Fluctuation Phenomena in Novel Systems at the Nanoscale

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Fluctuation induced phenomena give rise to different types of dispersive interactions, which are typically of long-ranged and collective nature. Forces, such as van der Waals, Casimir, and Casimir-Polder interactions, originating from electromagnetic fluctuations, are found to play a prominent role in many chemically inert 2D and 1D materials. In this presentation, we discuss how graphene nanostructures have given a unique platform to investigate novel fluctuation effects in light-matter interactions. We will focus on results concerning electromagnetic fluctuations induced interactions in graphene, graphene nanoribbons and nanotubes, and emphasize how the dimensionality and response characteristics can be used as means for modulations. Novel charge fluctuation interactions in graphene based nanocapacitors will also be presented via the quantum capacitance concept showing different pathways for quantum mechanical and thermal fluctuations effects. Preliminary results for other members of the graphene family, such as silicene and germanene, will also be discussed.