

LOW-TEMPERATURE MAGNETOMETRY AND EPR STUDIES OF $\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$ (0.75 wt. %) SINGLE CRYSTAL

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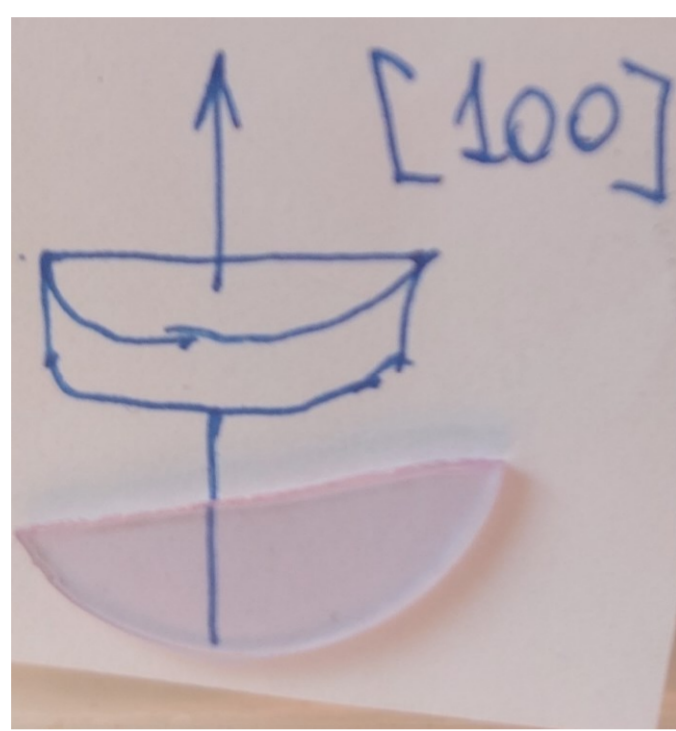


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Binary borates $\text{Ca}_3\text{RE}_2(\text{BO}_3)_4$ (RE - Y and rare earth elements) doped by rare earth elements are promising hosts for active laser media operating for different modes and spectral ranges. The crystal structure of the compounds are characterizing by **disordering, i.e. Ca and RE cations are statistically distributed over three crystallographic sites M**. The manifestation of spin-spin correlations have been observed in $\text{Ca}_3\text{Nd}_2(\text{BO}_3)_4$ crystal at temperatures close to the temperature of liquid helium. Therefore, low-temperature studies of the magnetic and resonance properties of $\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$ single crystals are relevant.

CRYSTAL GROWTH PROCEDURE AND CRYSTAL STRUCTURE

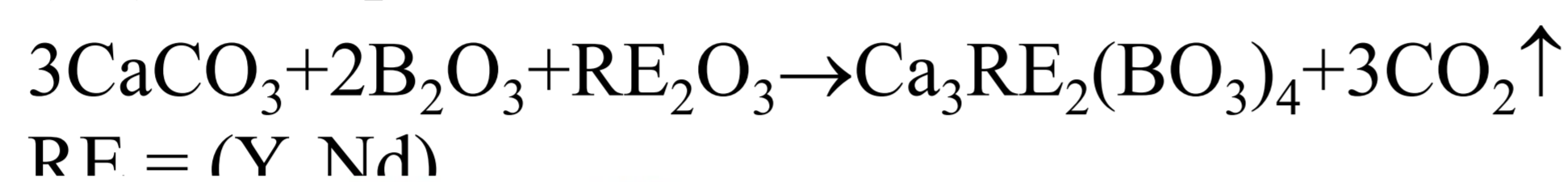
“ANALOG” automatic set up: RF heating, weight control system, vacuum chamber.



