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Conductivity of graphene in the framework of Dirac model: Interplay between nonzero mass gap and chemical potential

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Abstract

© 2017 American Physical Society. The complete theory of electrical conductivity of graphene at arbitrary temperature is developed with taking into account mass-gap parameter and chemical potential. Both the in-plane and out-of-plane conductivities of graphene are expressed via the components of the polarization tensor in (2+1)-dimensional space-time analytically continued to the real frequency axis. Simple analytic expressions for both the real and imaginary parts of the conductivity of graphene are obtained at zero and nonzero temperature. They demonstrate an interesting interplay depending on the values of mass gap and chemical potential. In the local limit, several results obtained earlier using various approximate and phenomenological approaches are reproduced, refined, and generalized. The numerical computations of both the real and imaginary parts of the conductivity of graphene are performed to illustrate the obtained results. The analytic expressions for the conductivity of graphene obtained in this paper can serve as a guide in the comparison between different theoretical approaches and between experiment and theory.

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