Magnetization Study of a *S* = 1 Linear-chain Antiferromagnet with *D*/*J* ≈ 1

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Introduction

Linear-chain, integer-spin antiferromagnets, commonly known as Haldane systems, continue to receive considerable attention for a variety of fundamental and technologically relevant reasons. After Haldane identified the gap in these systems, the boundary between the Haldane and Large-*D* phases was identified at *D*/*J* ≈ 1 [1], where *D* and *J* are the zero-field splitting and nearest-neighbor interaction parameters, respectively. Although no condensed matter system has been localized near this critical boundary, theoretical and numerical interest continues due to the possibility of identifying the transition in quantum gases. In fact, recent numerical work suggests that the critical ratio is $[D/J]_C = 0.97$ [2,3].

Recently, $[Ni(HF_2)(3\text{-}Clpy)_4]BF_4$ has been identified as a *S* = 1 linear-chain antiferromagnet with *D*/*J* ≈ 1 [4]. Specifically, the crystal structure consists of one-dimensional zig-zag chains, whereby NiN_4F_2 octahedra are linked only by HF_2- ligands. Fitting of the low-field, high-temperature $\chi(T)$ data suggests *J* = 4.86 K, whereas modeling of UV-Vis data indicates *D* ≈ 4.3 K. Since *D*/*J* ≈ 0.88, the present work was initiated to explore this system at temperatures below the previous lower limit of nominally 0.5 K [4].

Experimental Details

Low frequency (53 Hz) magnetic susceptibility studies were performed in the Williamson Hall Annex of the NHMFL High-B/T Facilities located at UF. The experimental approach has been described elsewhere [5].

Results and Discussion

To date, data have been acquired at 1.05 K and 210 mK while using a frequency of 53 Hz, and the differences between these two data sets are shown in **Figure 1**. Attempts to perform measurements at lower temperatures were not yet successful as the solvent, 3-chloropyridine, used to stabilize the samples, was surprisingly aggressive. Consequently, a new sample holder was constructed with Kel-F® by *3M* (now known as *Daikin* Neoflon® PCTFE), and the work is continuing.

Summary

Differences between the high (1.05 K) and low (210 mK) temperature magnetic susceptibilities have been observed. Additional studies to lower temperatures are needed to resolve the nature of this signal compared to the background of the sample container.

Acknowledgements

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References

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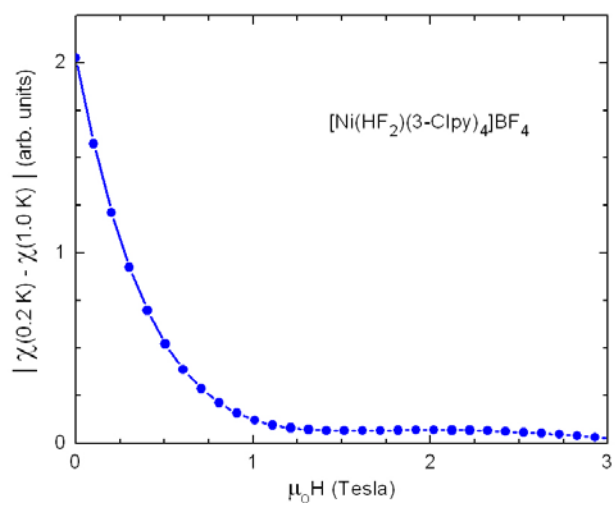

Figure.1. The difference between the isothermal data sets at 1.05 K and 210 mK are shown as a function of field. The studies were performed up to 10 T, but the low field region shows the differences that are similar to the ones observed in pulsed-field magnetometry studies performed at 1.6 K and 0.5 K, see inset of Fig. 3(b) of Ref. [4].