Contribution ID: **57** Type: **Invited Talk**

Soft-mode spectroscopy of ferroelectrics and multiferroics

Thursday, 17 September 2015 09:35 (40 minutes)

In proper ferroelectrics, the large dielectric anomaly observed at Curie temperature TC is caused by softening of some polar excitation. In displacive ferroelectrics, this excitation is a polar phonon active in far-infrared spectra. In order-disorder ferroelectrics, dielectric relaxation with frequency in the MHz-GHz region drives the ferroelectric phase transition. Many ferroelectrics exhibit crossover from displacive to order-disorder type of phase transition, i.e. some phonon softens on cooling far above TC, but additional relaxation (called central mode) appears close to TC and its relaxation frequency remarkably softens towards TC. As examples we will present phonon and central mode behavior near strain-induced ferroelectric phase transitions in EuTiO3 and Srn+1TinO3n+1 (n=1-6) thin films,[1-3] in relaxor ferroelectric Na0.5Bi0.5TiO3 [4] and multiferroic PbFe1/2Nb1/2O3.[5]
In multiferroics, where the ferroelectricity is induced by a spin order, only a small and narrow peak in temperature dependent permittivity appears at TC. We will show that this tiny dielectric anomaly is caused by softening of an electromagnon, whose frequency lies in the microwave region. This electrically active spin excitation can have relaxation character in dielectric spectra (e.g. in MnWO4)[6] or resonance character (e.g. in Sr3Co2Fe24O41 with Z-type hexaferrite structure).[7]
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Session Classification: Multiferroics and ferroelectrics

Track Classification: DyProSo2015 Main track