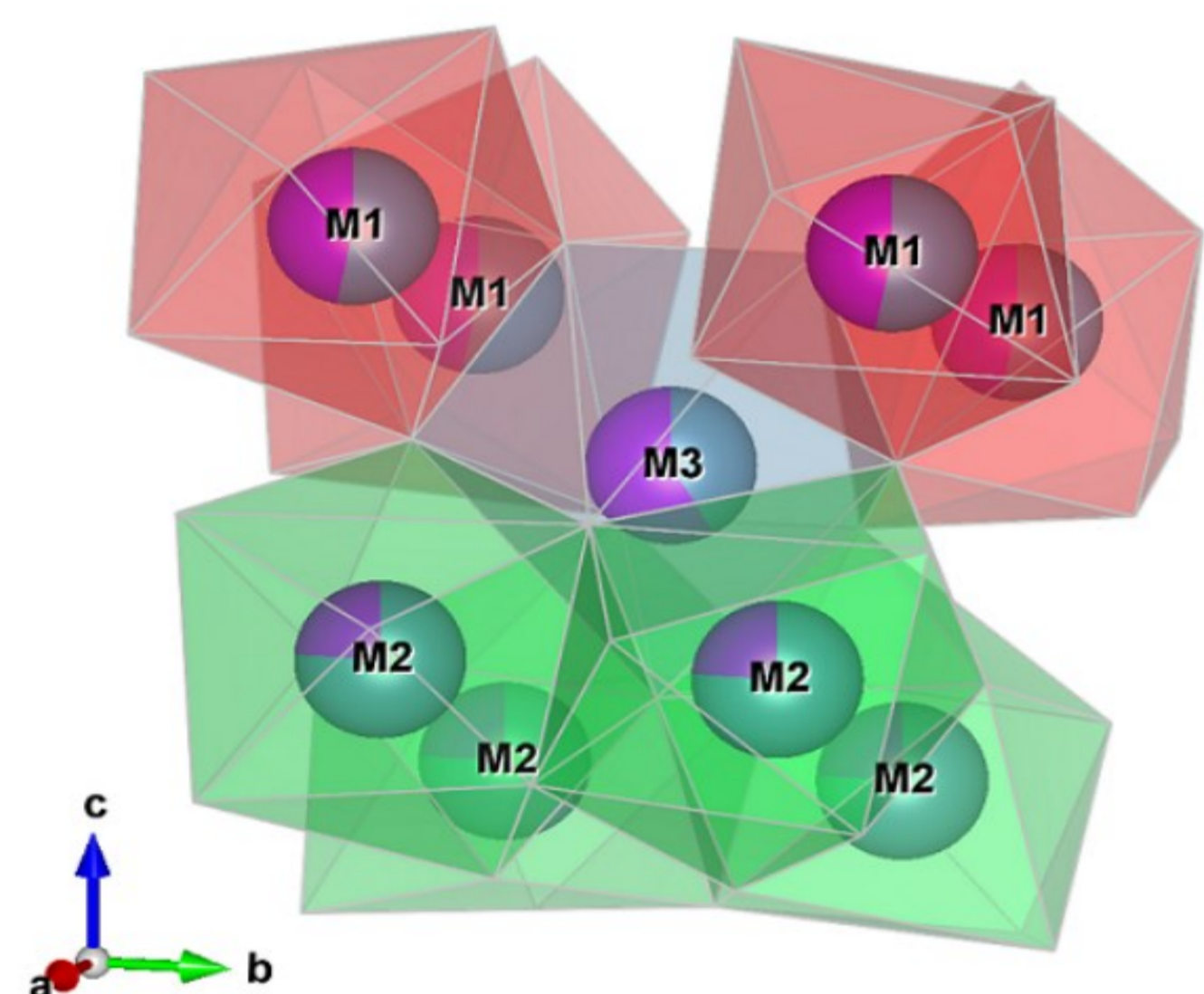
$\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$

Multistep solid state synthesis: $T=110-140^\circ\text{C}$, $T=210-230^\circ\text{C}$, $T=110-140^\circ\text{C}$, $T=730-750^\circ\text{C}$; 10 h for every temperature interval.

