PRAMANA
—journal of
physics

© Printed in India

Vol. 50, No. 3,
March 1998
pp. 263–269

Proton NMR in $CeNiInH_{0.53}$ down to liquid helium temperature

R RAY, A GHOSHRAY, K GHOSHRAY and N CHATTERJEE
S.S. and M.P. Division, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Calcutta 700 064, India
Email: agr@cmp.saha.ernet.in

MS received 19 December 1997

Abstract. The NMR probe and the matching network has been designed for the ^1H NMR study in $CeNiInH_{0.53}$ down to liquid helium temperature using Bruker MSL 100 spectrometer. NMR lineshape measurement shows the absence of any signature of proton pairing in $CeNiInH_{0.53}$ down to 3.86 K, as it was observed for high hydrogen concentration. The measurement of the spin-lattice relaxation time in the temperature range 300–20 K reveals that the relaxation rate is mainly governed by the Korringa-type relaxation mechanism.

Keywords. NMR; line shape; spin-lattice relaxation.

PACS Nos 76.60; 76.00

1. Introduction

The evidence of an ordered arrangement of proton pairs with H–H separation ~ 1.5–1.6 Å, as found in Fe_2P type intermetallic hydrides $CeNiInH_x$ and $PrNiInH_x$ ($x \geq 1$) [1, 2] from NMR, has attracted much interest. Such type of pairing of protons with separation 1.9 Å has recently been observed by Kumitomo *et al* [3] in the sodium insertion compound of hydrogen molybdenum bronze. These results violate Switendick's criterion – the nearest neighbour H–H distance in a metal lattice has never been found to the less than 2.1 Å. However, the discovery of the stable bonding neutral dihydrogen molecules to molybdenum and tungsten complexes by Kubas *et al* [4] has led to the speculation regarding the possibility for two hydrogen atoms in bulk metal hydride to favour either a molecular form of pairing or a pairing of the two hydrogen atoms mediated by a metal atom [5].

In this paper, we report on ^1H NMR studies on $CeNiInH_{0.53}$ in the temperature range 3.8–70 K. Our earlier measurements above 77 K show that in $CeNiInH_x$ with $x < 1.0$, protons do not exist in pairs and they are highly mobile in the interstices. The possibility of pairing of protons as mentioned above even in $CeNiInH_{0.53}$ at low temperatures, wherein hydrogens are supposed to be in rigid condition in comparison with NMR frequency, has led us to do this measurement. Results, however, indicate that there is no such type of pairing of protons in this compound even at liquid helium temperature. Nevertheless, the variation of spin-lattice relaxation time, T_1 with temperature (20–300 K) throw some light on the behaviour of f electron of the cerium ion in the compound.