

Nuclear magnetic resonance studies in rare earth ternary phosphides

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Abstract. The results of ^{31}P Knight shift (KS) and spin-lattice relaxation time (T_1) measurements in the temperature interval 4.2–300 K are reported for the compounds RENi_2P_2 (RE = Ce, Eu, Yb) in order to understand the nature of the ground state in these compounds. KS results conclusively establish that all these compounds exhibit non-magnetic ground states. The temperature dependence of spin-fluctuation temperature (T_{sf}) in each case is estimated from the measured data. For EuNi_2P_2 the values of T_{sf} above 77 K qualitatively agree with those obtained from Mössbauer and susceptibility data employing ionic interconfigurational fluctuation model, but disagree at lower temperatures.

Keywords. Nuclear magnetic resonance; rare earth ternary phosphides; Knight shift; spin-lattice relaxation.

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Ever since the phenomenon of valence instabilities has been realized in rare earth systems, there has been growing interest in the application of several experimental methods in understanding the nature of the ground state in these compounds (Lawrence *et al* 1981). Among these methods, nuclear magnetic resonance (NMR) occupies a special place, as it gives a lot of information about the static as well as the dynamic part of the $4f$ magnetism through the measurement of Knight shift (KS) and spin-lattice relaxation time (T_1) of a suitable non-magnetic nucleus, respectively. As a part of our programme on the application of NMR to such rare earth systems, we have investigated the compounds RENi_2P_2 (RE = Ce, Eu, Yb), crystallizing in the ThCr_2Si_2 -type tetragonal structure. We have chosen this relatively new series of compounds because a lattice volume anomaly (figure 1) has been observed for Ce, Eu and Yb indicating a non-trivalent state of these ions in this series (Jeitschko and Jaberg 1980). It should be mentioned here that EuNi_2P_2 has been earlier identified to be an interesting intermediate valent compound with a non-magnetic ground state (Nagaranjan *et al* 1985). Therefore, from the systematics observed in the ThCr_2Si_2 type compounds, one would naively expect that CeNi_2P_2 and YbNi_2P_2 also should exhibit non-magnetic ground states. The present work is aimed at verifying this hypothesis microscopically by the measurement of ^{31}P Knight shift. Another aspect of this work is to obtain an estimate of the spin-fluctuation temperature (T_{sf}) from the measured T_1 , KS and susceptibility (χ) values and to compare such results with those obtained by traditional methods. Such academic exercises are helpful in understanding the validity of the models of valence fluctuation.

The samples were prepared as described in the literature (Jeitschko and Jaberg 1980).