Millikelvin LEED apparatus: a feasibility study

K. Matsui, S. Nakamura, T. Matsui, and Hiroshi Fukuyama

Department of Physics, The University of Tokyo, Tokyo, Japan

Two-dimensional (2D) adlayers of helium on graphite have rich phase diagrams with various exotic quantum phenomena including supersolidity and the gapless spin liquid state. However, experimental information on structure of each phase is rather limited by technical reasons. So far, only the lattice constants of the commensurate phase in the first layer and incommensurate phases both in the first and second layers were studied by neutron diffraction.[1] The low-energy electron diffraction (LEED) technique has various advantages over neutron and X-ray diffraction methods. For instance, one can distinguish diffraction peaks of adlayers more easily from those of substrate as was demonstrated in the previous experiment on 2D hydrogen on graphite at $T = 5$ K.[2] We have made a feasibility study of LEED measurement of 2D helium below 300 mK. A cell, which contains a single-crystal graphite sample as well as Grafoil for ballast surface area, will be installed at the bottom of the mixing chamber of a cryogen-free dilution refrigerator. A small hole at the bottom of the sample cell will be opened for incident and diffraction electrons after preparing adsorbed samples below 4 K. We will keep the LEED optics near 80 K and use a tilted electron beam gun to suppress radiation heats as much as possible. We will present details of the feasibility study and designing of actual apparatus.

[1]H.J. Lauter, H. Godfrin, V.L.P. Frank, and H.P. Schildberg, Physica B **165**, 597 (1990).
[2]J. Cui and S.C. Fain, Phy. Rev. B **39**, 8628 (1989).