We present a scanning nanoSQUID microscope with record spatial resolution, spin sensitivity, and operating magnetic fields for the study of vortex matter. The key element of the microscope is the SQUID-on-tip (SOT) device, which is fabricated by pulling a quartz tube into a sharp pipette, followed by three steps of thermal evaporation of a thin superconducting film onto the sides and the apex of the pipette. The devices operate at 4.2 K in applied fields of up to 1T and can be made with diameters down to 50 nm. The SQUIDs-on-tip display an extremely low flux noise of $\Phi_n = 50 n\Phi_0/Hz^{1/2}$ and corresponding spin sensitivity of better than $1 \mu_B/Hz^{1/2}$ [1], which is about two orders of magnitude improvement over any previous SQUID. Using this new tool we have investigated static and dynamic behavior of vortices in superconducting Pb films. By driving ac and dc transport current we can study vortex displacement and the vortex potential landscape with sub-atomic precision.


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