A Novel SPM System for Determining Quantum Electronic Structure at the Nanometer-scale

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ABSTRACT

Since the beginning of the last century new frontiers in physics have emerged when advances in instrumentation achieved lower experimental operating temperatures. Notable examples include the discovery of superconductivity and the integer and fractional quantum Hall effects. New experimental techniques are continually adapted in order to meet new experimental challenges. A case in point is scanning probe microscopy (SPM) which has seen a wealth of new measurements emerge as cryogenic SPM instruments have been developed in the last two decades. In this talk I describe the design, development and performance of a scanning probe microscopy facility operating at a base temperature of 10 mK in magnetic fields up to 15 T [1]. The microscope is cooled by a custom designed, fully ultra-high vacuum (UHV) compatible dilution refrigerator (DR) and is capable of in-situ tip and sample exchange. Sub-picometer stability at the tip-sample junction is achieved through three independent vibration isolation stages and careful design of the dilution refrigerator. The system can be connected to a network of interconnected auxiliary UHV chambers used for sample and probe tip preparation. I will describe results from current measurements which are focusing on Dirac fermions in graphene [2] and in topological insulators.

FIGURE 1. 3D CAD model cross section of the double shielded SPM laboratory (left), and the suite of auxiliary systems for sample and probe tip fabrication in the adjoining laboratory (right) which can be connected to the SPM system [1].

REFERENCES