

# Magnetic excitations and field-induced magnetic phases in the geometrically frustrated system $\text{TbB}_4$

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The rare-earth tetraboride  $\text{TbB}_4$  is a fascinating material that illustrates the complexity of geometrically frustrated magnetism. Its crystal structure, which maps onto the Shastry-Sutherland lattice, hosts competing antiferromagnetic interactions that give rise to a rich and complex magnetic phase diagram. At zero field,  $\text{TbB}_4$  undergoes two antiferromagnetic transitions at 44 K and 24 K, while the application of a magnetic field along the  $c$  axis at low temperature induces a cascade of fractional magnetization plateaus. These plateaus, reminiscent of a devil's staircase, suggest intricate interactions between magnetic moments, lattice distortions, and external magnetic fields. Despite extensive research, the microscopic mechanisms driving these phenomena, particularly the role of structural distortions, magnetic anisotropy, and exchange interactions, remain poorly understood.

This PhD project aims to unravel the interplay between magnetic order, lattice dynamics, and external fields in  $\text{TbB}_4$ . By combining neutron scattering experiments, high-field magnetization measurements, thermal expansion and heat capacity studies, the project seeks to deepen our understanding of the material's magnetic phase diagram and excitations. Building on existing neutron diffraction data obtained in pulsed fields, this project will further analyze magnetic excitations and structures through additional neutron scattering experiments. High-field magnetization measurements will be revisited to elucidate the stability of field-induced phases. Meanwhile, thermodynamic and lattice responses, probed through thermal expansion and heat capacity measurements in static fields, should reveal the delicate balance between magnetic and structural degrees of freedom.

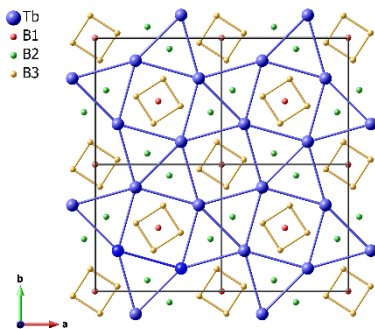


Fig. 1: Projection of  $\text{TbB}_4$  structure along the tetragonal  $c$ -axis. The Tb ions form a network that topologically maps the SSL lattice.

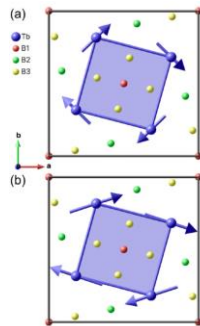


Fig. 2: Magnetic structure of  $\text{TbB}_4$  at low temperature and intermediate temperature from ref. [3]

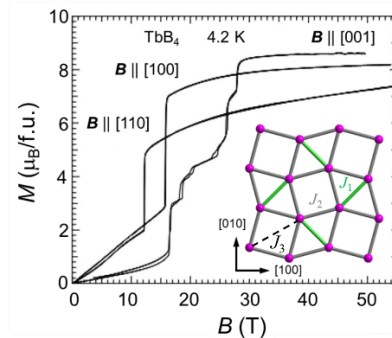


Fig. 3: Magnetization of  $\text{TbB}_4$  at 4.2 K for magnetic field applied along [100], [110] and [001] from ref. [2].

We are looking for a highly motivated candidate eager to conduct cutting-edge experiments under extreme conditions and to expand their knowledge of magnetism and quantum physics. The successful applicant will work in a collaborative international environment, gaining expertise in advanced experimental techniques while addressing fundamental questions in the physics of geometrically frustrated systems.

This project will be based at the Laboratoire National des Champs Intenses (LNCMI) in Toulouse, and conducted in close collaboration with the ILL, Institut Néel, CEA and the LNCMI in Grenoble. The successful candidate will have access to state-of-the-art neutron scattering and high-field facilities.

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