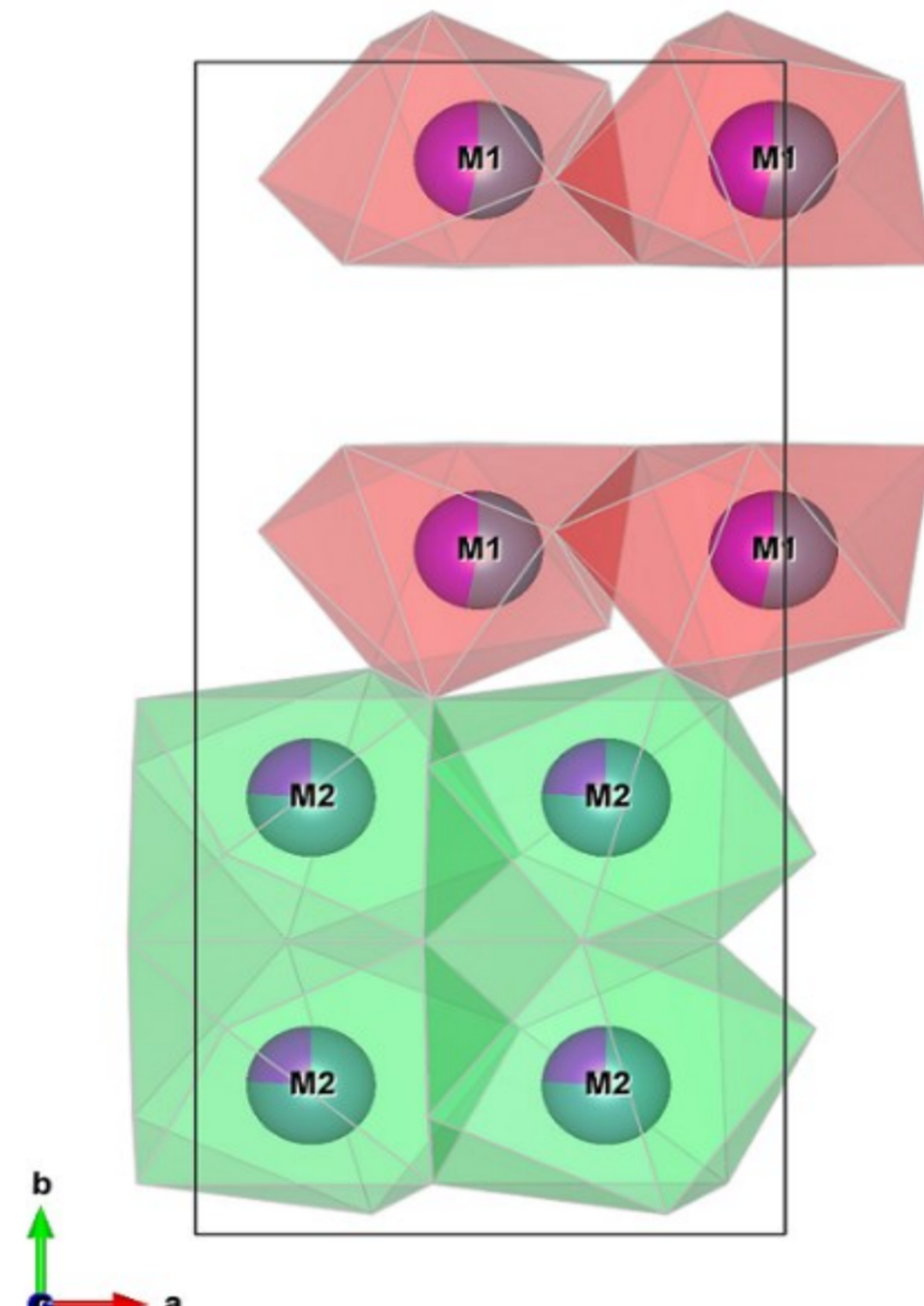
Growth conditions: Czochralski method, inert (Ar) atmosphere.



Space group $Pnma$ (D_{2h}^{16}), $Z=4$



(a)



