The electron motion in graphene, first fabricated by mechanical exfoliation method and later by various other methods, is governed by Weyl’s equation for a neutrino or the Dirac equation with vanishing rest mass. The pseudo-spin is quantized into the direction of the electron motion and the wave function exhibits a sign change due to Berry’s phase when the wave vector $k$ is rotated around the origin and therefore has a topological singularity at $k=0$. This singularity is the origin of the peculiar behavior in transport properties of graphene, such as the minimum conductivity at the Dirac point, the half-integer quantum Hall effect, the dynamical conductivity, crossover between weak- and anti-localization, and a very singular diamagnetic response.

In this talk, exotic electronic and transport properties of graphene [1-7] are reviewed from a theoretical point of view including those of carbon nanotubes. The subjects include the universal minimum conductivity at the Dirac point for scatterers with potential range shorter than the electron wavelength, its nonuniversal dependence on the disorder strength for long-range scatterers, the weak-field Hall conductivity and its deviation from the Boltzmann result when the potential range is larger than the Fermi wavelength.

Carbon nanotubes are a graphene sheet rolled into a cylindrical form and their electronic states are obtained by imposing periodic boundary conditions or by discretizing the wave vector in the circumference direction. When time permits, electronic states are also discussed for collapsed carbon nanotubes in which a bilayer graphene is formed in the flattened region.

References