Supercurrents flex cantilever to reveal vortices

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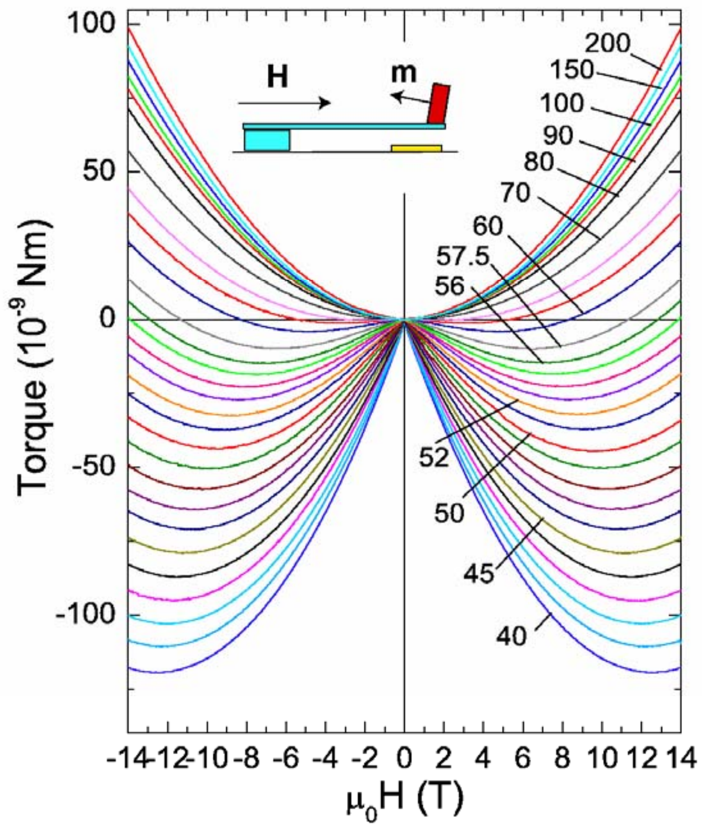
A soft cantilever beam (“diving board”) is capable of detecting a very weak force. In a car, for example, the release of an air-bag is triggered by an accelerometer based on a cantilever. A similar cantilever (inset) has been used by Ong and collaborators[1,2] to uncover a novel, striking property of cuprate superconductors. When a superconductor is exposed to a magnetic field, magnetic flux enters the sample as vortices. In the cuprates, evidence suggest that vortices exist at temperatures *above* the transition temperature T_c. Despite the loss of superconductivity, trace supercurrents around the vortices should produce a magnetic moment **m**. The layered structure of the cuprate crystal provides an elegant way to detect this weak moment. If the field is tilted at an angle to the layers, a force (torque) acts to rotate the crystal. The torque is easily resolved with a soft cantilever (curves in figure)[1]. In addition to confirming the existence of vortices above T_c, the results reveal that electrons drawn together as “Cooper pairs” are very strongly bound. The field needed to unbind them (called the upper critical field) is 60-100 times stronger than that inside a clinical MRI machine.

1. Yayu Wang *et al*., Phys. Rev. Lett. **95**, 247002 (2005).
2. Lu Li *et al*., Europhys. Lett. **72**, 451 (2005).



Variation of the torque versus applied magnetic field **H** at temperatures *T* indicated in Kelvin (T_c = 50 K). Curves with deep minima (40-45 K) reveal a large negative torque caused by strong supercurrents flowing in the layers. These supercurrents remain observable to *T* high above 50 K. The inset shows the cantilever beam (blue) with the cuprate crystal (red) glued to its tip [from Ref. 1].