

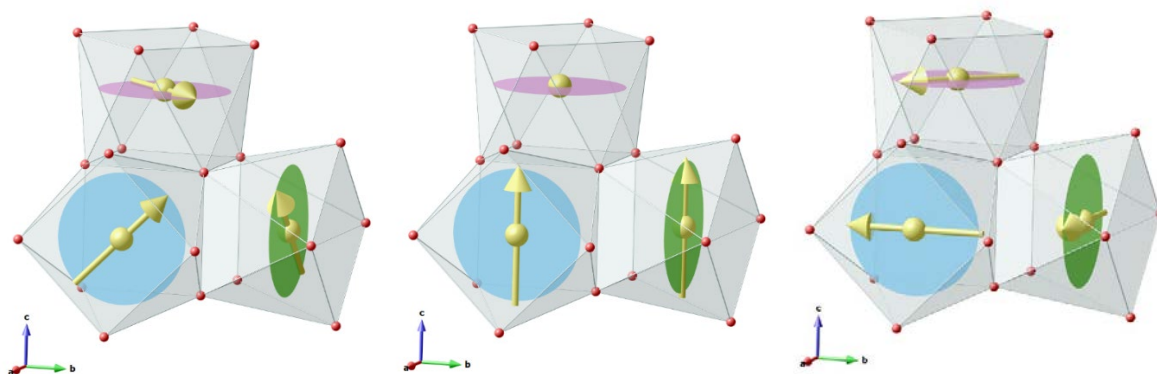
# Unusual planar anisotropy of the induced magnetism in $\text{KTb}_3\text{F}_{10}$

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$\text{KTb}_3\text{F}_{10}$  is a magneto-optical component [1] used as a high power Faraday rotator in optical insulators, to prevent light feedback in laser cavities. To understand better the origin of its magneto-optical properties, the magnetic ground state of  $\text{KTb}_3\text{F}_{10}$  was investigated using a combination of magnetization measurements and neutron scattering experiments, carried out on a polycrystal and a single crystal sample, in zero and applied magnetic fields. In the  $Fm\text{-}3m$  cubic crystal structure of  $\text{KTb}_3\text{F}_{10}$ , each  $\text{Tb}^{3+}$  is surrounded by a distorted fluorine cage, made of two twisted but parallel square faces (Figure 1). There are three distinct orientations of this fluorine cage in the structure, which correspond to the 4-fold axis of the  $Fm\text{-}3m$  space group being parallel to either the **a**, **b**, or **c** axis of the cubic cell [2]. Results show that  $\text{Tb}^{3+}$  actually remains in a crystal electric field singlet state down to 30 mK. Applying a magnetic field, however, induces magnetism on the Tb sites. Using a local susceptibility tensor approach, we show that the  $\text{Tb}^{3+}$  moment is highly anisotropic and remains confined within a local anisotropy plane, parallel to the square face of the fluorine cage, a rather rare occurrence in Tb compounds. The magnetic space groups of the magnetic orderings observed in a large magnetic field applied along the three main symmetry directions of the cubic structure were determined and are in excellent agreement with the combined planar nature of the moment anisotropy and the existence of three orientations for the Tb cage (Figure 1). These results are a first step towards a microscopic understanding of the Faraday rotator property in this compound [3].



**Figure 1.** Induced magnetic orders in  $\text{KTb}_3\text{F}_{10}$ , for a magnetic field applied along  $[111]$  (left),  $[001]$  (middle) and  $[1-10]$  (right panel). Illustrations are limited to only half of a  $\text{Tb}_6\text{F}_{32}$  cluster for clarity reasons. Tb atoms are shown in yellow, F atoms in red. Anisotropy planes are shown as blue, green or pink ellipses, to distinguish planes perpendicular to the **a**, **b** or **c** axis of the cubic cell, respectively.

[1] Pues, P., et al. (2020). *J. Lumin.* **227**, 117523.

[2] Podberezskaya, N., et al. (1976). *J. Struct. Chem.* **17**, 815.

[3] Demortier, O., et al. (2025). Submitted to *Phys. Rev. Mater.*