ESR IN THE HEAVY-FERMION UPt_3 DOPED WITH Er AND Gd

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In a previous paper[1] it was shown that the ESR data of the heavy-fermion (HF) compound UBe_{13} doped with magnetic impurities of Er and Gd do not reflect the enhanced density of states determined by specific heat measurements. For this compound the ESR linewidth thermal broadening was expected to be very large and nonlinear. But in fact, we measured a linear Korringa rate for Er about four times bigger than the value for the reference compounds, within however, the same order of magnitude. One reason for this behaviour is that in UBe_{13} the U atom is surrounded by a cage of 24 next neighbours Be atoms that shield the effect of the U ion valence fluctuation, so that the Rare Earth (RE) ion is not coupled to the U atom and therefore, cannot reflect the corresponding large density of states. To test this argument we need another HF compound with a smaller number of neighbours which also becomes superconducting. We choosed UPt_3, an hexagonal HF, with the same basic features of the specific heat. The ESR data was taken in both poly and monocrystalline samples between 0.6 and 15K in a conventional X - band spectrometer. In all samples the magnetic impurity concentration was 1000 ppm to avoid interactions effects. The single crystals were needle like, with the c_{3+} axis directed along the needle. For Er^{3+} the single crystal ESR spectra was highly anisotropic with g perpendicular and g parallel to the c axis respectively 9.21 and 0.86. The Korringa rate was determined for magnetic field perpendicular to c axis where the linewidth was minimum and we observed a linear relation $\Delta H = a + b*T$ with b = (8±1) G/K and a = (20±2) G. We were also able to determine the ground state for the Crystal Field (CF) as a $\Gamma 7$ state, $\Gamma 7 = -0.198/\pm 13/2> + 0.95/\pm 1/2> - 0.25/\mp 11/2>$ that corresponds to a ratio between the fourth and sixth order CF parameters of -0.4. The Korringa rate for Gd was also linear with B=1.1 G/K. The reference compund in this case is UPd_3 that is also hexagonal and shows a well behaved low temperature specific heat. The Korringa rate for Er^{3+} in UPd_3 is very small b=(1±1) G/K and difficult to be determined. As expected, a less effective shielding in UPt_3 yield a factor 8, bigger than in UBe_{13}, on the HF Korringa rate as compared to the reference compound. The conclusion is that even for a less complicated HF system such as UPt_3 the RE ESR reflects a disminished influence of the large density of states of the host material. Considering the deviation of the linear behaviour for the Korringa rate of the NMR of the Be nuclei[2], one possible explanation for the ESR results is that, besides the shielding effect, the RE magnetic impurity locally changes the band structure leading to a different density of states at the RE site. The increase by a factor 4 in the HF UBe_{13}:Er Korringa rate compared to non HF reference compounds might be due to s and d band contributions to the product of the density of states and J the exchange coupling constant as a result of part of the full effect of the enhanced γ at the RE site. The reduction of the Korringa rate of Gd is consistent with the results obtained in many HF and valence fluctuation compounds.

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