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Femtoscale magnetically induced lattice distortions in multiferroic $TbMnO_3$

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Magnetoelectric multiferroics, as exemplified by $TbMnO_3$, exhibit both magnetic and ferroelectric long range order. Whilst the magnetic order is mostly understood, the origin of the ferroelectricity has proved more elusive. Competing models ascribe the ferroelectricity to either charge transfer[1] or ionic displacements.[2] I will review how a new experimental technique, exploiting the interference between charge and magnetic X-ray scattering, enabled our resolution of femtometric ionic displacements[3] in $TbMnO_3$. In so doing, I will demonstrate not only that our data provide decisive support for microscopic models attributing P to ionic displacements, but also the importance of including both symmetric and antisymmetric magnetic interactions in any such models.

[1]H. Katsura, N. Nagaosa, A. V. Balatsky, *Phys. Rev. Lett.* **95** 057205 (2005).
[2]I. A. Sergienko, E. Dagotto, *Phys. Rev. B* **73** 094434 (2006).
[3]H. C. Walker *et al., Science* **333** 1273 (2011).