J Laser Opt Photonics 2018, Volume 5
DOI: 10.4172/2469-410X-C4-033

On corrected formula for irradiated graphene quantum conductivity

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Graphene membrane irradiated by weak activating periodic electric field in terahertz range is considered. The corrected formula for the graphene quantum conductivity is found. The obtained formula gives complex conjugate results when radiation polarization direction is clockwise or it is opposite clockwise. The found formula allows us to see that the graphene membrane is an oscillating contour. Its eigen frequency coincides with a singularity point of the conductivity and depends on the electrons concentration. So the graphene membrane could be used as an antenna or a transistor and its eigen frequency could be tuned by doping in a large terahertz-infrared frequency range. The obtained formula allows us also to calculate the graphene membrane quantum inductivity and capacitance. The found dependence on electrons concentration is consistent with experiments. The method of the proof is based on study of the time-dependent density matrix. The exact solution of von Neumann equation for density matrix is found for our case in linear approximation on the external field. On this basis the induced current is studied and then the formula for quantum conductivity as a function of external field frequency and temperature is obtained. The method of the proof suggested in this paper could be used to study other problems. The found formula for quantum conductivity can be used to correct the SPPs dispersion relation and for the description of radiation process. It would be useful to take the obtained results into account when constructing devices containing graphene membrane nanoantenna. Such project could make it possible to create wireless communications among nanosystems. This would be promising research area of energy harvesting applications.