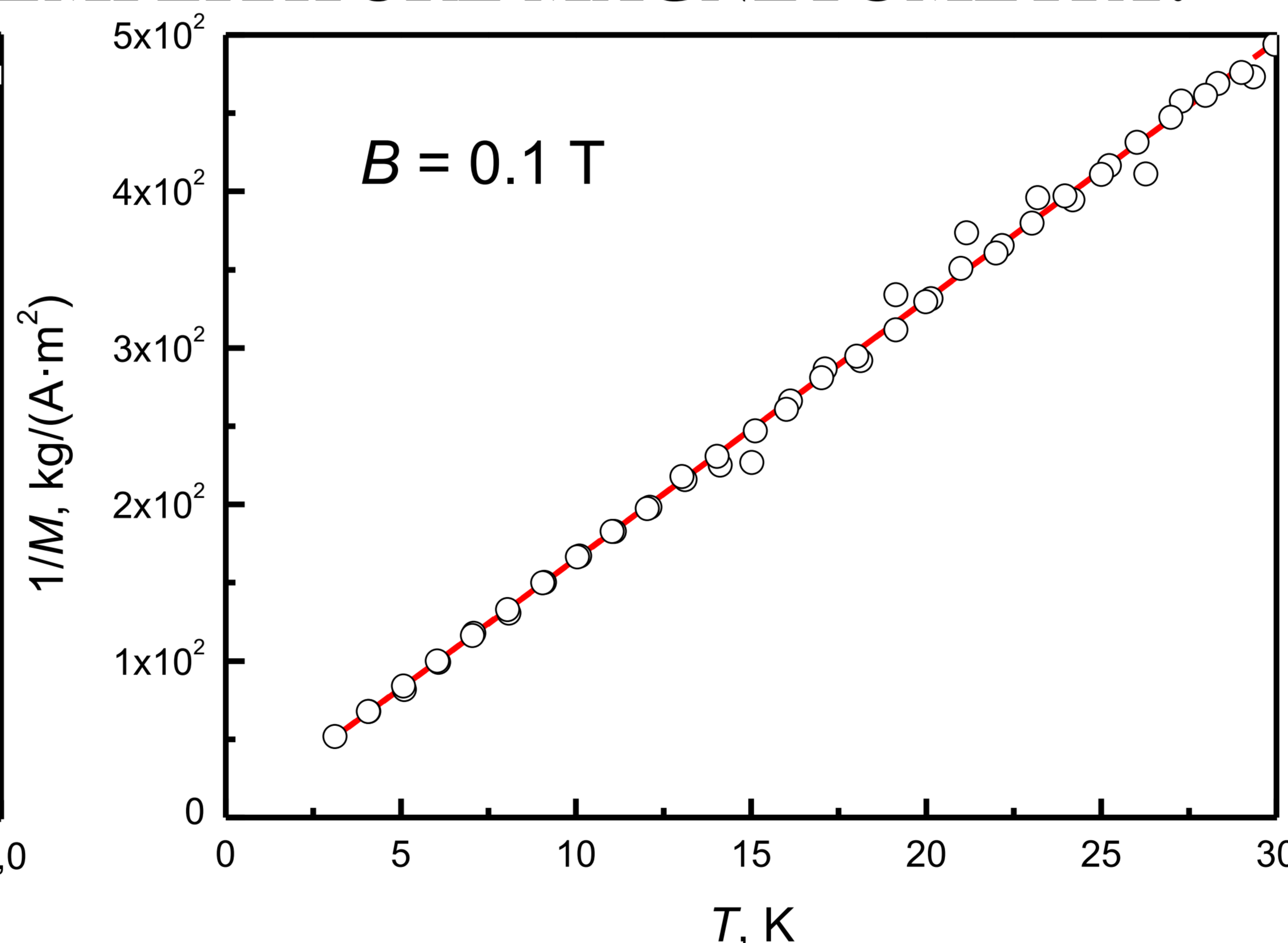
