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Strain-induced effects of topological deformed graphene

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The dynamics of electrons in graphene can be described by a two-dimensional (2D) Dirac equation. Graphene is a two dimensional material embedded in three dimensions and is assumed to define a 2D flat surface. However, one expects deviations from flatland. Structural corrugations and ripples, have been observed in suspended graphene, and furthermore, atomistic simulations have shown that ripples appear spontaneously owing to thermal fluctuations [1]. Geometric curvature and strain in graphene can give raise to pseudo-magnetic fields which can lead to observable phenomena. Furthermore, it is possible to connect strain with the possibility of opening energy gaps in the graphene electronic spectrum and already experimentally observed [1].
We present an analytical solution of the relativistic Dirac equation defined in the framework of quantum field theory in curved space and apply it to study the electronic properties of deformed monolayer graphene [2]. We obtain as solution the Dirac oscillator equation where an effective vector potential term naturally appears. Such a term describes a pseudo-magnetic field which emerges due to the initially defined curvature, and influences the dynamics of the charge carriers as if these were under the influence of an applied external magnetic field.

References

[1] A. J. Chaves et al. J. Phys. Condens. Matter 26, 18 (2014).
[2] M.C. Santos et al., J. Magn. Magn. Mater. 540, 168429 (2021) and references therein.

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