Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Electric Polarization and ME effect in layered iron oxide SUMIO ISHIHARA, MAKOTO NAKA, JYOJI NASU, Department of Physics, Tohoku University — Rare-earth iron oxides $R\mathrm{Fe_2O_4}$. (R: rare-earth elements) is an exotic dielectric material with charge-order driven electric polarization and magnetoelectric effect caused by spin-charge coupling. The crystal structure consists of paired Fe-O triangular lattices and R-O block ones alternately stacked. Since a nominal valence of Fe ion is 2.5+, an equal amount of Fe^{2+} and Fe^{3+} coexists in the paired triangular lattices. In the electron diffraction experiments, Bragg reflections at $(h/3\ h/3\ 3m+1/2)$ appear below 320K($\equiv T_{\mathrm{CO}}$) in $\mathrm{LuFe_2O_4}$. This observation indicates a valence order of Fe ion, i.e. a charge order of the Fe $3d$ electrons. Around T_{CO}, a spontaneous electric polarization and dielectric anomalies turn up. Moreover, around the ferrimagnetic spin ordering temperature (T_{SO} =250K), the gigantic ME effects are recently discovered. We present a theory of a dielectric magnet $R\mathrm{Fe_2O_4}$ as a electronic ferroelectric and multiferroic material [1]. We address the following issues: (i) origin of the electric polarization and the FE transition, (ii) mechanism of the coupling between electric polarization and magnetization. Present study shows that the novel dielectric properties in this material arises from interplay among the geometrical frustration and the multi-degrees of freedom of electron.
[1] A. Nagano, M. Naka, J. Nasu, & S. Ishihara, Phys. Rev. Lett. **99**, 217202 (2007).

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Date submitted: 11 Dec 2007 Electronic form version 1.4