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Neutron diffraction study of magnetic structure in multiferroics under pressure

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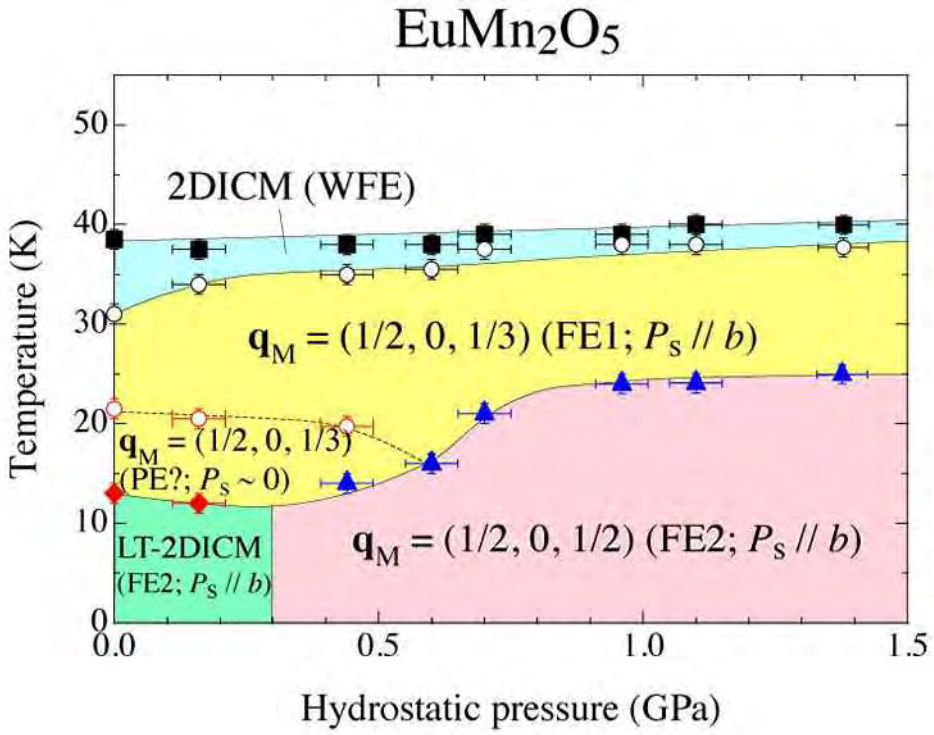
RMn2O5 (R = Y, Bi, rare-earth) is one of the prototypical multiferroic materials that exhibits a rich variety of magnetoelectric effects. Since the successive magnetic and ferroelectric phase transitions simultaneously take place, magnetic order has been thought to be a primary order parameter for the ferroelectricity in this system. We recently have found that in neutron diffraction study of 153EuMn2O5, magnetic phase transition is induced by applying hydrostatic pressure. As temperature decreases upon p = 1.4 GPa, the magnetic propagation wave vector changes from qM = (1/2, 0, 1/3) to (1/2, 0, 1/2), indicating that the period of magnetic unit cell as well as the magnetic structure change at the phase transition. We have also carried out the dielectric and polarization measurements under pressure and established magnetic and dielectric phase diagram as functions of temperature and pressure as shown in the figure. This study has revealed that the ferroelectric (FE1) – ferroelectric (FE2) phase transition concomitantly occurs at the magnetic phase transition, where the electric polarization is enhanced. To clarify the relevance between the ferroelectricity and the magnetic structure, we carried out single crystal magnetic structure analysis of 153EuMn2O5 upon ambient- and high-pressure. In the magnetic phase with qM = (1/2, 0, 1/3), cycloidal magnetic structure of manganese spins propagating along c-axis is realized. On the contrary in the magnetic phase with qM = (1/2, 0, 1/2), the spins arrange almost collinearly along c-axis. The result indicates that the presence of the cycloidal spin structure plays an important role for inducing (or reducing) the electric polarization in this compound. This study was supported by "KAKENHI"-programs of Scientific Research (B) (24340064), Scientific Research (A) (21244051), Challenging Exploratory Research (23654098) and of Scientific Research on Priority Areas "Novel States of Matter Induced by Frustration" (19052001).



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