# High-pressure study of magnetic and magnetic resonance properties of rare-earth paramagnet $KEr(MoO_4)_2$

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**Recently we found that rare-earth paramagnetic compound $KEr(MoO_4)_2$ exhibits massive magnetostriction induced by the single-ion effect, which becomes most prominent for 12 T ⩽ $\mu_0 H$ ⩽ 17 T [1]. Through a variety of experimental techniques and theory calculations, we have shown that the magnetic field induces a lattice distortion in $KEr(MoO_4)_2$ due to the change of the $Er^{3+}$ ions quadrupolar moments.**

**For better understanding the microscopic mechanism behind the strong magnetostrictive response we investigate the effect of hydrostatic pressure (up to 2 GPa) on the magnetic and resonant properties of $KEr(MoO_4)_2$ single crystal.**

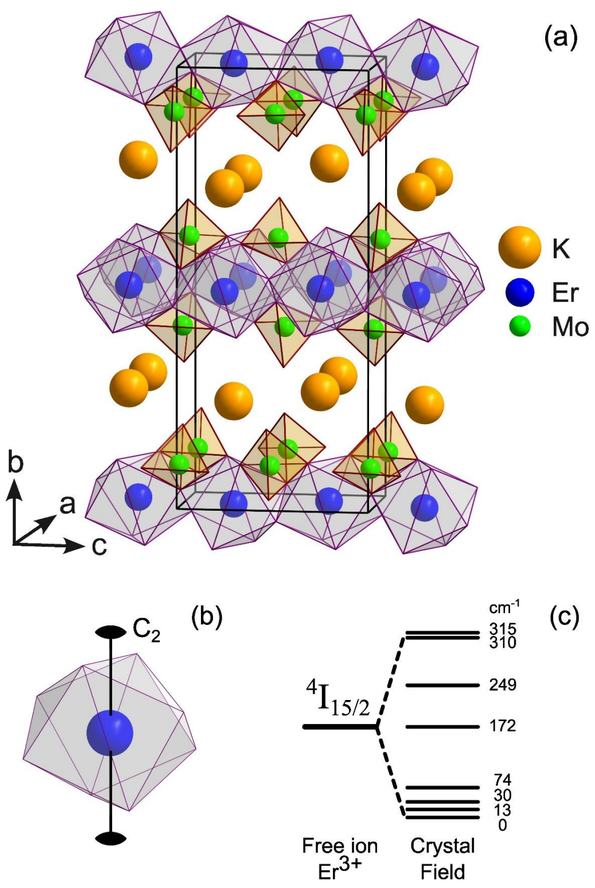


***Figure 1.*** *(a) Crystallographic structure of $KEr(MoO_4)_2$ [2]; (b) Local environment of $Er^{3+}$ ion; (c) The splitting of the $Er^{3+}$ ground multiplet $^4I_{15/2}$ into eight Kramers doublets by crystal electric field (CEF) [3].*

