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Dipoles on monopoles in spin ice

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Close connection of electricity and magnetism is one of the cornerstones of modern physics. This connection plays crucial role both from the fundamental point of view and in practical applications, including recent advance in spintronics and in the study and development of multiferroic materials. A new breakthrough was the recent proposal of Castelnovo, Moessner and Sondhi that in spin ice systems, e.g. in some pyrochlores, one can model the magnetic monopoles – the objects displaying the properties of isolated magnetic charges. Such monopoles are a hot topic nowadays. Usually one discuss mainly their thermodynamic and magnetic properties. I will show that every *magnetic monopole* in spin ice should have an *electric dipole* attached to it. This can be seen from the results obtained for frustrated Hubbard system [1]. Both the electronic mechanism discussed in [1] and the lattice effects (magnetostriction) lead to the conclusion that for 3in/1out and 3out/1in tetrahedra there should appear an electric dipole directed from the center of tetrahedron to the "special" spin. This will lead to electric activity of monopoles, and to possibility to address and influence them not only by magnetic, but also by an electric field. Several consequences of this effect will be discussed. In general, the analogy between electricity and magnetism goes even further than usually assumed: whereas electrons have *electric charge* and spin, i.e. *magnetic dipole*, magnetic monopoles in spin ice have both *magnetic charge* and *electric dipole*.

[1] L.N.Bulaevskii, C.D.Batista, M.V.Mostovoy and D.I.Khomskii, Phys.Rev. B**78**, 028402 (2008)