Dispersive crystal electric field excitations in rare-earth magnet $NaTmTe_2$

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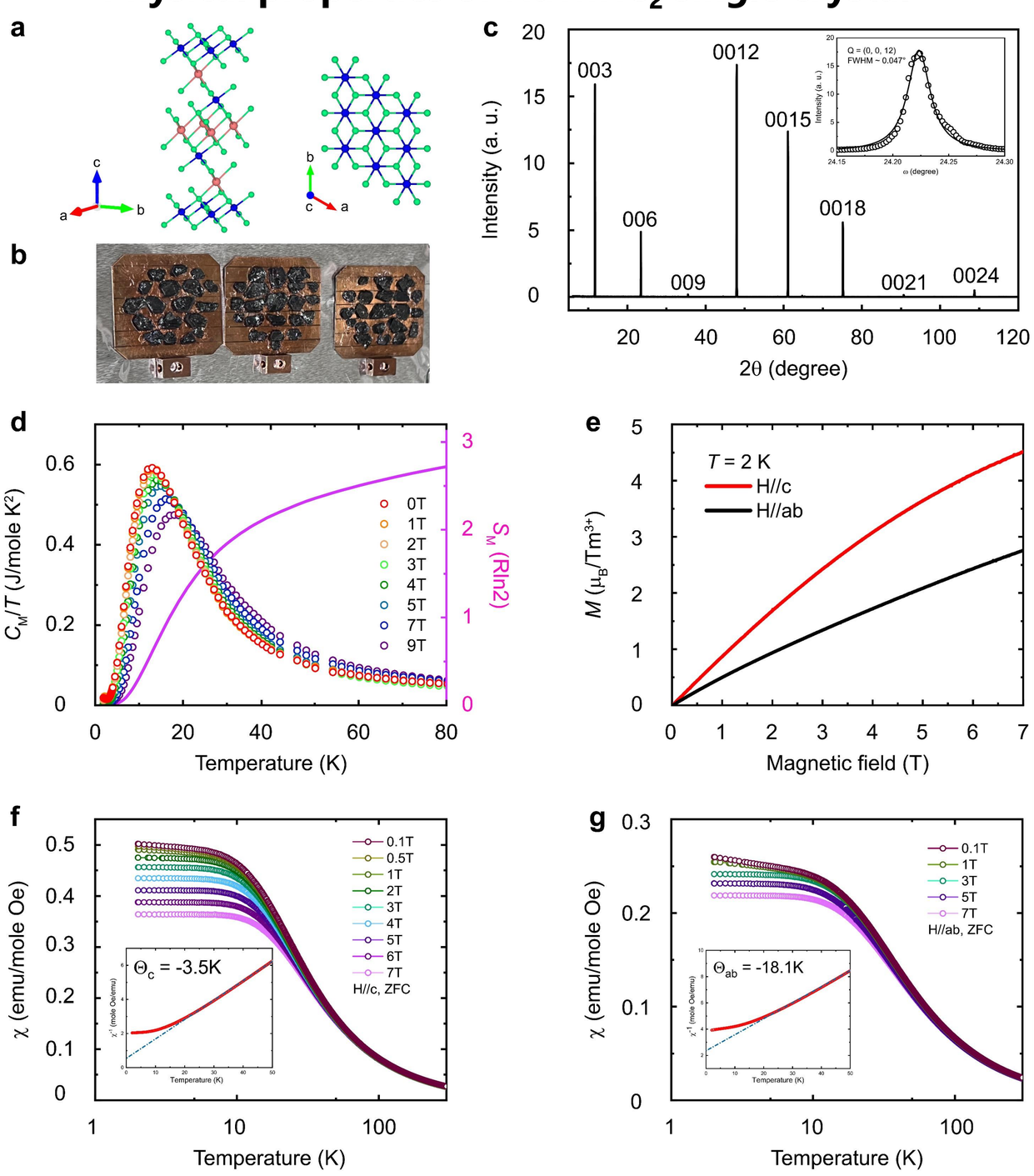
Abstract

