Evidence for a FM QCP in URhGe doped with Ru

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Outline

- Introduction URhGe
- Alloying URhGe with Ru
- QCP in URh$_{1-x}$Ru$_x$Ge
- Conclusions
The correlated metal URhGe

- Crystal structure: orthorhombic, TiNiSi-type, Pnma
- Correlated metal: $\gamma = 160 \text{ mJ/molK}^2$
- Itinerant ferromagnet:
  \[ T_C = 9.5 \text{ K} \]
  \[ m_s = 0.42 \mu_B/\text{U-atom} \]
- Superconductor:
  \[ T_{SC} = 0.25 \text{ K} \]

Coexistence of SC and FM (at ambient pressure) suggests SC mediated by spin fluctuations. It is interesting to tune URhGe to QCP.

Control parameters $g$: magnetic field, pressure, chemical substitution...
Alloying URhGe


→ Tune $T_c$ to 0 K in URhGe by replacing Rh with Ru
**Magnetization** SQUID, fields up to 5 T, 1.8 - 300 K

- Ordered moment suppressed smoothly
\( \text{URh}_{1-x}\text{Ru}_x\text{Ge} \)

**Resistivity** MagLab and \(^3\text{He Heliox VL, 0.3 - 300 K} \)

- Temperature dependence of \( \rho \sim A T^n \)
  (FL theory \( n = 2 \))
For $x = 0.38$, $n_{\text{min}} = 1.2$, NFL behavior
**5f-electron specific heat** $^3$He-system, 0.4 - 20 K

- For $x = 0.38$, $c/T \sim -\ln T/T_0$ ($T_0 = 41$ K)
$T$-$x$ diagram

- $x \leq 0.05$, $T_C$ increases (chemical pressure)
- $x \geq 0.2$, $T_C$ decreases linearly ($d$-band emptying)
- $T_C$ tuned to 0 K at $x = 0.38$

See also W. Müller et al., Materials Science - Poland, in print
Conclusions.

- Ferromagnetism in URhGe is suppressed by replacing Rh with Ru
- At $x_{cr}$-Ru = 0.38 $\rightarrow$ FM QCP
  - $\rho \sim T^{1.2}$
  - $c/T \sim -\ln T$
  - $T_C \sim x$-Ru
  - $\rho \sim T^{5/3}$
  - $c/T \sim -\ln T$
  - $T_C \sim x^{3/4}$
  (clean) FM QCP theory

- Possibility to study magnetic fluctuations in a ferromagnetic superconductor
- First FM QCP in $f$-electron system at ambient pressure
  (the FM QCP in CePd$_{1-x}$Rh$_x$ is smeared)

Sereni et al., PRB 75 (2007) 024432
Poster Session III-79-QPT, *Thermal expansion*, A. Gasparini

N.T. Huy *et al.*, PRB 75 (2007), *in print*

S. Sakarya *et al.*, J. Alloys and Compounds, *in print*
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