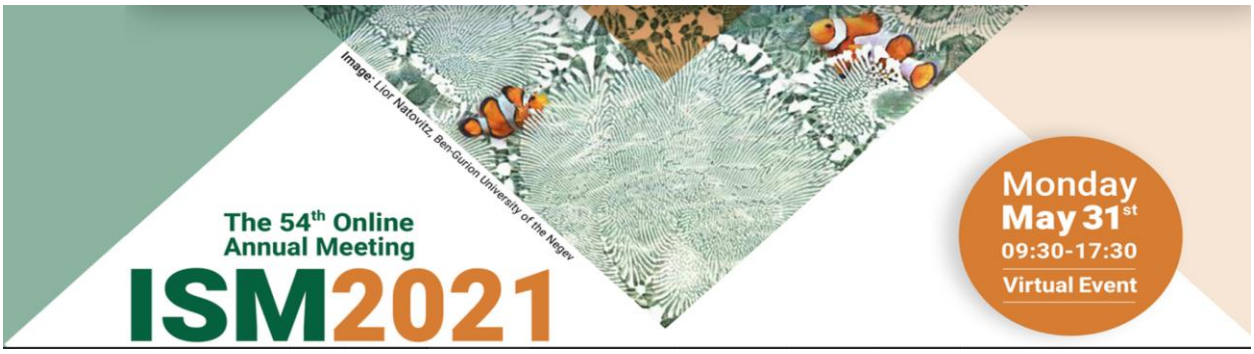

SQUID-ON-TIP OPERATING AT ULTRA-LOW TEMPERATURE AND AT HIGH MAGNETIC FIELD WITH SINGLE SPIN SENSITIVITY

Yonathan Anahory

Racah Institute of Physics, The Hebrew University, Jerusalem, Israel

Scanning nanoscale superconducting quantum interference devices (nanoSQUIDs)[1-3] are of growing interest for highly sensitive quantitative imaging of magnetic, spintronic, and transport properties of low-dimensional systems. Utilizing specifically designed grooved quartz capillaries pulled into a sharp pipette, we have fabricated the smallest SQUID-on-tip (SOT) devices with effective diameters down to 39 nm (Figure 1a). Integration of a resistive shunt in close proximity to the pipette apex combined with self-aligned deposition of In and Sn, have resulted in SOT with a flux noise of 42 $n\Phi_0 Hz^{-1/2}$, yielding a record low spin noise of 0.29 $\mu_B Hz^{-1/2}$ [3]. In addition, the new SOTs function at sub-Kelvin temperatures and in high magnetic fields of over 2.5 T. Integrating the SOTs into a scanning probe microscope allowed us to image the stray field of a single Fe_3O_4 nanocube (Figure 1b) at 300 mK. Our results on single nanocube (Figure 1c) show that the easy magnetization axis direction undergoes a transition from the (111) direction at room temperature to an in-plane orientation, which could be attributed to the Verwey phase transition in Fe_3O_4.

References

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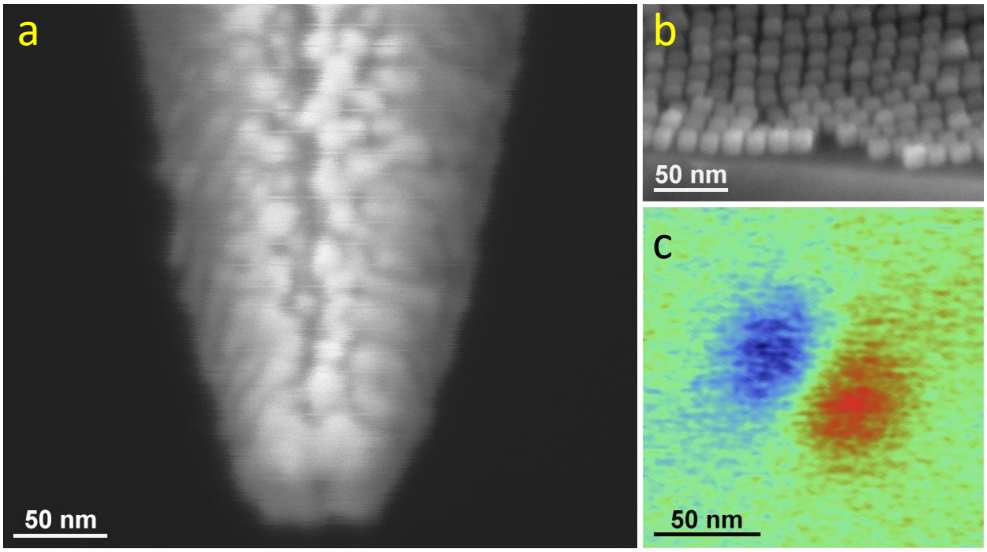

Figure 1. (a) SEM image of an SOT with an effective diameter of 39 nm which uses tin as it's superconducting layer; (b) SEM image of Fe_3O_4 nanocubes. (c) Out-of-plane field emanating from a single Fe_3O_4 nanocube. The color scale represents 13 G.