# FIELD-INDUCED PHASES OF THE SPIN-LIQUIDS $Tb_2Ti_2O_7$ AND $Nd_3Ga_5SiO_{14}$

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## Introduction

Geometrical frustration is a central theme in contemporary condensed matter physics, as it allows the possibility of exotic ground states [1]. Geometries which support magnetic frustration typically involve edge- and corner- shared triangles and tetrahedra. Here we combine high field bulk measurement techniques, particularly magnetic torque and magnetization, with polarized elastic and inelastic neutron scattering techniques to study the nature of the magnetic phases emerging from two frustrated compounds that do not display any magnetic ordering down to the lowest temperatures, i.e., the pyrochlore $Tb_2Ti_2O_7$ and the distorted Kagome lattice $Nd_3Ga_5SiO_{14}$. We have thus determined the *H-T* phase diagram of both spin-liquid compounds.

## Experimental

We used a combination of superconducting and resistive magnets, as well as cantilever beam and vibrating sample holder magnetometry down to $^3$He temperatures to extract the *H-T* phase diagram of both compounds. While elastic and inelastic neutron scattering was performed at NIST in order to both explore the magnetic ordering and the spectrum of spin excitations in both compounds.

## Results and Discussion

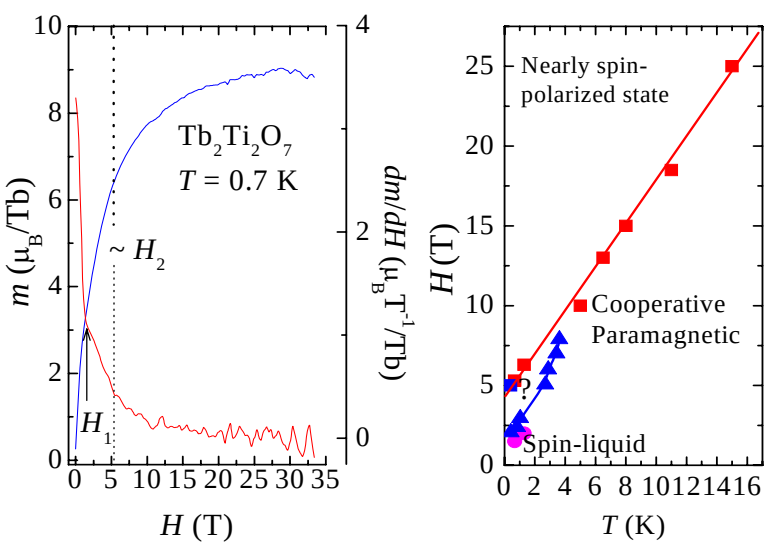


FIG. 1 Left panel: Magnetization *m* as a function of the external field *H* for a $Tb_2Ti_2O_7$ single crystal grown at the NHMFL at *T* = 0.7 K. The same graph also display the derivative of *m*(*H*) vs *H* in red. Right panel: the resulting *H-T* phase diagram (unpublished). The physical properties as well as the nature of the field-induced phases are yet to be established. This figure represents just an example, a small sub-set of the data collected so far.

## Conclusions

Tb2Ti2O7 under field undergoes a transition from a cooperative paramagnetic state (i.e., a spin liquid state) into what seems to be a new paramagnetic state where the spins a nearly polarized and then to a nearly polarized state at higher fields. The description of this intermediary phase is currently under consideration by our theoretical partners. While $Nd_3Ga_5SiO_{14}$ reveals a new field-induced phase characterized by a plateau at half of the magnetization maximum. This new phase is produces Bragg peaks revealing magnetic ordering, but many of the spins still contribute to diffuse scattering in the neutron spectrum indicative of the coexistence between an un-gapped liquid like state with magnetic ordering.

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## References

[1] See, for example, Diep, H.T. (World Scientific, Singapore 2004).