Dynamical energy gap engineering in graphene via oscillating out-of-plane deformations

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Abstract
Research on the relation between electronic properties and mechanical deformations in graphene has attracted considerable interest in recent years. At low energies, pseudo-magnetic fields, whose spatial distribution and intensity are tunable via the deformations' geometric features, are used to represent the corresponding strain. Previous results showed that electromagnetic fields (light) have the potential to induce dynamical gaps in graphene's energy bands, transforming graphene from a semimetal to a semiconductor. However, the required laser frequencies are in the THz range, imposing severe challenges for practical implementations. In this work we report a novel method to create dynamical gaps using oscillating mechanical deformations, i.e., time-dependent pseudo-magnetic fields. Using the Floquet formalism we show the existence of a dynamical gap in the band structure at energies set by the frequency of the oscillation, and magnitude controlled by the geometry of the deformation. This dynamic mechanical manipulation strategy serves as a promising venue to engineer electronic properties of suspended graphene devices.

Figures

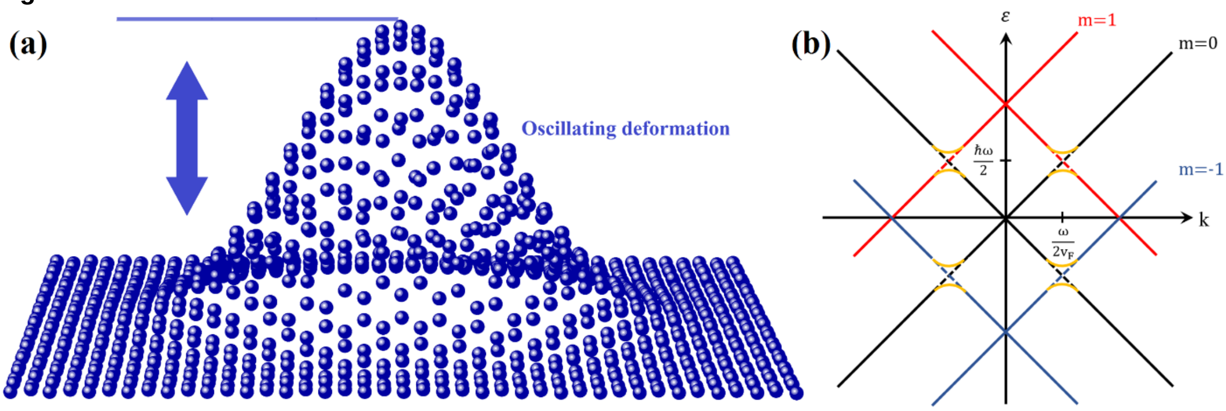

Fig. 1. (a) Schematic diagram of an oscillating Gaussian deformation, and (b) Floquet energy gaps (yellow curves) due to the dynamical deformation.