Magnetic Ground States of $Yb_2B_2O_7$ Studied by AC Susceptibility

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Introduction

Recently, the pyrochlore $Yb_2Ti_2O_7$ has received a lot of attention as a potential quantum spin liquid (QSL) at low temperatures, due to the effective S = 1/2 nature of the Yb^{3+} cations [1]. However, the effects on this QSL state from various perturbations have not been systematically studied. The ability to synthesize a series of $Yb_2B_2O_7$ (B = Sn, Ti, Ge) pyrochlores with different lattice parameter makes it possible to study the chemical pressure effects on the magnetic ground state of $Yb_2B_2O_7$.

Experimental

The AC susceptibility including the linear and the nonlinear components was measured using a custom coil set in SCM1 at the NHMFL [2].

Results and Discussion

Based on all of the AC susceptibility results, we clarify that (i) $Yb_2Sn_2O_7$ is FM below 0.13 K but with short-range ordering feature; (ii) in $Yb_2Ti_2O_7$, at least for our studied polycrystalline sample, there is a FM ordering at 0.25 K; (iii) $Yb_2Ge_2O_7$ has an AFM ordering transition at 0.62 K. Therefore, the magnetic ground states among all three Yb-pyrochlores are different, which shows that the quantum spin fluctuations in Yb-pyrochlores are very sensitive to the chemical pressure due to the lattice change. The 4.6% lattice shrinkage from Sn to Ge sample efficiently changes the magnetic ground state from ferromagnetic to antiferromagnetic ordering.

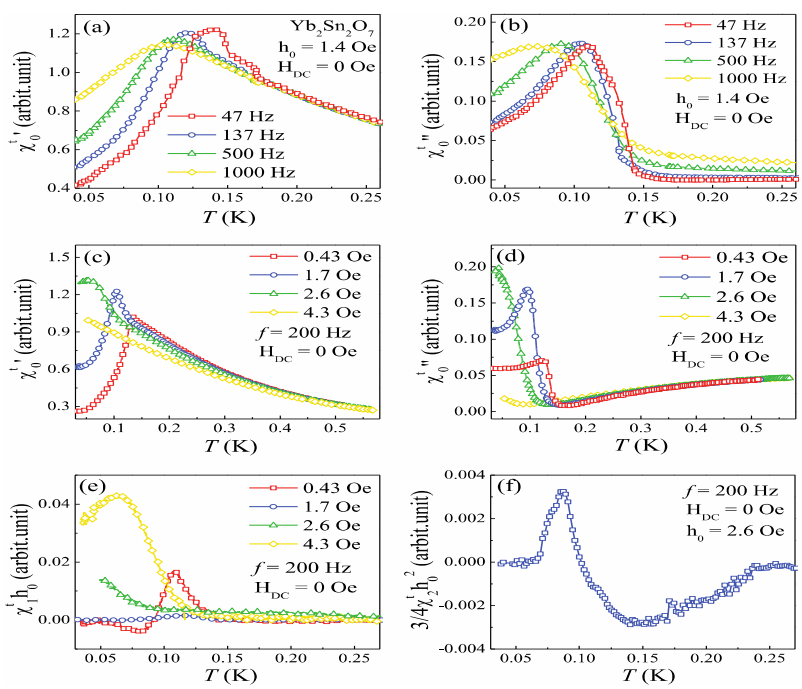

FIG. 1: All data were taken with H_{DC} = 0 Oe for $Yb_2Sn_2O_7$. Temperature dependencies of (a) $\chi_0^{t'}$ and (b) $\chi_0^{t''}$ measured with h_0 = 1.4 Oe under different frequencies. Temperature dependencies of (c) $\chi_0^{t'}$ (d) $\chi_0^{t''}$, (e) χ_1^{t} h_0 measured with f = 200 Hz, H_{DC} = 0 Oe under different h_0 and (f) $3/4\chi_2^{t}h_0^2$ measured with f = 200 Hz, h_0 = 2.6 Oe, and H_{DC} = 0 Oe.

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References

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[2] Dun, Z. L., *et al*., Phys. Rev. B, **87**, 134408 (2013).