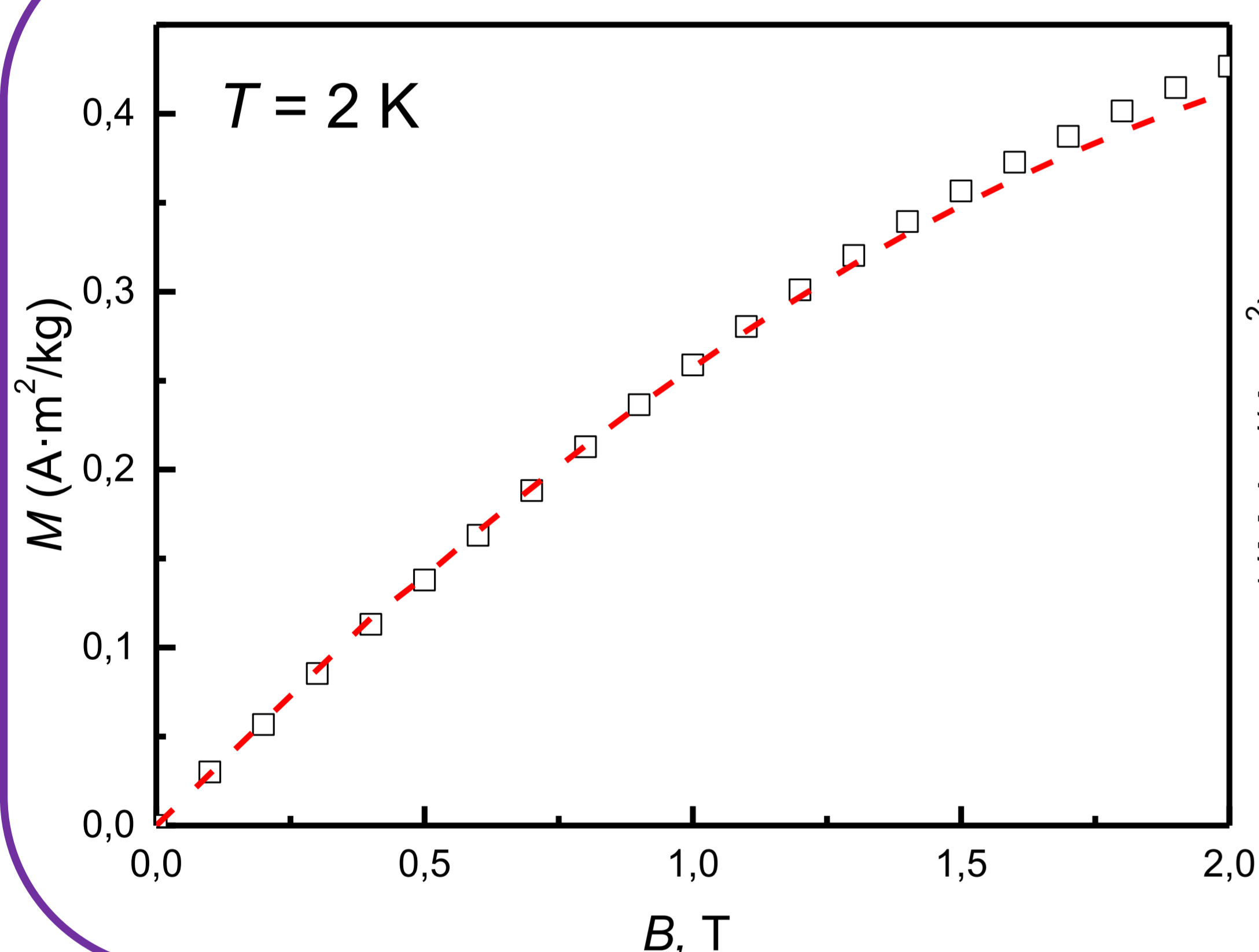
(b)

