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Electric-field control of magnetism and magnons in the room temperature multiferroic $BiFeO_3$[1]

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The ability to control magnetism using electric fields is of great fundamental and practical interest. It may allow the development of ideal magnetic memories with electric write and magnetic read capabilities, as well as logic devices based on magnons that dissipate much less energy. The application of an external E field to bulk magnetoelectric bismuth ferrite ($BiFeO_3$ or BFO) was shown to lead to a giant shift of magnon frequencies that is linear in E and 10^5 times larger than any other known E-field effect on magnon spectra [1]. I will present a theory of this effect based on the combination of multiferroicity with strong spin-orbit interaction, and show that it enables E-field control of BFO's magnetic state [2]. The application of moderate external E and B fields at appropriate orientations enable competing magnetoelectric interactions to interfere in such a way that the system transitions from a cycloid to a homogeneous state at much lower field values than if only one type of field was applied. These results clarify the conditions required to make BFO a useful material in device applications, and shed light on experiments where BFO is interfaced with other magnetic and ferroelectric materials.

[1] P. Rovillain *et al.*, Nat. Mater. **9**, 975 (2010).
[2] R. de Sousa, M. Allen, and M. Cazayous, Phys. Rev. Lett. **110**, 267202 (2013).

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