Quantum Nanoelectromechanics of Graphene Membranes

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Suspended graphene films can be used as mechanical resonators with applications in, e.g., radio technology and mass sensing. In this theoretical study we consider nanomechanical graphene resonators operating in the quantum limit where the mechanical motion exhibits quantum effects. Compared to one-dimensional beam resonators, using graphene literally adds another dimension to quantum nanomechanical systems. For instance, symmetric graphene structures exhibit degeneracies in their vibration spectra and nonlinearities become important already at very small amplitudes. This naturally limits excitation amplitudes and facilitate mode coupling. Here we propose to use asymmetrically applied gate voltages to achieve a controlled breaking of the degeneracies as well as tuning of the nonlinearities. This opens many possibilities for studying mechanical effects in the quantum regime.