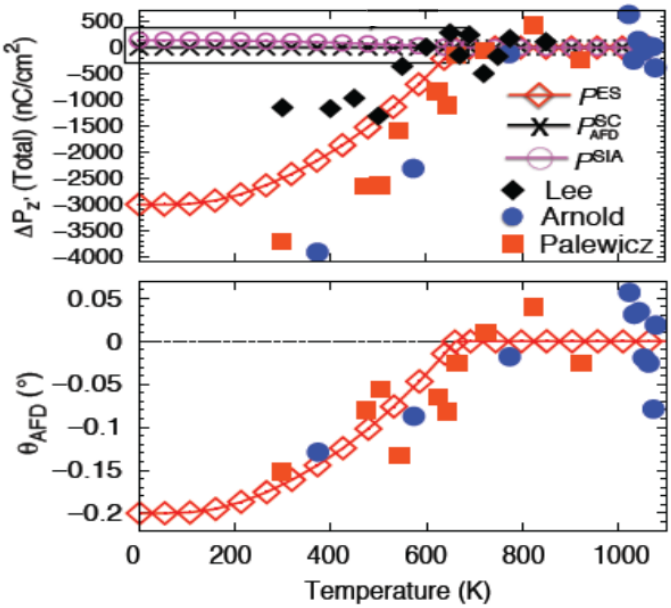
Giant Spin-Driven Electric Polarization in the Room Temperature Multiferroic $BiFeO_3$

Multiferroic materials are important because their electrical and magnetic properties are coupled. Because it magnetically orders below T_N = 640 K, $BiFeO_3$ is one of two known room-temperature multiferroic materials. Recently[1], theorists at Oak Ridge National Lab discovered that the spin-driven electric polarization of $BiFeO_3$ below T_N is much larger than in any other known multiferroic.



Comparison between the predicted and observed spin-driven polarization and of the octahedral rotation angle θ_{AFD}.

The spin-driven polarization below T_N is produced by the rotation of the FeO_6 octahedron and points opposite to the even larger pre-existing electric polarization above T_N. Ironically, the large size of the pre-existing polarization has prevented the giant spin-driven polarization from being directly observed. However, recent neutron diffraction measurements of the crystal parameters, plotted as a function of temperature on the right, confirm the theoretical predictions.

This giant spin-driven polarization will allow the development of devices that control the magnetic properties of $BiFeO_3$ with an electric field or control its electric properties with a magnetic field. The theoretical technique developed in this work can also be used to study the spin-driven electric polarizations in other technologically important multiferroic materials.

[1] Jun Hee Lee and Randy S. Fishman, *Physical Review Letters* (in press)