Oral

NUCLEAR SPIN DETECTION ENABLED BY ULTRA-SENSITIVE CANTILEVERS.

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Force sensors that can achieve attonewton force resolution are key for a number of applications. For magnetic resonance force microscopy (MRFM), we use ultra-sensitive cantilevers to detect magnetic resonance in small ensembles of nuclear spins, measured through the magnetic force between them and a nearby nanoscale ferromagnetic tip [1]. Scaling down the technique to the level of single nuclear spins would enable 3D-magnetic resonance imaging with atomic resolution, with revolutionary impact for structure determination in molecular biology. Reaching this goal, however, crucially depends on our ability to further enhance the force sensitivity and to understand and control the behavior of the nuclear spins.

In this contribution, we focus on our recent progress in using ultra-sensitive cantilevers for real-time tracking and control of nuclear spin fluctuations [2]. We discuss the role of statistics in estimating the number of spins from the fluctuating magnetization, and show that our estimation can be much improved by rapidly randomizing the spins using RF pulses. We also consider the issue of energy dissipation occurring mutually between spins and cantilever. Finally, we discuss a possible alternative path using ultra-small cantilevers for high-frequency (1 MHz) detection of nuclear spin precession (Fig. 1).

References:

[1] D. Rugar, R. Budakian, H.J. Mamin, and B.W. Chui, Nature (London) **430**, 329 (2004).
[2] C.L. Degen, M. Poggio, H.J. Mamin, and D. Rugar, in preparation.

Figures:

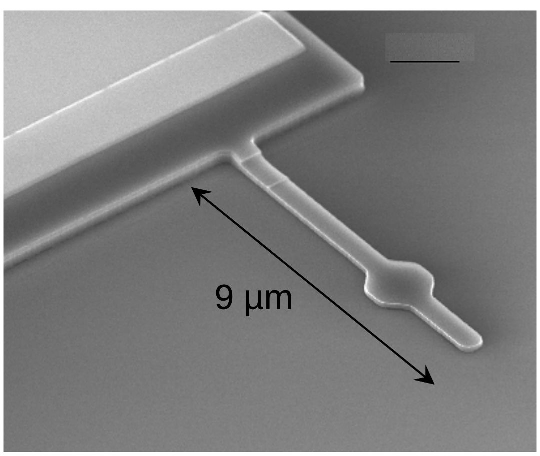

Fig. 1: Ultrasmall cantilever (340 kHz resonance frequency, 2.6 mN/m spring constant) for high-frequency detection of nuclear spin precession.