Graphene: New bridge between condensed matter physics and QED

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Graphene, which is the first example of truly two-dimensional crystals (it's just one layer of carbon atoms) turns out to be gapless semiconductor with unique electronic properties resulting from the fact that charge carriers in grapheme demonstrate charge-conjugation symmetry between electrons and holes and possess an internal degree of freedom similar to "chirality" of ultrarelativistic elementary particles. It provides unexpected bridge between condensed matter physics an quantum electrodynamics. In particular, the "Klein paradox" of relativistic quantum mechanics is of crucial importance for design of carbon-based transistors; "vacuum polarization" around charge impurities is essential to understand electron mobility; "index theorem" explains anomalous quantum Hall effect in graphene. Due to thermal fluctuations in two-dimensional systems, the graphene membrane turns out to be rippled which leads to an interesting problem of two-dimensional massless Dirac fermions in a curved space.