Quantum Spin Liquid Behavior in $Yb_2Sn_2O_7$

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Introduction

In the classical spin ices $R_2Ti_2O_7$ (R = Ho and Dy), strong quantum spin fluctuations are absent [1]. On the other hand, in some other rare-earth pyrochlores, the low-energy spin dynamics can be reduced to that of an effective spin-1/2 moment, which gives the strongest possible quantum effect. $Yb_2Sn_2O_7$ is a promising example for quantum spin liquid.

Experimental

Polycrystalline samples of $Yb_2Sn_2O_7$ were prepared by solid-state reaction. The low temperature magnetic torque and specific heat were measured with an in-house designed magnetometer and calorimeter in SCM1 at the NHMFL.

Results and Discussion

In order to search for a possible magnetic transition for $Yb_2Sn_2O_7$, the AC susceptibility measurements were performed down to 0.03 K. As shown in **Figure 1**(a), the real part of the AC susceptibility (χ') shows a broad peak at 0.13 K (T_{peak}) with f = 47 Hz at zero magnetic field. Accordingly, the imaginary part χ" rises below 0.14 K and shows a peak at 0.11 K. With increasing frequency, this peak moves to lower temperatures. When a small magnetic field, such as 0.02 T, is applied, the χ' peak significantly becomes broader and moves to higher temperatures (Figure (1(b)). The frequency-dependent behavior suggests the short-range magnetic ordering nature of the χ' peak.

The T_{peak} decreases with increasing frequency, which is distinct from other short range ordering systems, for example spin glass. Accordingly, the energy barrier calculated from the linear fitting of the ln(f)~ 1/$\mathbf{T}_{peak}$ (Insert of Figure 1(b)) is -1.7 K. Recently, our neutron scattering results shows an almost temperature-independent relaxation time for $Yb_2Sn_2O_7$, which indicates a quantum dynamics regime with zero activation energy below 2 K. The possible barrierless reactions below 2 K then could cause the abnormal frequency dependence with negative activation energy when the system finally enters a spin freezing or quantum spin liquid state below 0.13 K.

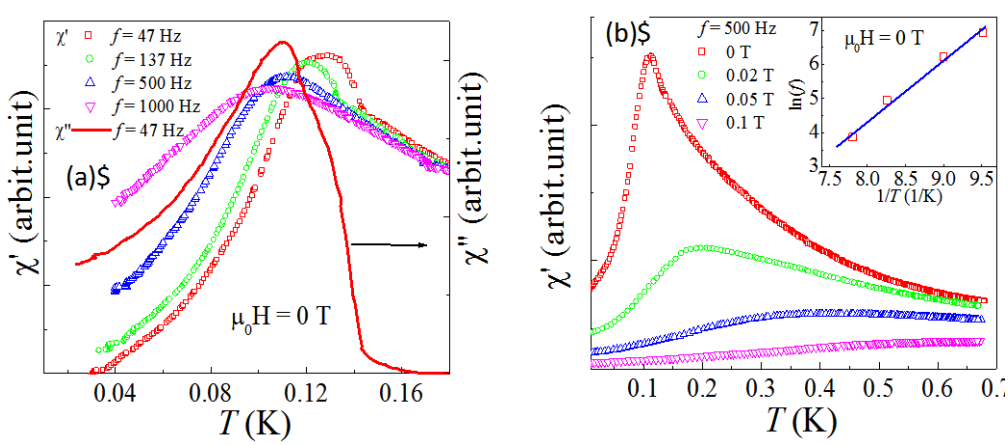

Figure 1. (a) The real (χ') and imaginary parts (χ") of AC susceptibility with different frequencies at zero magnetic field; (b) χ' with 500 Hz at different magnetic fields. Insert: frequency dependence of T_{peak}.

Acknowledgements

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References

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