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Electromotive force and huge magnetoresistance in magnetic tunnel junctions with zinc-blende MnAs nano-magnets

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For nanostructures such as magnetic nanowires or spin valves, it is theoretically predicted that an electromotive force (emf) arises from a time-varying magnetization in a static magnetic field [1]. This reflects the conversion of magnetic energy to electrical energy. Here we show that such an emf can indeed be induced by a *static* magnetic field in magnetic tunnel junctions containing zinc-blende (ZB) MnAs quantum nano-magnets. The ZB MnAs nanomagnets are coupled to a NiAs-structure hexagonal MnAs top electrode through an AlAs tunnel barrier, and to a GaAs:Be bottom electrode through a GaAs barrier. Under a static magnetic field, an emf of up to 7 mV was observed for a time scale of $10^2 \sim 10^3$ sec. This emf is induced by a co-tunneling process of electrons and magnetization of ZB MnAs nanomagnets subject to a strong Coulomb blockade of 50 meV. Huge magnetoresistance of up to 100,000% is observed for certain bias voltages. Our results strongly suggest that Faraday's Law of induction must be generalized to account for purely spin effects in magnetic nanostructures [2]. The author thanks S. Ohya, M. Tanaka, S.E. Barnes and M. Maekawa for their collaboration.

[1] S. E. Barnes et al. APL 89, 122507 (2006); PRL 98, 246601 (2007).
[2] P. N. Hai et al., Nature 458, 489 (2009).