BIASED GRAPHENE BILAYER: A TUNABLE GAP SEMICONDUCTOR

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The two-dimensional (2D) arrangement of carbon atoms forming a honeycomb lattice structure is called *graphene*. It can be viewed as the fundamental unit of several carbon allotropes: three-dimensional graphite is obtained upon stacking; rolling it up gives a one-dimensional nanotube; and it can be wrapped up to form zero-dimensional fullerenes. However, it was not until very recently that graphene, the 2D allotrope of carbon, was experimentally realized [1, 2].

Graphene has immediately attracted great deal of attention. Low energy quasi-particles in graphene have a linear dispersion relation, behaving as massless relativistic particles. This property is responsible for quite unusual (and interesting) solid state physics in graphene; the unconventional integer quantum Hall effect (QHE) being a paradigmatic example [3-6]. Moreover, the surprising stability of this new 2D material and the observed ballistic transport makes graphene a promising candidate for future carbon-based electronics [7].

The technics that made possible the production of single layer graphene were successfully applied to produce *bilayer graphene* – two coupled single layers. The bilayer turned out to have interesting properties on its own. A third kind of integer QHE was recently observed [8], and the possibility of externally control the bilayer band structure [9] makes this system even more promising for some electronic devices.

A graphene bilayer with an electrostatic potential difference between layers – *biased bilayer* – has been experimentally realized recently [10]. Using a tight binding description we have demonstrated that the externally applied gate bias effectively controls the electronic gap between the valence and the conduction bands of bilayer graphene.

Applying the theory to the description of magneto-transport data (Shubnikov-de Haas measurements of the cyclotron mass) we have extracted the value of the gap as a function of the electronic density. It was shown that the gap can be tuned between zero and mid-infrared energies using fields still below the electric breakdown of SiO_2.

The opening of a gap is clearly seen in the quantum Hall regime, where the zero-energy double step characteristic to the anomalous QHE in unbiased bilayer graphene, splits into two, giving rise to an additional plateau at zero Hall conductivity, besides the standard quantum Hall sequence.

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