NMR investigation of the high-magnetic-field "Bose-glass" regime of the Br-doped DTNX compound, $Ni(Cl_{1-x}Br_x)_2$-$4SC(NH_2)_2$

Anna Orlova[1], Rémi Blinder[1], Edwin Kermarrec[1], Maxime Dupont[2], Nicolas Laflorencie[2], Sylvain Capponi[2], Claude Berthier[1], Armando Paduan-Filho[3], Mladen Horvatić[1]

[1] Laboratoire National des Champs Magnétiques Intenses, LNCMI - CNRS (UPR3228), EMFL, UGA, UPS and INSA, BP 166, 38042 Grenoble Cedex 9, France
[2] Laboratoire de Physique Théorique, IRSAMC, Université de Toulouse, CNRS, 31062 Toulouse, France
[3] Instituto de Física, Universidade de São Paulo, 05315-970 SP, Brazil

We report on the Nuclear magnetic resonance (NMR) investigation of the high-magnetic-field "Bose-glass" (BG) regime of the (bond-) Br-doped DTNX compound, $Ni(Cl_{1-x}Br_x)_2$-$4SC(NH_2)_2$. The undoped (x = 0) DTN compound is one of the most studied spin compounds[1] presenting, between the two critical magnetic fields H_{c1} and H_{c2}, a magnetic-field-induced low-temperature 3D-ordered phase that can be described as a Bose-Einstein condensate (BEC). The system consists of weakly coupled chains of S = 1 (Ni-ion) spins subject to a single-ion anisotropy of the easy plane type. Doped DTNX allows studying the effect of bond disorder introduced by doping[2], which may lead to the appearance of a BG phases adjacent to the (disordered) BEC phase, as suggested from the thermodynamic measurements[3].

We present here the first microscopic information on the high-field ($H > H_{c2}$ = 12.2 T) regime in DTNX[4]; the low-energy spin fluctuations (dynamics) are measured by T_1^{-1} NMR relaxation rate, while the NMR line-position and spectra revealed the local spin polarizations. As compared to DTN, the main feature of spin dynamics in DTNX is a peak of T_1^{-1} appearing at H^* = 13.6 T independently of the doping level. This is attributed to the level crossing of energy levels of the states strongly localized at the doped bond position, which is then somewhat distributed/ disordered by the mutual interaction of these states. The disorder is seen by NMR as the inhomogeneous relaxation, relatively broad width of the T_1^{-1} peak, and by the modification of the Arrhenius $T_1^{-1}(T)$ dependence.

From the NMR spectra we could determine the local spin-polarization value of the spin adjacent to the doping position, which allows us to experimentally define the related local exchange coupling and local single-ion anisotropy. We thereby fully characterize the impurity state created by doping, making it possible to make a microscopic theoretical model of this system and discuss how well is DTNX (above H_{c2}) expected to represent a true Bose-glass.

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