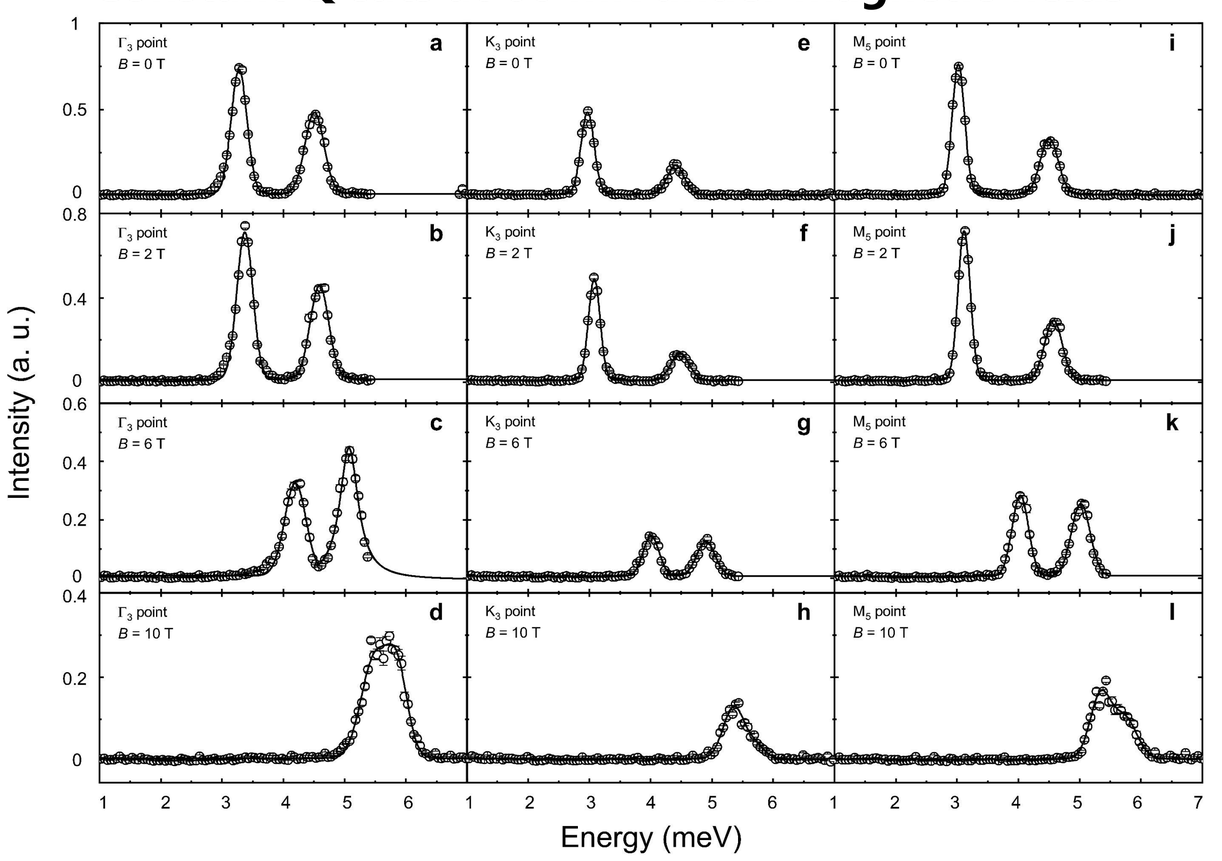
An elucidation of the structure of crystal electric field levels in rare-earth magnets is important for understanding its magnetism. Here we report thermal dynamic and neutron scattering measurements of newly discovered triangular lattice magnet $NaTmTe_2$ under zero and external magnetic fields. Our experiments revealed that the crystal field ground state of Tm^{3+} in $NaTmTe_2$ is a singlet, and that the energy gap between ground state and the $1^{st}/2^{nd}$ excited state is ~3 meV/4.5 meV. Moreover, the crystal field excitations are surprisingly highly dispersive and field dependent, indicating strong coupling between crystal electric field and magnetic exchange interactions in $NaTmTe_2$.

