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Ferroelectricity with Ferromagnetic Moment in Orthoferrites[1]

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Exotic multiferroics with gigantic magnetoelectric (ME) coupling have recently been attracting broad interests from the viewpoints of both fundamental physics and possible technological application to next-generation spintronic devices. To attain a strong ME coupling, it would be preferable that the ferroelectric order is induced by the magnetic order. Nevertheless, the magnetically induced ferroelectric state with the spontaneous ferromagnetic moment is still quite rare apart from a few conical-spin multiferroics. To further explore multiferroic materials with both the strong ME coupling and spontaneous magnetization, we focused on materials with magnetic structures other than conical structure. In this talk we present that the most orthodox perovskite ferrite systems $DyFeO_3$ and $GdFeO_3$ have "ferromagnetic-ferroelectric," i.e., genuinely multiferroic states in which weak ferromagnetic moment is induced by Dzyaloshinskii-Moriya interaction working on Fe spins and electric polarization originates from the striction due to symmetric exchange interaction between Fe and Dy (Gd) spins [1] [2]. Both materials showed large electric polarization (>0.1 $\mu C/cm^2$) and strong ME coupling. In addition, we succeeded in mutual control of magnetization and polarization with electric- and magnetic-fields in $GdFeO_3$, and attributed the controllability to novel, composite domain wall structure.

[1] Y. Tokunaga et al., Phys. Rev. Lett. **101**, 097205 (2008).
[2] Y. Tokunaga et al., Nature Mater. **8**, 558 (2009).

[1]In collaboration with N. Furukawa, S. Iguchi, H. Sakai, Y. Taguchi, T. Arima, and Y. Tokura.