NanoMechanics: new insights into helium superfluidity and thermal transport in 2D

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Mechanical resonators based on carbon nanotubes, graphene, and semiconductor monolayers are truly exceptional sensors of mass and force [1-3]. We are taking advantage of these sensing capabilities to study physical phenomena in extreme regimes that have not been explored thus far, because conventional measurement methods lack sensitivity. In a first experiment, we demonstrate the formation of superfluid helium monolayers and multilayers on a carbon nanotube. We observe layer-by-layer growth with discontinuities in both the number of adsorbed atoms and the velocity of the third sound, pointing to the hitherto unobserved layering first-order phase transition. In a second experiment, I will discuss a novel approach to measure the thermal properties of low-dimensional materials in an unprecedented way, down to cryogenics temperature, and with a device that is simple to fabricate. We measure the temperature dependence of the thermal conductivity and the specific heat capacity of a transition metal dichalcogenide (TMD) monolayer, something that has never been achieved thus far with a single nanoscale object.

References

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Figures

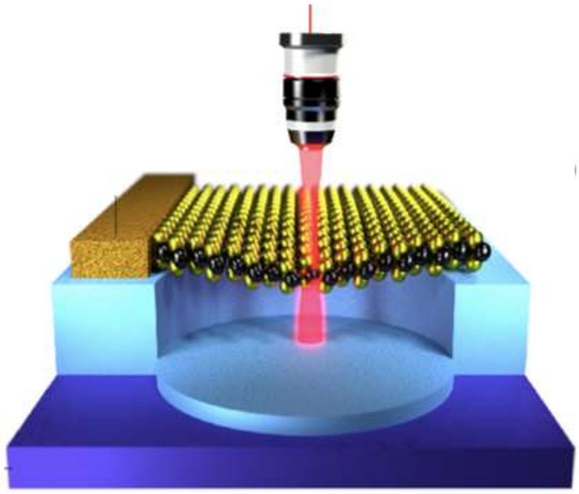

Figure 1. Schematic of an optomechanical drum based on a transition metal dichalcogenide monolayer