Magnetic Susceptibility of the Pyrochlore Magnet $Tb_2Ti_2O_7$ at High Fields

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Introduction

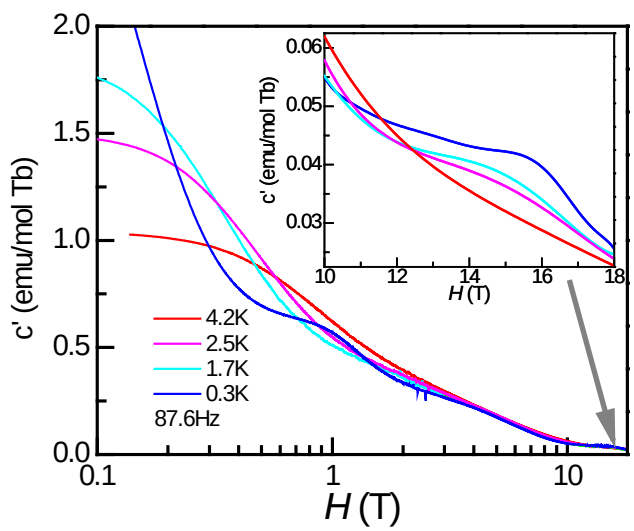
The geometrically frustrated pyrochlore magnet $Tb_2Ti_2O_7$ has drawn much attention due to its failure to order at zero magnetic field at least down to 50 mK. Most rare-earth pyrochlore magnets display either a spin-ice ground state or a long-range magnetic order at low temperature. Ferromagnetic Heisenberg interactions on the lattice of corner-linked tetrahedra occupied by Tb^{3+} spins (the effective spin = 1/2) are highly frustrated, because of the Ising anisotropy along the local <111> axis, leading to macroscopic degeneracy in the ground state. However, the Heisenberg interactions in $Tb_2Ti_2O_7$ are believed to be antiferromagnetic, for one because the Curie-Weiss temperature is negative. Therefore, the inability of this material to order is puzzling. The low-temperature low-field phase diagram has been established in Ref.[1], but high-temperature regions have been poorly explored. For better understanding of the magnetism of $Tb_2Ti_2O_7$, it is important to perform measurements of magnetic susceptibility above 300 mK.

Experimental

The magnetic susceptibility of a single crystalline $Tb_2Ti_2O_7$ was measured above 300 mK and up to 18 T, using the NHMFL DC Field Facility (SCM2). The direction of the external magnetic field was along the [111] direction. The frequency of the AC excitation was 87.6 Hz.

Results and Discussion

At 1T, an antiferromagnetic transition was found at 300 mK. This is similar to that reported by Ref.[2]. At about 16 T, there exists another magnetic transition. As temperature is increased from 300 mK to 4.2 K, the shoulder-like feature indicative of the transition gradually collapses and disappears. The mechanism of this new transition is still unknown. It is quite possible that the new phase above about 16 T involves a new spin configuration.



Conclusions

We have measured the magnetic susceptibility of $Tb_2Ti_2O_7$ above 300 mK and in magnetic fields up to 18 T and found two magnetic transitions. The transition at about 16 T is new.

Acknowledgments

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References

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[2] Legl, S., *et al., Phys. Rev. Lett*., **109**, 047201 (2012).