# Low Temperature Quantum Critical Behavior in the One Dimensional Spin Chain Compound Copper Pyrazine Dinitrate Probed by $^{13}$C NMR

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The compound copper pyrazine dinitrate (CuPzN) is one of the best realizations of the AFM $S$ = 1/2 Heisenberg chain (AFHC) model, which is one of the main paradigms of many-body physics. Compared to other $S$ = 1/2 chain systems it has a small nearest neighbor exchange coupling constant $J/k_B$ = 10.7 K, allowing experimental access to the parameter range of the zero temperature saturation field $B_c \approx$ 14.6 T and above. CuPzN has been characterized by a number of methods such as inelastic neutron scattering, specific heat and magnetization measurements [1]. All of these studies are consistent with a description of CuPzN in terms of the AFHC model.

We performed low temperature $^{13}$C NMR experiments on a single crystal of CuPzN in SCM1 at temperatures between 140 mK and 1200 mK and fields between 10 T and 16 T. In order to reduce the off-diagonal elements of the hyperfine coupling tensor, the crystal orientation with respect to the external magnetic field was adjusted by comparing the observed anisotropy of the NMR frequency shift to a simulation based on a localized dipole approximation for the electronic magnetic moments.

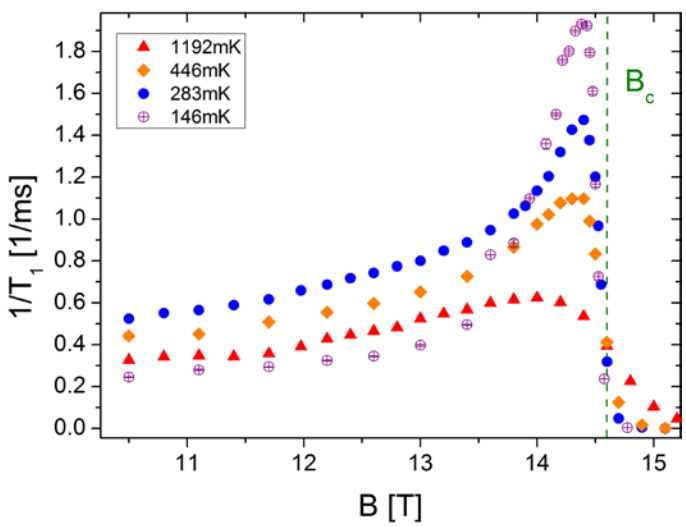


***Figure 1:*** *Field dependence of the $^{13}$C nuclear spin lattice relaxation rate at different temperatures in the regime of the field driven quantum phase transition.*

The results of our low temperature experiments show a pronounced maximum of the nuclear spin lattice relaxation rate $1/T_1$ at fields slightly *below* the zero temperature saturation field $B_c$, compare **Figure 1**. Approaching 146 mK, the maximum in $1/T_1$ shifts towards $B_c$ and gets sharper than predicted by field theoretical calculations (not shown) for the isotropic S = 1/2 antiferromagnetic Heisenberg chain with dominant nearest neighbor interactions [2].

This unexpected sharpening is likely due to small interchain interaction mechanisms, which previously were found to lead to a long-range ordered state below 107 mK, probed by zero field µSR measurements [3]. The comparison of our experimental data to future calculations for a Heisenberg chain with additional mean field type interaction mechanisms will shed light on the interplay of 1D magnetic excitations and higher dimensional correlations in one of the best characterized sample systems of low dimensional quantum spin physics.

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