Physical properties of $NaTmTe_2$ single crystal



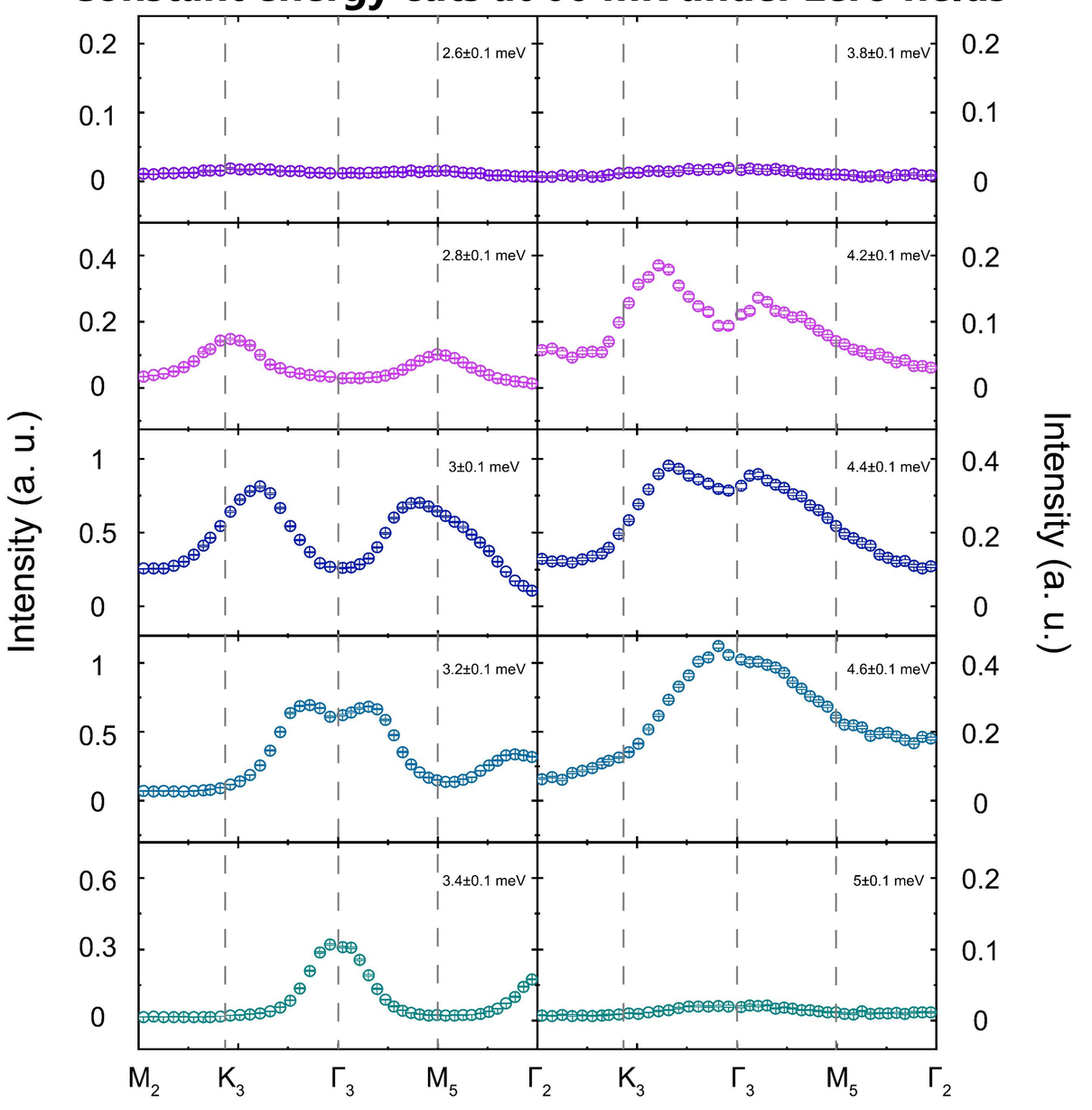
a Schematic diagram of $NaTmTe_2$ crystal structure. **b** Co-aligned samples in the (*H*, *K*, 0) plane. **c** X-ray diffraction measurements in the (*H*, *K*, 0) plane. **d** Heat capacity measurements. **e** Isothermal magnetization measurements along the c direction and in the ab plane at 2 K. **f,g** Temperature-dependence of susceptibility under various external fields. The inserts suggest negative Curie-Weiss temperatures.

