

MAGNETIC PROPERTIES OF CeNiSn DOPED WITH Cu OR Pt

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CeNiSn is a non magnetic Kondo semi-metal. Replacing Ni in part by Cu or Pt induces magnetism when a certain critical concentration is exceeded. The absence of long- or even short-range magnetism in CeNiSn [1] is due to the dominance of Kondo interaction over RKKY coupling ($T_K > T_{RKKY}$). The magnitude of T_K is determined by the degree of hybridization of the Ce 4*f* state with the conduction electron sea. The nominal picture is, that the introduction of Cu or Pt widens the unit cell which weakens the hybridization and in turn reduces T_K below T_{RKKY} when exceeding the critical concentration. The transition temperature (T_M) into a magnetic state is determined as the temperature where the muon spin relaxation rate (in ZF) exhibits a sharp upturn. For CeNi_{1-x}Cu_xSn we had found earlier [2] a critical concentration $x_{cr}^{Cu} \approx 0.07$. In the present work we studied CeNi_{0.74}Pt_{0.26}Sn which was found to be magnetic ($T_M = 1.5$ K) while the compound with $x = 0.2$ is non magnetic. This leads to $x_{cr}^{Pt} \approx 0.23$. Fig. 1 (which supersedes the corresponding figure shown in [2]) shows that in order to create a magnetic state one needs a volume expansion about twice as large when doping with Pt relative to Cu, meaning that volume increase is not the only mechanism inducing magnetism in the CeNiSn series. Pt is isoelectronic to Ni, but Cu contains one additional 3*d* electron. One concludes that an increase of *d* electron density helps to move towards the onset of magnetism.

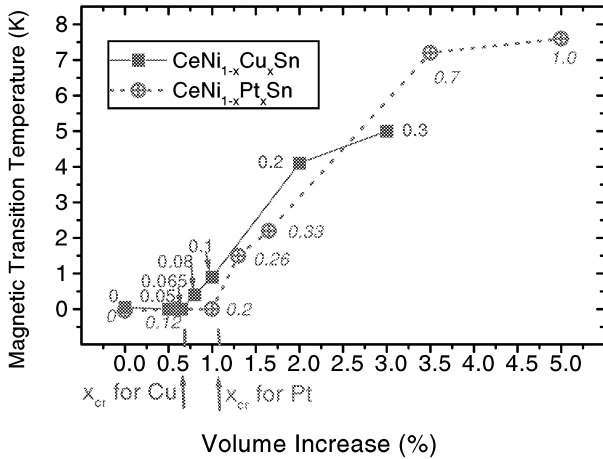


Figure 1: Volume dependence of T_M for CeNi_{1-x}Cu_xSn and CeNi_{1-x}Pt_xSn. The numbers at the data points give the values of x .

In addition, we have performed μ SR Knight shift and TF relaxation rate measurements for CeNi_{1-x}Cu_xSn compounds with $x = 0.065, 0.08, 0.2$ (i.e. just below, just above the onset of, and well inside the magnetic regime). A small Knight shift exists for $x = 0.065$, but without any temperature dependence. Although the magnitude of the Knight shift

is roughly the same as in CeNiSn [3] at base temperature, the absence of a temperature dependence is a distinct difference signaling a definite change in electronic structure whose origin may be the loss of coherent AFM spin excitations with crystallographic disorder [4]. Furthermore, we find a linear field dependence of the Knight shift, again contrasting the behavior of CeNiSn where a slight curvature is present. In the pure material the spin correlations at low temperatures are weak and respond to even small external fields. The addition of Cu strengthens the correlations. The corresponding studies for the magnetic compounds with $x = 0.08$ and 0.2 are summarized in Fig. 2. The Knight shift in the paramagnetic regime of the $x = 0.2$ compound exhibits a clear temperature dependence, reflecting weak critical behavior. At T_M a jump of Knight shift occurs. Both features are barely visible in the $x = 0.08$ material which obviously is only weakly magnetic. The TF relaxation rates show little critical behavior for both compounds, but a distinct field dependence in the paramagnetic regime which vanishes at the transition point. In the magnetic regime the internal field fully dominates the applied field in both cases. The ZF spectra at low temperatures for $x > 0.07$ are characterized by a monotonic gaussian decay of muon spin polarization, implying a disordered cluster-type magnetic state [5].

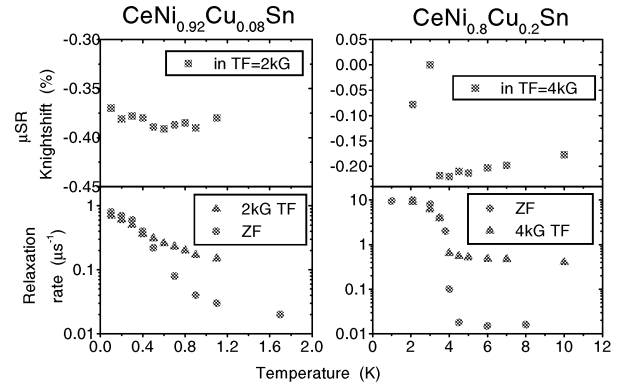


Figure 2: μ SR Knight shift and TF relaxation data for CeNi_{1-x}Cu_xSn with $x = 0.08$ (left) and $x = 0.2$ (right). The ZF data are taken from previous studies.

REFERENCES

- [1] A. Kratzer *et al.*, Europhysics Lett. **19**, 649 (1992).
- [2] G. M. Kalvius *et al.*, Physica B **289-290**, 256 (2000).
- [3] G. M. Kalvius *et al.*, Physica B **206-207**, 807 (1995).
- [4] A. Brückel *et al.*, Physica B **240**, 199 (1997).
- [5] D. R. Noakes, J. Phys: Cond. Matt. **11**, 1589 (1999).