CARBON-BASED NANOELECTROMECHANICAL RESONATORS AS PROBES OF HELIUM CONDENSATES

J.-P. Kaikkonen, P. Häkkinen, A. Laitinen, A. Savin, I.A. Todoshchenko and P.J. Hakonen

Low Temperature Laboratory, Department of Applied Physics, Aalto University, P.O. Box 15100, FI-00076 AALTO, Finland
email: jukka-pekka.kaikkonen@aalto.fi

Suspended graphene and carbon nanotube (CNT) devices are among the most precise mass and force sensors. We aim at utilizing these ultra-sensitive devices to investigate atomic thin films and bulk superfluid phases of ^{3}He and ^{4}He.

In the proposed thin film experiments, mechanical graphene/CNT resonators act both as substrates for adsorption and as detectors. The adsorbed mass can be accurately deduced from the frequency shift of the mechanical resonance while electrical transport properties also provide a powerful probe of the adsorbed atoms [1]. Different phases of two-dimensional helium have been widely studied on graphite but new phase transitions may emerge on suspended graphene/CNT. For the studies of bulk superfluid ^{3}He, a mechanical CNT resonator is expected to be particularly interesting as the diameter of CNT is well below the coherence length of the superfluid. Therefore, a CNT resonator could possibly be used as an accurate local probe of the excitations and defects of the superfluid.

This contribution discusses the state-of-the-art of CNTs as adsorbed gas detectors and outlines their future prospects for quantum-coherent liquid phases. Preliminary results and recent developments are presented.

[1] B. Dzyubenko, H.-C. Lee, O. E. Vilches and D. H. Cobden, Nature Physics **11**, 398 (2015).