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Manifestation of explicit and spontaneous chiral symmetry breaking in graphene SUNG-HOON LEE, HYUN-JONG CHUNG, JINSEONG HEO, HEEJUN YANG, SUNAE SEO, Samsung Advanced Institute of Technology, Korea — Using first-principles calculations of graphene having high- symmetry distortion or defects, we investigate the chiral symmetry breaking in graphene as the source of gap opening. We identify that the gap opening by the chiral symmetry breaking in the honeycomb lattice is an ideal two-dimensional (2D) extension of the Peierls metal-insulator transition in a linear lattice, the elemental 1D Dirac lattice, and find that the chiral symmetry breaking manifests itself in graphene by the formation of an internal structure of the lattice, which represents the intrinsic internal structure of massive Dirac fermions. We then show that the gap opening of many of previously reported structures of gapped graphene occurs by explicit breaking of the chiral symmetry, rather than by quantum confinement effects or others, and also show that spontaneous chiral symmetry breaking takes place via electron- phonon coupling at certain quasi-1D graphene structures and at 2D graphene under strain.

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