

# Crystal structure analysis in pressure-induced commensurate magnetic phase of multiferroic $\text{HoMn}_2\text{O}_5$

H. Kimura<sup>1</sup>, Y. Sakamoto<sup>1</sup>, T. Yamazaki<sup>1</sup>, Y. Noda<sup>1</sup>, N. Aso<sup>2</sup>, T. Fujiwara<sup>3</sup>, K. Matsubayashi<sup>4</sup> and Y. Uwatoko<sup>4</sup>

<sup>1</sup>IMRAM, Tohoku University, <sup>2</sup>Ryukyuu University, <sup>3</sup>Department of Physics, Yamaguchi University, <sup>4</sup>ISSP, The university of Tokyo

$\text{HoMn}_2\text{O}_5$  is well known as multiferroics showing colossal magnetoelectric effect. We have reported recently that hydrostatic pressure induces the incommensurate–commensurate magnetic phase transition[1], which leads to the induction of large electric polarization[2]. This indicates the strong relevance between the magnetic structure and ferroelectricity. It was thought that the minute change of bond lengths (or angles) between the magnetic manganese ions by applying pressure has much effect on the competing magnetic ground states in this magnetically frustrated system. In the present study we thus performed crystal structure analysis under pressure to elucidate what kind of magnetic interactions between manganese ions is essential for stabilizing the pressure induced magnetic phase.

Crystal structure analysis was carried out at FONDER. Hydrostatic pressure was applied up to  $p = 1.39$  GPa, at which the magnetic structure is almost commensurate. Temperature was fixed at  $T = 8$  K. Crystal structure was well solved with  $R = 0.035$ . Figure 1 shows two different bond lengths between  $\text{Mn}^{4+}$  and  $\text{Mn}^{4+}$  ions linked by oxygens as function of ionic radii of rare-earth ion. The interatomic bonds shown in Fig. 1(a) and in Fig. 1(b) contribute to the magnetic interactions of  $J_1$  and  $J_2$ , respectively, of which paths are schematically shown in Fig. 1(c). This figure indicates that the length associated with  $J_1$  decreases with decreasing the ionic radii. On the contrary, the length associated with  $J_2$  is hardly affected by the size of the ionic radii. Furthermore in  $\text{HoMn}_2\text{O}_5$ , the bond length associated

with  $J_1$  significantly shortens with applying pressure while that associated with  $J_2$  doesn't change at all, indicating that magnetic interaction  $J_1$  highly contributes to stabilizing the commensurate magnetic phase.

## References

- [1] H. Kimura *et al.*: JPSJ 77 (2008) 063704.
- [2] C. R. Cruz *et al.*: PRB 76 (2007) 174106.

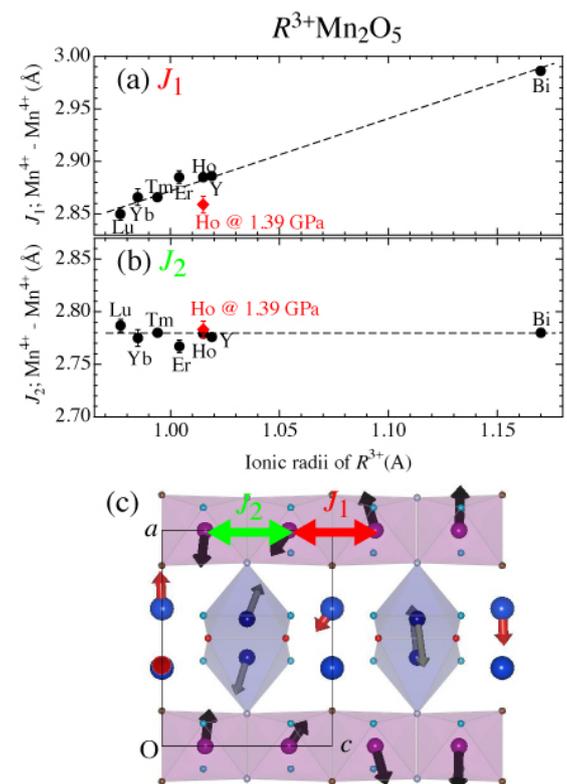


Fig. 1. (a), (b) Two different bond distances between  $\text{Mn}^{4+}$  ions as functions of ionic radii of  $R^{3+}$  ions. (c) Schematics of magnetic structure and two different  $\text{Mn}^{4+}$ - $\text{Mn}^{4+}$  bonds.