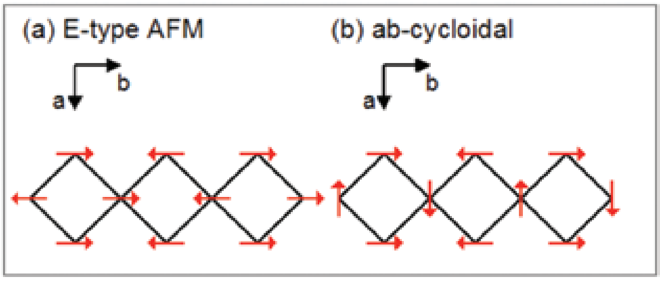


Spin configurations of magnetic structures of multiferroic $YMnO_3$ thin films. (a) Spins align antiparallel to each other, resulting in a large lattice strain and large electric polarization.(b) Spins align helically along the b-axis, resulting in small electric polarization.

Photon Factory, KEK, Japan.

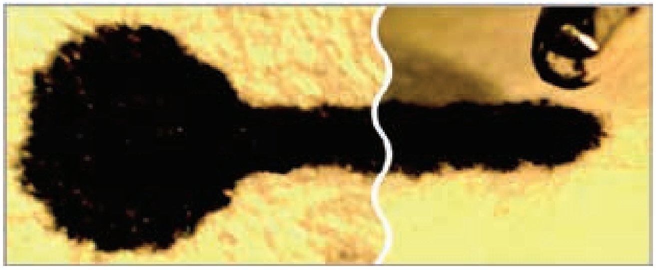
We discovered that the spin of Mn ions has two coexisting magnetic structures, namely the cycloidal and E-type antiferromagntic (AF) orderings. Below 40K, small electric polarization appears as a result of the cycloidal ordering and the periodicity of the cycloidal magnetic structure is incommensurate with the crystal lattice. The E-type AF ordering appears in addition to the cycloidal ordering below 35K. The periodicity of the E-type AF ordering is commensurate with the crystal lattice, and the lattice strain due to interactions between ions with parallel spins was found to be the origin of the large polarization. This understanding of the mechanism of the multiferroic behaviors in $YMnO_3$ thin films is expected to support the design of multiferroic materials for practical applications in the future.

H. Wadati, **J. Okamoto**, **M. Garganourakis**, **V. Scagnoli**, **U. Staub**, **Y. Yamasaki**, **H. Nakao**, **Y. Murakami**, **M. Mochizuki**, **M. Nakamura**, **M. Kawasaki** and **Y. Tokura**,
'Origin of the Large Polarization in Multiferroic $YMnO_3$ Thin Films Revealed by Soft- and Hard-X-Ray Diffraction', *Phys. Rev. Lett.* **108**, 047203 (2012)

Hydrodynamics

Hydrodynamics of Writing with Ink

Although millennia have passed since humans started to write and draw with ink on paper (papyrus in the beginning), the mathematics of writing with ink has been out of the focus of scientists so far. The team led by Prof. Ho-Young Kim at Seoul National University studied how ink spreads from a pen onto paper using a minimal pen made of a capillary tube which writes on a model of paper, a hydrophilic micropillar array. They found that the ink is pulled toward small pores on paper which is smaller than the pen opening due to capillary action. No pores, no ink writing, they said, as one can easily observe by attempting to write on smooth glass plate. By considering the balance of the capillary force and the viscous resistance, they succeeded in accurately predicting the dynamics of the blot emanating from a stationary pen and the frontal shape and the final width of the line laid out by a moving pen.



Because paper is made of cellulose fibers, which are a major constituent of cell walls of plants, this study has more profound implications than it first seems. They aim to better explain how water is delivered from roots of gigantic trees to leaves more than 100 meters above ground, which has eluded scientists' understanding so far. Also functional porous materials that absorb water are increasingly used in biomedical fields, which may benefit from this study.

J. Kim, **M.-W. Moon**, **K.-R. Lee**, **L. Mahadevan** and **H.-Y. Kim**, 'Hydrodynamics of Writing with Ink', *Phys. Rev. Lett.* **107**, 264501 (2011)

Fractals

Dynamic Structure Factor of Vibrating Fractals

Porous materials, proteins, sol-gel branched polymer clusters, colloidal aggregates and the spatial organization of chromatin in the nucleus are well known examples of naturally occurring fractals. Scattering experiments, in which the dynamic structure factor $S(k, t)$ (DSF) is measured, provide an important method for the characterization of fractal structure and dynamics. Offering simultaneous probing of correlations in both space and time, DSF measurements have provided invaluable data in various areas of research. In the context of solid fractals, the DSF has been extensively analyzed on the single phonon level, and in the absence of any source of friction. As a result, we now have a robust description of the inelastic (Brillouin) scattering from solid fractals. However, due to large fluctuations and friction dominated dynamics, this description is not adequate for the quasi-elastic scattering from low dimensional fractals in solutions. An adequate theory, aimed at explaining DSF measurement taken from the naturally occurring fractals mentioned above, is therefore lacking.