SQUID Detection of Gold Nanomechanical Resonators

A. Casey[a], L. Levitin[a], J. Saunders[a], A. Venkatesan[c], C.J. Mellor[b], and J.R. Owers-Bradley[b]

[a]Physics Department, Royal Holloway, University of London, Egham, Surrey, TW20 0EX, UK
[b]School of Physics and Astronomy, University of Nottingham, Nottingham, NG7 2RD, UK
[c]IISER Mohali, Transit Campus: MGSIPAP Complex, Sector 26 Chandigarh 160 019 India

It has recently been shown that nanomechanical resonators can be cooled to the quantum regime.[1] Thermal motion, at mK temperatures, of a doubly-clamped beam has been detected by fabricating the resonator into a SQUID [2]. Here we demonstrate that a separate SQUID can be used to detect the motion of a resonator, such that any resonator in the bandwidth of the SQUID amplifier could be detected.
We report measurements on a doubly-clamped beam shaped gold nanomechanical resonator (50 μm length, 300 nm width and 80 nm thick) fabricated on a Si substrate. Previous measurements on gold wire resonators have employed magnetomotive detection schemes in high magnetic fields.[3] In this work the resonant response of the beam is detected in a low magnetic field (30 mT)using a DC SQUID based detection scheme. A simple piezo device was used to excite the observed resonance at 1.2 MHz. The response was studied at 1.5 and 4.2K and a Q of the order of 100,000 was observed at 4.2K. The temperature of the gold wire could be extracted from the measured Johnson noise coupled to the SQUID.

[1]A.D.O'Connell *et al.*, Nature 464, 697-703 (2010)
[2]S. Etaki *et al.*, Nature Physics 4, 785-788 (2008)
[3]A.Venkatesan, et al., *Phys. Rev. B* **81**, 073410 (2010)