Unit cell parameters:

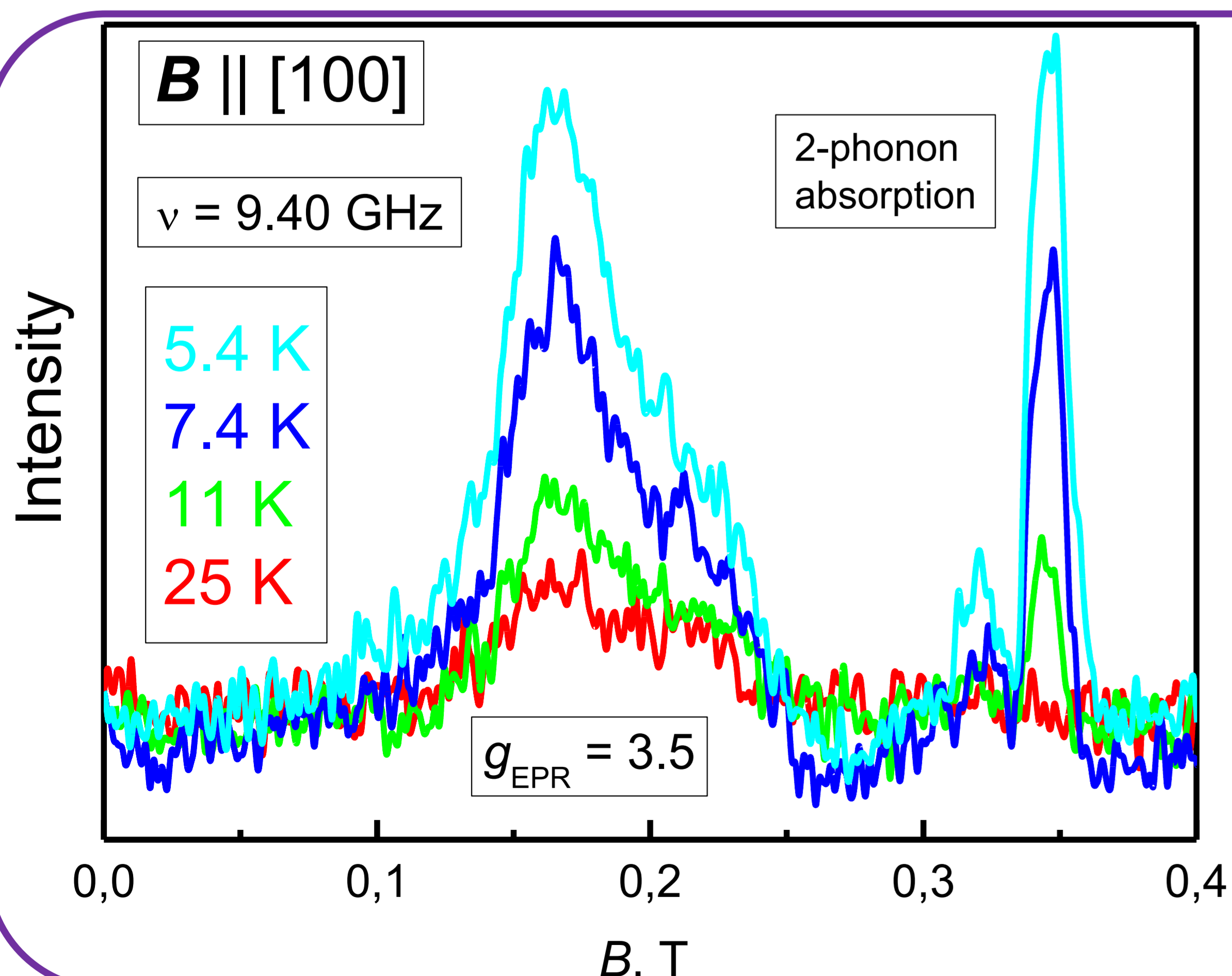
	a, Å	b, Å	c, Å	v, Å ³
$\text{Ca}_3\text{Y}_2(\text{BO}_3)_4$	7.1517(2)	15.4691(4)	8.5577(2)	946.74(4)
$\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$ (2.63 wt.%)	7.1583(1)	15.4840(3)	8.5627(2)	949.09(3)

Panel (a) - fragment of $\text{Ca}_3\text{RE}_2(\text{BO}_3)_4$ crystal structure consisting of four $M(1)$ -, four $M(2)$ - and one $M(3)$ -based polyhedra. Panel (b) - alignment of $M(1)$ - and $M(2)$ -based polyhedra in the (ab) plane, belonging to the two neighboring pseudo-cubes. Axe **a** corresponds to $[100]$ direction.

LOW-TEMPERATURE MAGNETOMETRY:



The magnetic response (symbols) at $B \parallel [100]$ can be approximated by considering **only** the ground-state Kramers doublet with $g_{\text{eff}} = 3.52$ (red lines).



LOW-TEMPERATURE EPR MEASUREMENTS:

- ✓ absorption peak 1 is assigned to transitions within the lowest Kramers doublet of the Nd^{3+} ion, $B_{\text{res}} \approx 0.17$ T, $g_{\text{EPR}} \approx 3.5$
- ✓ peak 2 associated with two-photon absorption in the $\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$ crystal with a change in the magnetic quantum number $\Delta_{ms} = \pm 2$, $B_{\text{res}} \approx 0.34$ T

CONCLUSIONS:

- Magnetometric and EPR measurements performed on the $\text{Ca}_3\text{Y}_2(\text{BO}_3)_4:\text{Nd}$ crystal demonstrated that the magnetic properties at low temperatures are governed by the lowest Kramers doublet of the Nd^{3+} ion. Both methods consistently yielded an effective g -factor of approximately 3.52 for the $[100]$ crystallographic direction.
- A resonance line associated with two-photon absorption was identified in the EPR spectra.