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Quasi-frustrated spin systems as magnetoelectrics with strong spin-lattice coupling[1]

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The magnetoelectric effect –i.e. the induction of a magnetization by means of an electric field and the induction of a polarization by means of a magnetic field- was already presumed to exist at the end of 19^{th} century, and subsequently attracted a great deal of interest in the 1960s and 1970s. Whereas the symmetry-conditioned properties and phenomenological aspects of magnetoelectrics are rather well understood, there is a great paucity of studies of the microscopic mechanisms in specific compounds and no devices have been made so far because of small interaction coefficients. The recent observation of gigantic magnetoelectric and magnetocapacitive effects in rare-earth manganites, $TbMnO_3$ and $DyMnO_3$ [1,2], provides a novel approach to the mutual control of magnetization and electric polarization in magnetic ferroelectrics. We can control the magnitude and/or direction of the electric polarization vector by the application of magnetic field in these materials. In comparing the results from the both manganites, we noticed that a characteristic common to the both materials is that they possess modulated magnetic structures with long wavelengths (as compared to the chemical unit cell) which arise from competing magnetic interactions (i.e. *quasi-frustrated spin systems*). Ferroelectricity in these materials appears to originate from the competing magnetic interactions which cause lattice modulations through magnetoelastic coupling. In this talk, we propose that quasi-frustrated spin systems provide new route to design magnetoelectrics with strong spin-lattice coupling.
[1] T. Kimura, T.Goto, H. Shintani, K. Ishizaka, T. Arima, and Y. Tokura, Nature 426, 55 (2003). [2] T. Goto, T. Kimura, G. Lawes, A. P. Ramirez, and Y. Tokura, Phys. Rev. Lett. 92, 257201 (2004).

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