: the highest Tc seems to have the lowest superfuid density; (i) is a pieak in the penetration depth a signature of a QCP?, (ii) Why no peak in Ba(Fe(1-x)Co(x))2As2?, (iii) Why a single quantum phase transition? Maybe just 1st order transition?