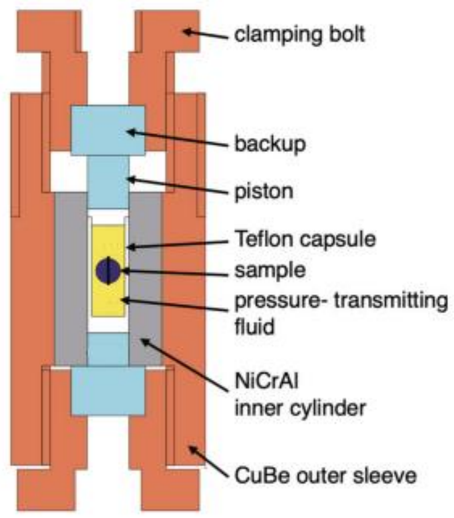


***Figure 2.*** *Cross section of a hybrid-type pressure cell for the EPR measurements* [4].

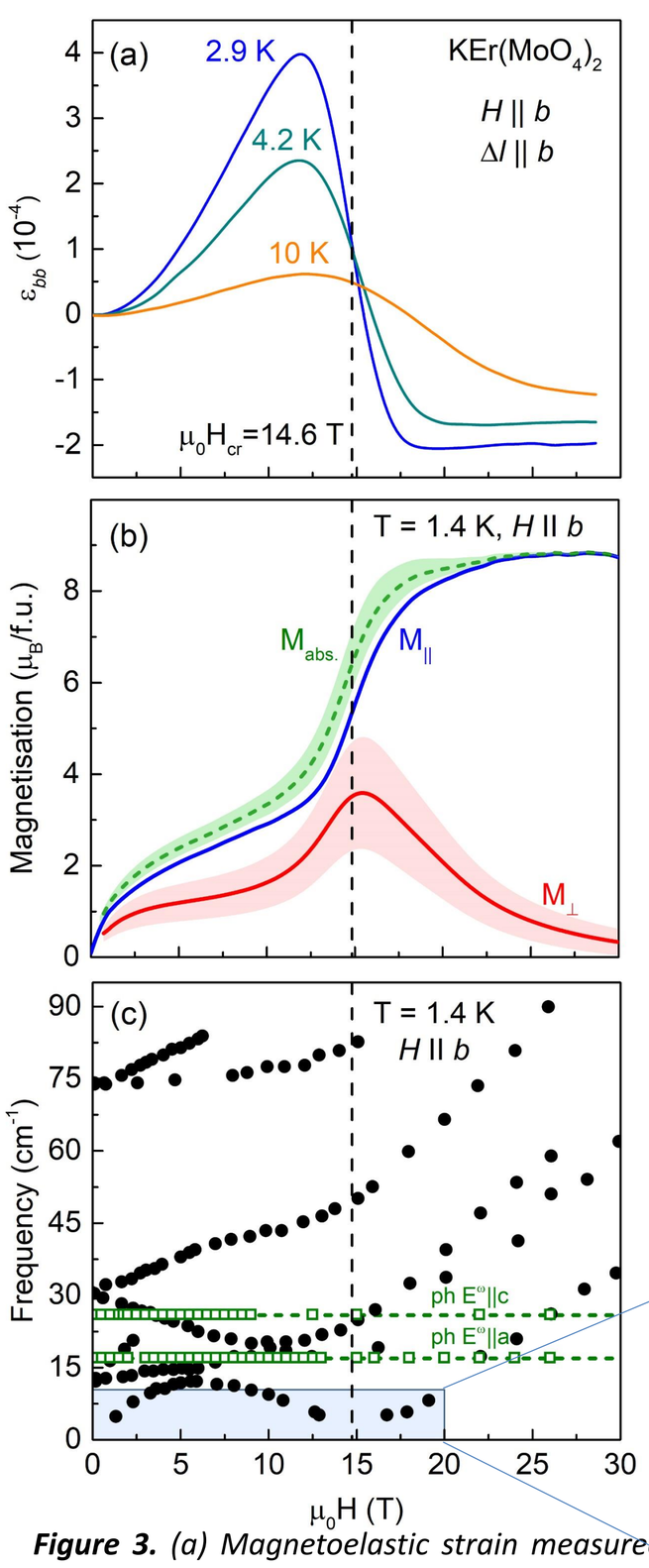


***Figure 3.*** *(a) Magnetoelastic strain measured at 2.9, 4.2, and 10.0 K [1]. (b) The calculated absolute value of the magnetization of $KEr(MoO_4)_2$ (dashed green) and its parallel (solid blue) and perpendicular (solid red) components, see ref. [5] for details. (c) Frequency-magnetic field dependence of the low-energy excitations in $KEr(MoO_4)_2$ measured by Fourier Transform Infrared spectroscopy.*

