Magnetic Ordering in $EuNiO_3$

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The metal to insulator transition at $T_{MI}$and related changes in structure and magnetic behavior in the rare-earth nickelates $RNiO_3$ have been intensively studied in recent years. Evidence for charge disproportionation occurring in $EuNiO_3$ has been reported using 1at% ^{57}Fe substituted for Ni as nuclear probe for Mössbauer spectroscopy [1,2]. For $EuNiO_3$ T_{MI} = 460 K is much higher than the Néel temperature T_N $\approx$ 210 K. The magnetic hyperfine patterns below T_N in the insulating state reveal two high spin Fe^{3+} sites with roughly equal spectral weights attributed to iron substituted into Ni sites with different charge state. Fe^{3+} is expected to be magnetically frustrated in one of these sites as proven from the dynamic Mössbauer hyperfine spectra. In an earlier μSR study [3] on pure $EuNiO_3$ only a partial loss of asymmetry was detected below T_N. Neutron diffraction studies are precluded for studying the magnetism of $EuNiO_3$ and the ordered state still is ill defined.

We have performed μSR at the GPS facility of SμS between 5 K and 290 K, both for undoped and 1% Fe doped $EuNiO_3$. T_N of the Ni sublattice is only weakly indicated in susceptibility which reveals a temperature dependence which is far from typical for an antiferromagnet. The moment is further increasing below T_N and saturating below $\sim$ 120 K. At low temperatures Eu^{3+} is expected to be in the non-magnetic $F_{J=0}$ ground state. There are, however, contributions to susceptibility from induced moments due to mixing with the higher crystal electric field states.

Our ZF μSR data clearly reveal several spontaneous muon spin rotation signals as expected in a magnetically ordered state with various sites occupied by μ^+. For the analysis we used a superposition of three rotating signals with exponential damping and a non-magnetic background signal.

Above 160 K the three signals cannot be resolved. For the sample doped with 1% Fe only one rotating signal is detected. There appears however a considerable non-rotating magnetic contribution indicating a severe disturbance by doping. Magnetic long-range order occurs below T_N= 210 K for both samples. The perturbation introduced by the iron, however, prevents the observation of two of the three muon sites detected for the undoped material. For the undoped material there is an indication for two magnetic regimes: Between 210 K and 160 K the muon magnetic response is the same for the three sites, below the signals can be well resolved. We propose that the antiferromagnetic spin structure of Ni just below T_N is changing to a more complex one at lower temperatures as found e.g. for $NdNiO_3$[4]. Reason is the increasing induced moment at Eu below T_N. Saturation of this moment is only achieved below about 120 K where also the rotation frequencies saturate. Comparison will be made to $YNiO_3$ where Y is carrying no moment at all.

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