The electromotive force of MnAs nanoparticles

ARISING FROM P. N. Hai, S. Ohya, M. Tanaka, S. E. Barnes & S. Maekawa. *Nature* **458,** 489–492 (2009)

Magnetic tunnel junctions can produce large magnetoresistance effects that are of use in a variety of applications. Hai *et al.*[1] recently published a very interesting paper in which the application of a large static magnetic field to a tunnel junction containing superparamagnetic MnAs nanoparticles resulted in the generation of an electromotive force. The authors attributed this phenomenon to a conversion of the nanoparticles' magnetic energy to electrical energy by way of quantum tunnelling. Here I point out that the electrical energy output measured by Hai *et al.*[1] was more than 1,000 times greater than the maximum amount of magnetic energy that could be induced in their MnAs nanoparticles by the applied magnetic field. Therefore the induced magnetic energy cannot be the source for the observed electromotive force, as was asserted by Hai *et al.*[1].

The maximum magnetic energy that can be induced in the MnAs nanoparticles by the applied magnetic field has the form $E_{\mathrm{mag}} = 2N\mu B$, where N is the number of nanoparticles in the sample, μ is the average saturation magnetic moment per nanoparticle, and B is the applied magnetic field. The values of these parameters as determined by Hai *et al.*[1] were $N \approx 10^9$, $B = 10\,\mathrm{kG}$ and $\mu = 2\mu_{\mathrm{B}}S$, where S is the average spin per nanoparticle (in units of $\hbar$), $\sim$200, and μ_{B} is the Bohr magneton. This yields $E_{\mathrm{mag}} \approx 7 \times 10^{-12}\,\mathrm{J}$ for their device. However, by using the inset of figure 2c in ref. 1 to calculate the electrical output power delivered to a 200 kΩ load resistor and integrating over time, it can be seen that the electrical energy output of the device was greater than 10^{-8} J; this is more than a factor of 1,000 greater than E_{mag}.

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