Comment on "Theory of One-Channel versus Multichannel Kondo Effects for Ce^{3+} Impurities"

Recently, Kim and Cox [1] discussed the competition between the local Fermi-liquid fixed point of the single-channel Kondo model and the non-Fermi-liquid (NFL) fixed points of the two- and three-channel Kondo models. From their model Hamiltonian they calculated the susceptibility $\chi(T)$ and the thermoelectric power (TEP) for the $M = 1, 2$, and 3, $S_I = \frac{1}{2}$ Kondo-impurity models. The sign of the TEP at low T is concluded to be a fixed-point diagnostic; e.g., a well-developed negative peak is expected for the $M = 2$ case, in contrast to the common positive peak for $M = 1$. Strict conditions concerning site symmetry and energy-level scheme have to be fulfilled for the Ce^{3+} ion to obtain the $M = 2$ model.

$La_{0.9}Ce_{0.1}Cu_{2.2}Si_2$ is considered a good candidate to test these predictions for the TEP, as the above-mentioned conditions seem to be fulfilled. Further on, NFL behavior is evident for this composition, as both $\chi(T)$ and the specific-heat coefficient $\gamma(T) = C(T)/T$ were found to be $\propto -\ln T$ at low T [2].

Stimulated by this work, we have measured the TEP for a polycrystalline $La_{0.9}Ce_{0.1}Cu_{2.2}Si_2$ sample, cf. Fig. 1. Our data are in striking contrast to the predictions mentioned above. Instead of a negative peak we observe a pronounced positive one around $T_{max} = 9$ K, consistent with a conventional single-channel Kondo effect. An estimate of the $4f$-derived TEP via a Nordheim-Gorter analysis using TEP data for $LaCu_2Si_2$ by Franz *et al.* [3] yields absolute values which are even higher and almost reach those calculated in [1] for the $M = 1$ model.

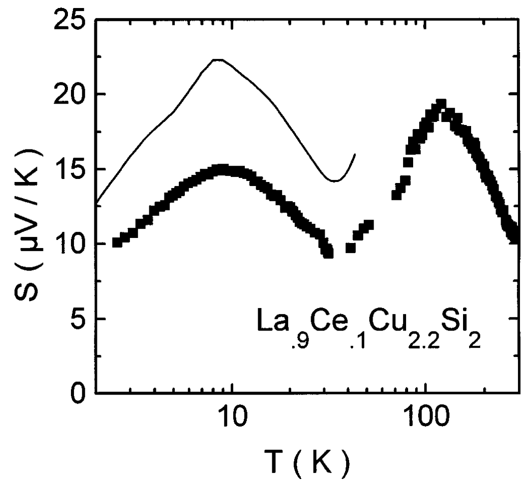

FIG. 1. Measured TEP of $La_{0.9}Ce_{0.1}Cu_{2.2}Si_2$ (squares) and $4f$-derived part as calculated via Nordheim-Gorter analysis (line) at $2.5 < T < 300$ K. The low-T peak is consistent with a single-channel Kondo effect of the spin-degenerate crystal field (CF) ground-state doublet, while the high-T peak reflects excited CF levels.

Preliminary results [4] of $\gamma(T)$ and $\rho(T)$ on $La_{0.9}Ce_{0.1}Cu_{2.2}Si_2$ clearly show NFL signatures with temperature dependences compatible to those reported in [2] at $T > 1.5$ K, but a crossover to $\gamma(T) = \gamma_0 - \alpha T^{1/2}$ and $\rho(T) = \rho_0 - \beta T^{3/2}$ at still lower temperatures. Note that our resistivity data deviate strongly from $\rho(T) = \rho_0 - \beta' T^{1/2}$, the theoretical prediction for the $M = 2$ Kondo model [1]. $\Delta\gamma \propto -T^{1/2}$ and $\Delta\rho \propto -T^{3/2}$ power laws have recently been calculated in the mean-field approximation by Sachdev *et al.* [5] as well as by Sengupta and Georges [6] for the case of a $T = 0$ spin-glass transition in a Kondo lattice with randomly quenched local magnetic moments. As evidence for spin-glass transitions at low but finite temperatures in $La_{1-x}Ce_xCu_{2.2}Si_2$ with $x \geq 0.15$ is given in Refs. [2,7], we think that the nearness to disordered magnetism rather than a two-channel Kondo effect governs the physical properties $La_{0.9}Ce_{0.1}Cu_{2.2}Si_2$ at low temperatures.

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