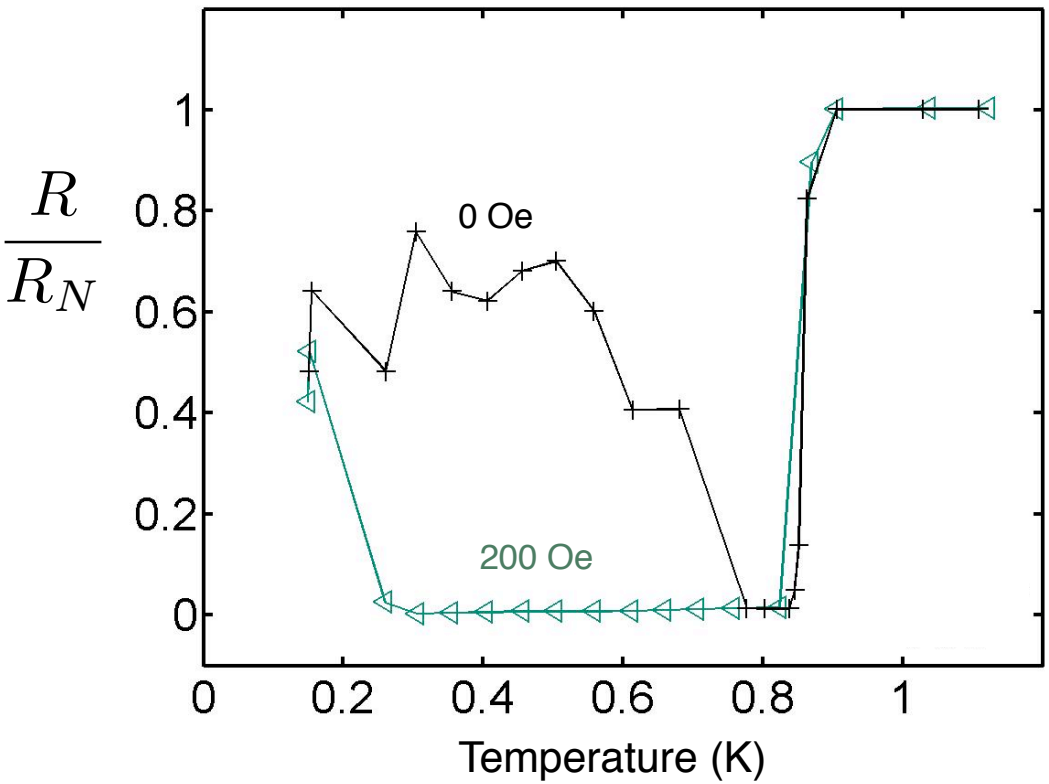
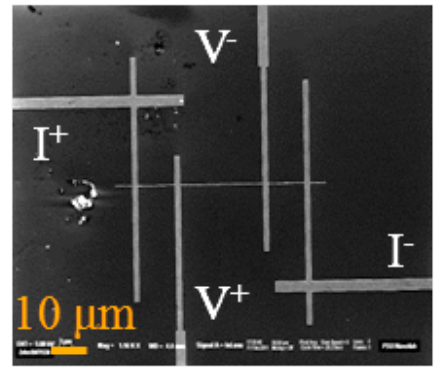
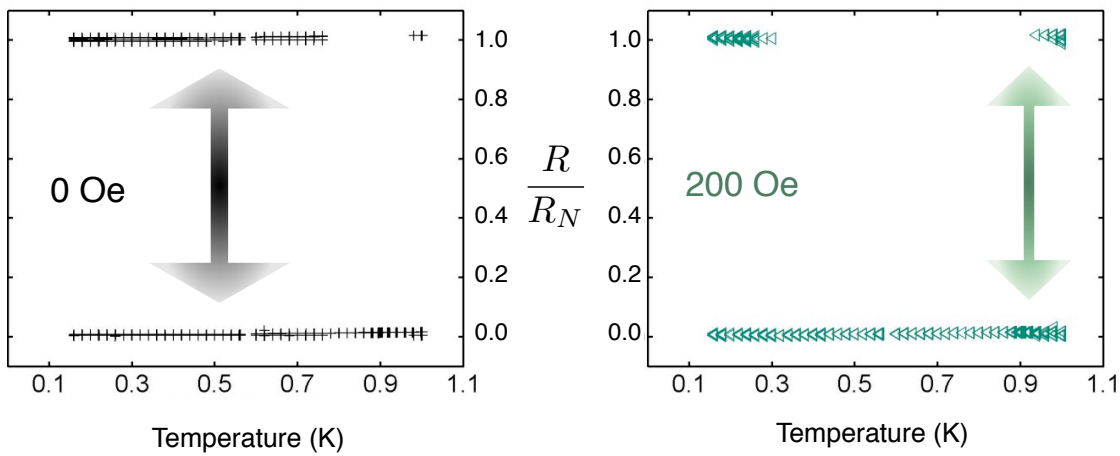
Quantum Phase Slips and Switching Bistability in Superconducting Nanowires





A thin aluminum wire is contacted by 4 wider electrodes, as shown at left. The larger upper plot shows the resistance of this wire as a function of temperature at zero and non-zero magnetic field, following the standard practice of averaging over many repeated measurements. The paradoxical return of the resistive state at low temperature is a consequence of the anti-proximity effect, where the superconductivity of the wire is suppressed when the electrodes become superconducting. The lower plots show the resistance of the wire obtained by a *single* measurement.



Remarkably, only zero or normal-state resistances are found: the resistance doesn't follow a smooth curve, but switches randomly between two discrete values. This bi-stability is triggered by individual thermal phase slips (near T_c) and by quantum phase slips (at lower temperature where the antiproximity effect dominates). The observation of individual phase slip events has been an elusive goal of many prior experiments. This discovery may also assist in the long-term development of quantum computing. (M. Singh & M.H.W. Chan, PRB 88, 64511 (2013))