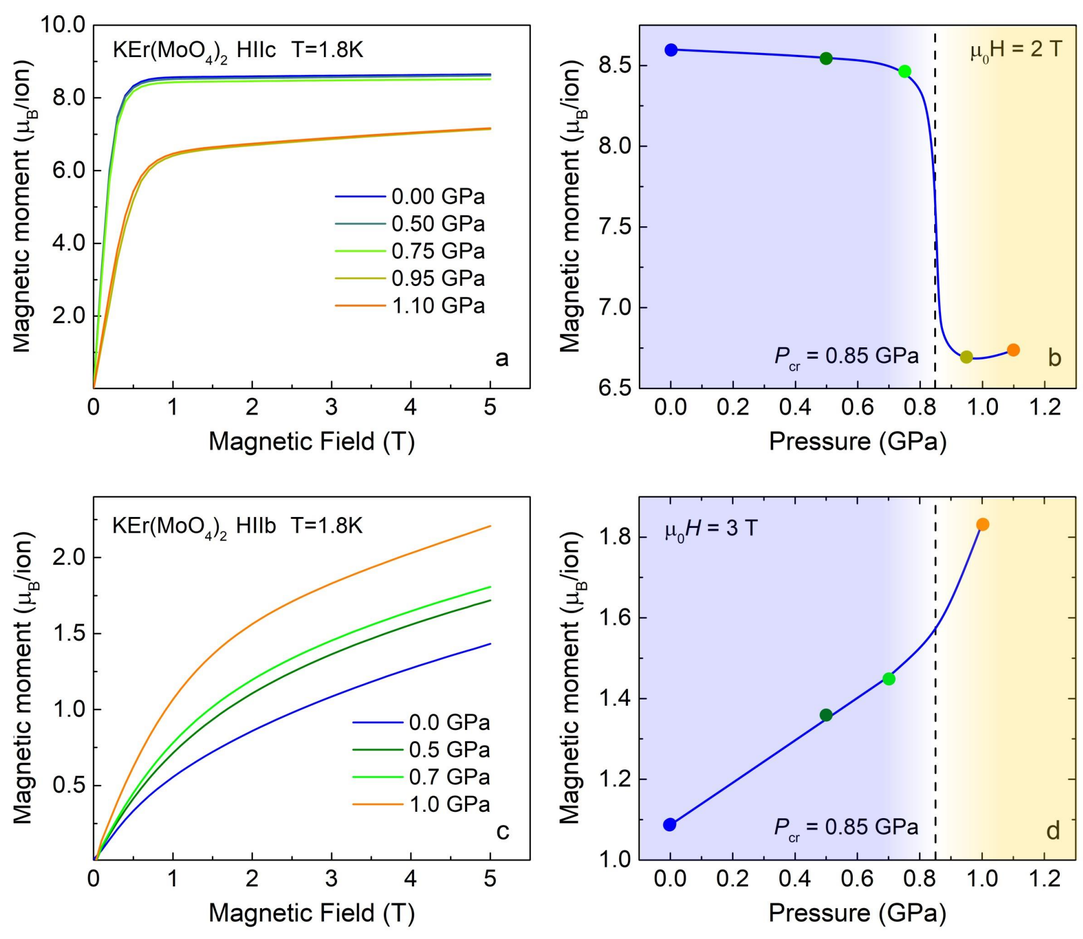


***Figure 4.*** *(a, c) The magnetic field dependences of magnetic moment of $KEr(MoO_4)_2$ at H||c (easy axis) and H||b (hard axis) (T = 1.8K) under different hydrostatic pressure; (b, d) the hydrostatic pressure dependence of the effective magnetic moment at H||c and H||b. Dashed lines denote the critical pressure, $P_{cr} \approx 0.85$ GPa.*

