Magnetic Dispersion and Anisotropy in Multiferroic $BiFeO_3$

Based on neutron-scattering measurements of the low energy magnetic excitations, the exchange and anisotropy parameters of multiferroic $BiFeO_3$ have been determined for the first time. These results will help to develop device applications for multiferroic $BiFeO_3$, which has attracted great interest due to its high magnetic transition temperature of 640 K.

The low-energy excitations of $BiFeO_3$ were measured using newly-available single crystals and the recently-commissioned US-Japan Cold Neutron Triple-Axis Spectrometer CTAX at the High Flux Isotope Reactor (HFIR). As shown in Fig.1, zone-center peaks were observed at 1.1 and 2.5 meV.

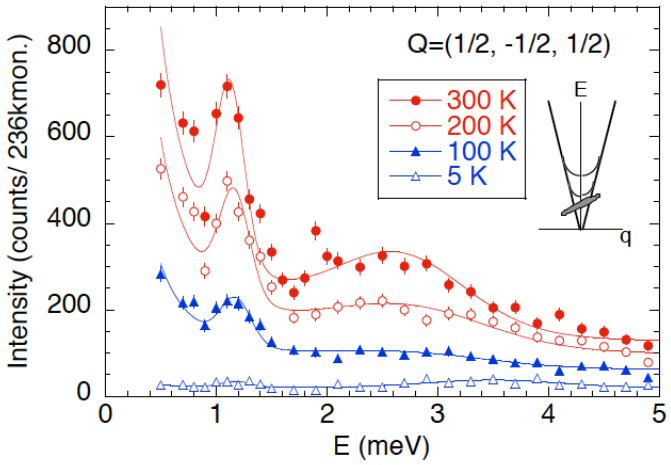

Figure 1. Low energy magnetic excitations at the zone center of $BiFeO_3$ measured using cold neutrons and showing peaks at 1.1 and 2.5 meV.

Those peaks were successfully explained by a model that includes exchange interactions J_1 and J_2, a Dzaloshinsky-Moriya interaction D due to the broken inversion symmetry of the crystal, and a weak easy-axis anisotropy K along the electric polarization. The dispersion of the spin excitations was used to fix J_1 and J_2. For the observed periodicity of the multiferroic spin state and based on the observed low-energy peaks, this model determined that D = 0.16 meV and K = 0.0068 meV. Those values yield zone-center peaks at 1.10 and 2.33 meV, in excellent agreement with the experimental observations.

Results for the weak anisotropy K have implications for the manipulation of the spin state and electric polarization in multiferroic devices using $BiFeO_3$. This work by M. Matsuda, R.S. Fishman, and T. Hong appeared in *Physical Review Letters* **109**, 067205 (2012).