THERMAL TRANSPORT AT ^{3}He TEMPERATURES UP TO 15 T IN $NiCl_2$-4SC$(NH_2)_2$

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Spin gap compounds can exhibit many interesting quantum effects that are only be realized at low temperatures and high magnetic fields. One of the most exciting possibilities is that these spin gap compounds may be magnetic analogs of the Bose Einstein Condensate (BEC). Thermal conductivity, κ, measurements may provide a more direct probe of the BEC state, e.g. κ of superfluid liquid ^{4}He is extremely large below the BEC λ-transition. $NiCl_2$-4SC$(NH_2)_2$ may be one promising candidate for realizing the spin-BEC state [1]. The supposed BEC state occurs below 1 K in fields from 2-12 T, therefore, we have measured κ with the Oxford ^{3}He system with a 15 T magnet at the NHMFL-LANL.

We show our results for the thermal conductivity along the c-axis of $NiCl_2$-4SC$(NH_2)_2$ in Fig. 1 as a function of temperature at various fixed fields. Two Cernox thermometers were used to monitor the temperature gradient across the sample while heat was applied using a 10 kOhm chip resistor. No field calibration was performed so that the magnitude of κ and the temperature scale may be off by 20%. Nevertheless, we have observed some features in the vicinity of the phase boundary for the proposed spin-BEC state.

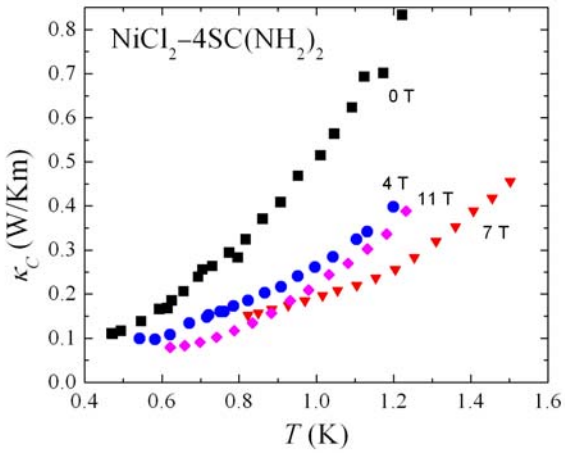

Fig. 1. *Thermal conductivity along the c-axis for $NiCl_2$-4SC$(NH_2)_2$ as a function of temperature at various fixed fields.*

It appears that no sharp features are seen, although it is possible that κ does show an increase at the BEC phase boundary as might be naively expected. Judging from the results it is possible that the thermal conductivity may become larger at lower temperatures. By measuring the anisotropic κ at dilution refrigerator temperatures and high fields, one may be able to observe "superfluid" behavior in the thermal conductivity. We will continue this work with the 20 T magnet equipped with a dilution refrigerator at NHMFL-LANL next year.

Acknowledgements

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References

[1] Zapf, V., *et al.*, cond-mat/0505562.