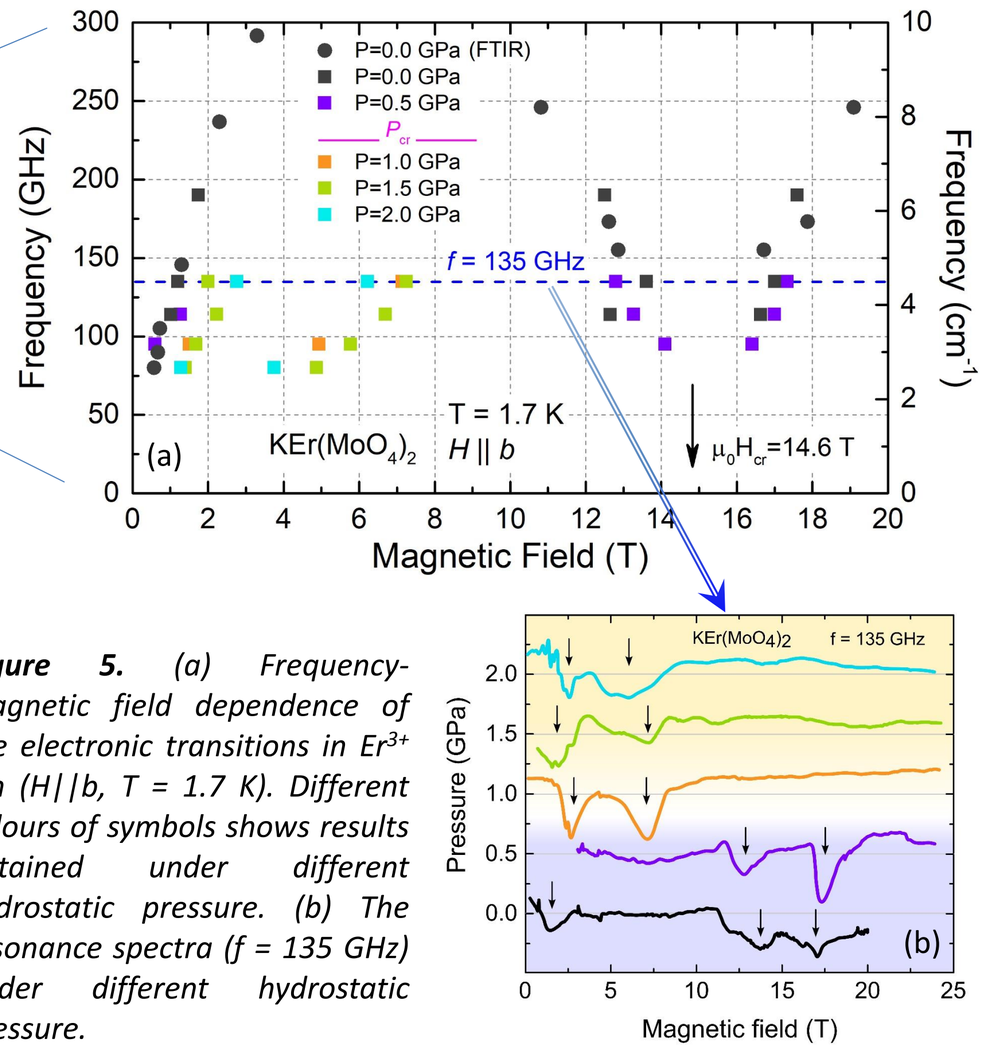


***Figure 5.*** *(a) Frequency-magnetic field dependence of the electronic transitions in $Er^{3+}$ ion (H||b, T = 1.7 K). Different colours of symbols shows results obtained under different hydrostatic pressure. (b) The resonance spectra (f = 135 GHz) under different hydrostatic pressure.*

- Magnetisation measurements under hydrostatic pressure (Fig. 4) reveal the critical pressure $P_{cr} \approx 0.85$ GPa when the effective magnetic moment changes abruptly. This indicates significant deformations in local environment of the $Er^{3+}$ ion that leads to changes in magnetic anisotropy of the compound.
- Combination of the EPR and Fourier-Transform Infrared spectroscopy (FTIR) data measured in magnetic fields up to 30 Tesla, allow us to reconstruct the frequency-field diagram of the transitions between electronic levels of $Er^{3+}$ ion (in magnetic field along "hard-axis" direction). On the figure 3 clearly seen the field position of the anomalies in magnetostriction and magnetisation (~15 T) corresponds to the magnetic field where the gap between the electronic states closes and the configuration of the ground state changes. Above $P_{cr}$ the excitations in a vicinity of 15 T disappeared while two new excitations at low magnetic field arise (Fig. 5a). We conclude that hydrostatic pressure induces the phase transition into more stable structure, where the magnetostriction effect is reduced.

***References***

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***3.*** G. Bogomolova *et al*, *Optica i spectroskopija* **31**, 259 (1971).
***4.*** T. Sakurai *et al*, Applied Magnetic Resonance **52**, 267(2021).
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