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Multiferroicity from charge ordering? A case study

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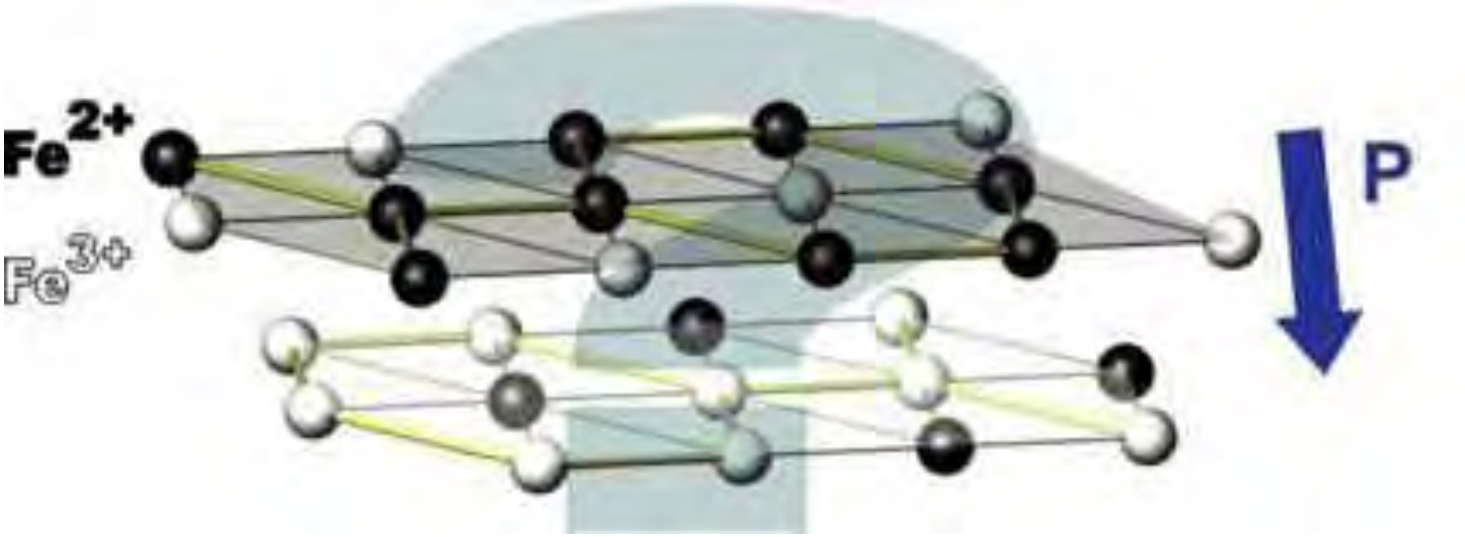
Magnetoelectric multiferroics have a large applications potential. Among possible mechanisms of multiferroicity, ferroelectricity originating from charge ordering (CO) is particularly intriguing because it potentially combines large electric polarizations with strong magnetoelectric couplings – but example materials where this is realized are very difficult to find. I will present a case study of such materials, rare earth ferrites, which were recently found to be a non-example. After LuFe2O4 had been proposed to be a multiferroic due to ferroelectricity originating from Fe2+/Fe3+ CO below 320 K, it has become the generally accepted prototypical example of this mechanism, attracting increasing attention. The proposal had been made due to indications of a polar state by dielectric and pyroelectric measurements, and a reasonable model of CO based on the location of superstructure reflections. This model has not been verified though, and the spin-order has been unknown. I will present x-ray and neutron diffraction, and circular dichroism, measurements that allowed i) a full refinement of the CO crystal structure [1], ii) the determination of the spin structures in two nearly degenerate competing magnetic phases [2], and iii) the relation between these orderings [1]. The results reveal a very strong spin-charge coupling. Most importantly, the unambiguously determined arrangement of Fe2+ and Fe3+ ions excludes any CO-based ferroelectricity – suggesting that LuFe2O4 and other rare earth ferrites are not ferroelectric [3]. Time permitting I will also briefly discuss recent time-resolved diffraction experiments on magnetite, another (more likely) candidate material for CO-based ferroelectricity.

[1] *J. de Groot, T. Mueller, R. A. Rosenberg, et al., Phys. Rev. Lett., 2012, 108, 187601,* ***[2]*** *J. de Groot, K. Marty, M. D. Lumsden, et al., Phys. Rev. Lett.,2012, 108, 037206,* ***[3]*** *M. Angst, Phys. Status Solidi RRL, 2013, 7, 383-400*



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