Field:

Materials Science/Biomaterials

Session Topic:

Advances in Graphene-Based Science and Application

Speaker:

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1. Introduction

Graphene is a two dimensional array of carbon atoms on a honeycomb lattice. Its experimental realization [1,2] opens a breakthrough new world in physics and material science, which put a road to the Stockholm again as its zero dimensional (0D) and 1D analogue, C60 and polyacetylene. These carbon based materials have further large variety such as quasi-1D carbon nano-tubes, 3D diamond and graphite. They are clearly key ingredients for coming development of nano-science and technology. Physically most of them belong to a class of insulators/semiconductors which are characterized by a finite excitation gap. In the family, graphene is special, which is a zero-gap semiconductor. Since the energy gap is vanishing, any standard description is no longer applicable. Then a law to govern behavior of electrons in graphene is not a usual Schrödinger equation but a relativistic law by Dirac for vanishing mass.

2. More than new material

It is true that graphene can be useful and groundbreaking new material for nano-technology and supplies a basic platform for various industrial applications. At the same time, graphene is physically fundamental since it is a perfect 2D crystal and electrons live there are relativistic and quantum particles. One of the surprises of the papers [1,2] is that a theoretically famous "theorem" prohibits isolation of 2D perfect crystal, although it is really realized. The other is that realization of the zero-gap semiconductor implies lots of fancy predictions for the massless Dirac fermions by high energy particle physicists should be confirmed within labs. Graphene is a stage for condensed matter realization of the quantum theory with relativity and gauge symmetries.

3. Conclusions

Significance of graphene's experimental realization is, at least, twofold, for huge possibility as groundbreaking new material and for fundamental physics. Let me stress the latter in the talk which I hope to be useful key ideas in graphene based technology for a long term over several decades[3-9]. Although the massless Dirac fermions living in graphene are anomalous, they are, at the same time, quite universal in that they also appear in many different physical systems such as a d-wave superconductor and a topological insulator which is another quite hot topic in the recent condensed matter physics with its relation to possible spintronics applications. I will also put the focus on

the universality without going into any math details [3-9].

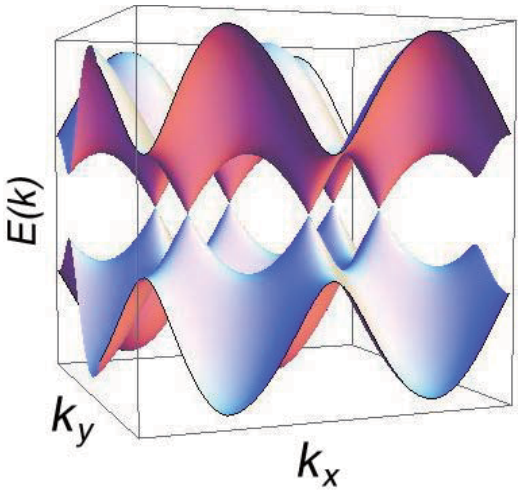

Fig. Energy dispersion of graphene

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