Scanning Tunneling Spectroscopy of Dirac Fermions at mK Temperatures

J.A. Stroscio

Center for Nanoscale Science and Technology, NIST, Gaithersburg, MD 20899

Since the beginning of the last century new frontiers in physics have emerged when advances in instrumentation achieved lower experimental operating temperatures. New experimental techniques are continually adapted in order to meet new experimental challenges. A case in point is scanning tunneling microscopy (STM) which has seen a wealth of new measurements emerge as cryogenic STM 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] Current measurements are focusing on Dirac fermions in graphene and in topological insulators. Scanning tunneling spectroscopy of graphene at mK temperatures reveals the detailed structure of the degenerate Landau levels in graphene, resolving the full quartet of states corresponding to the lifting of the spin and valley dengeneracies.[2] Significant electron correlation effects are observed when the Fermi level lies inside the four-fold Landau manifold resulting in enhanced energy splittings, as well as new many-body states observed at fractional filling factors of 7/2, 9/2, and 11/2.

[1]Y. J. Song, A. F. Otte, V. Shvarts, Z. Zhao, Y. Kuk, S. R. Blankenship, A. Band, F. M. Hess, and J. A. Stroscio, Rev. Sci. Instrum. **81**, 121101 (2010)
[2]Y. Jae Song, A. F. Otte, Y. Kuk, Y. Hu, D. B. Torrance, P. N. First, W. A. de Heer, H. Min, S. Adam, M. D. Stiles, A. H. MacDonald, and J. A. Stroscio, Nature **467**, 185 (2010).