Constant Q cuts at 60 mK under magnetic fields



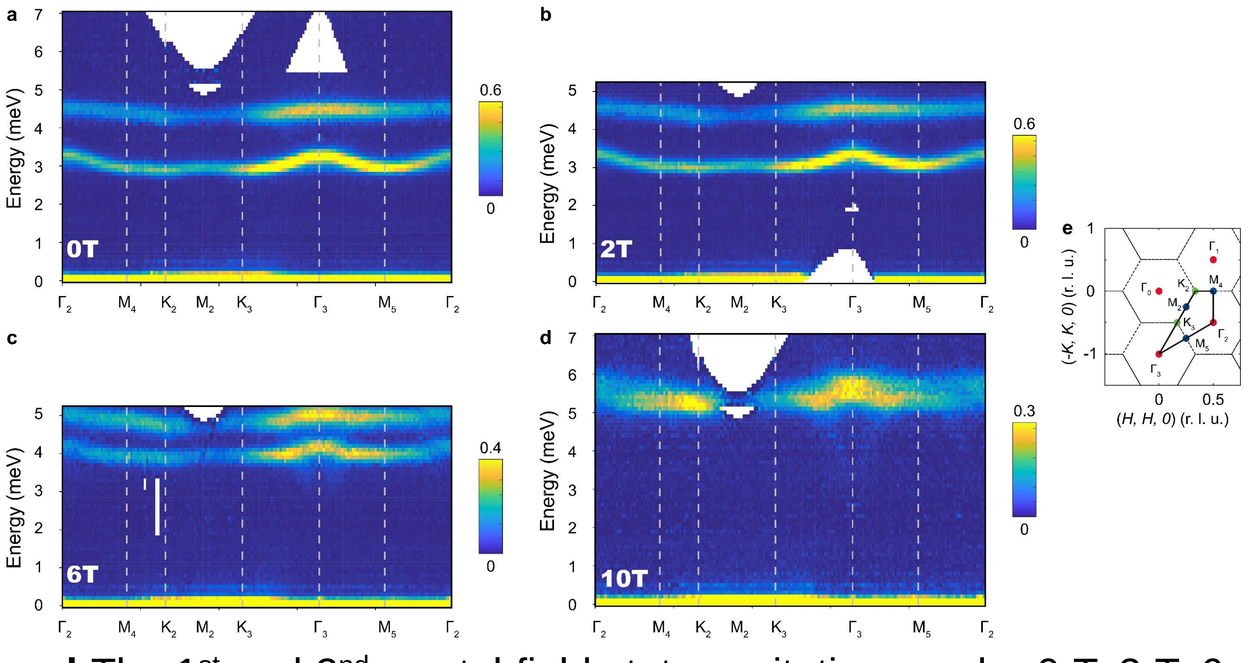
a-d, e-h, i-l Constant **Q** cuts at the high-symmetry K, M and Γ points under various magnetic fields at 60 mK.

Constant energy cuts at 60 mK under zero fields



Constant energy cuts along the high-symmetry Γ-K-Γ-M-Γ direction at the indicated energy at 60 mK under zero field.

Dispersive CEF excitations under external fields



a-d The 1st and 2nd crystal field state excitations under 0 T, 2 T, 6 T, 10 T, respectively. The external magnetic fields are parallel to the *c* direction of sample. **e** Sketch of the reciprocal space. Black dashed lines show the Brillouin zone boundaries.

Reference

Yao Shen, *et al.* Intertwined dipolar and multipolar order in the triangular-lattice magnet $TmMgGaO_4$, Nature Communications **10**, 4530 (2019)