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Spectroscopy of single emitters using a scanning optical microscope in a dilution refrigerator SAIKAT GHOSH, COLIN HEIKES, FRANK WISE, ALEXANDER GAETA, DAN RALPH, Cornell University — We report the design and implementation of a fiber-based optical scanning microscope, capable of operating at temperatures down to 20 mK and in magnetic fields in excess of 9 Tesla, with sub-micron spatial resolution and ultra-low light levels. A home-made modular, piezo-based scanning head is at the heart of the design, with optical fibers coupling light in and out of a commercial dilution refrigerator. The microscope can be operated both in transmission and reflection modes. In the transmission mode, we can analyze the polarization of the light transmitted through the sample down to femto-Watt light levels, using detectors and polarizers integrated with the scanning head inside the refrigerator. In the reflection mode, the instrument can be operated in a confocal geometry in conjunction with single photon counting modules to measure anti-bunching and the decay times of fluorescent photons. We are using this microscope to study individual nano- emitters, focusing initially on spin dynamics in semiconductor quantum dots.

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