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Dynamical gap generation in graphene with frequency dependent renormalization effects

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In recent years there has been much interest in the study of graphene, which is a 2-dimensional crystal of carbon atoms that exhibits many interesting electronic properties and quantum effects. The dynamical generation of a gap would cause the system to undergo a phase transition to an insulating state. From a technological point of view, a finite gap would make graphene more promising as a potential material for producing novel electronic devices. A gap would also be theoretically interesting as a concrete realization of the phenomena of chiral symmetry breaking.

We consider the simplest form, mono-layer suspended graphene at half filling. The low energy dynamics are described by a continuum quantum field theory. The effective coupling is of order c/v_F ˜ 300 times the fine structure constant of QED, where v_F is the velocity of a free electron in graphene. The system is strongly coupled and non-perturbative.

We solve a set of coupled Schwinger Dyson equations for frequency dependent fermion dressing functions. We include vertex corrections (using an ansatz which is constructed to preserve gauge invariance). We study frequency dependencies in the renormalization of the fermion Green functions and their influence on dynamical gap generation. The result is a critical coupling of ˜3.2. This is slightly larger than the most recent calculations in the literature and predicts (in agreement with experiment) that the insulating state does not form.

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