# Absorption of twisted and linearly polarized light in graphene with Rashba spin-orbit interaction

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ABSTRACT

Graphene is one of the most important materials for possible applications now. The absorption of light by electrons in graphene was calculated and discussed. It is known now that the absorption coefficient in graphene as function of light frequency is a constant equal to the constant of fine structure, $I(\omega) = \pi\alpha$ [1]. But for the applications, it is not just linear or circular polarized light, which is of main importance. It is necessary to find the interaction of electrons with a real laser beam light. A quarter of century ago L. Allen et al. described the laser light with a Laguerre-Gaussian distrubution of amplitude [2]. The orbital angular momentum (OAM) associated with certain types of laser light has been the focus of much attention in both theoretical and experimental contexts [3, 4]. Here we considered the absorption coefficient in graphene taking into account various polarization, namely linear, circular, and the so called Bessel light described by the vector potential $\mathbf{A}(\mathbf{r}, t)$ in form proposed in Refs. [5, 6] with the intensity of radiation for two different angular momenta $\ell$, like presented in Fig. (1). In our cacluation we include the influence of graphene substrate, which is manifested by the Rashba spin-orbit interaction with coupling constant $\alpha = 2\lambda$. In this case the graphene electron structure near K, K' Dirac points has a four bands where exist the optical transitions [7].

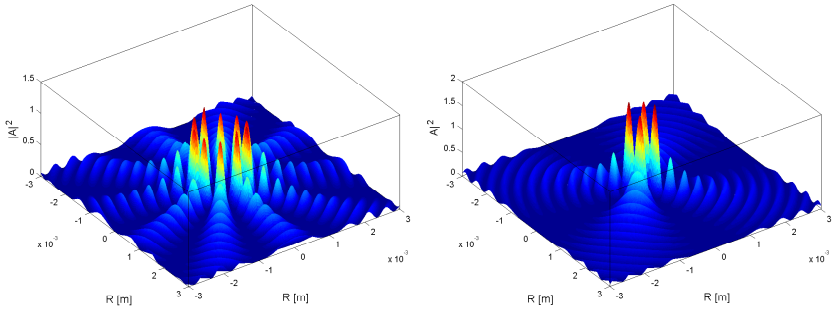


Figure 1: Intensity of Bessel light $|\mathbf{A}|^2$ as function of area position for $q = 1 \times 10^4\,\mathrm{m}^{-1}$ and angular momentum number $\ell = 5$ on the left hand side ($\ell = 3$ on the right hand side).

# References


[1] M. I. Katsnelson, Graphene: Carbon in Two Dimensions (Cambridge University Press, Cambridge, 2012).

[2] Allen, L., Beijersbergen, M.W., Spreeuw, R.J.C., Woerdman, J.P., Orbital angular momentum of light and the transformation of Laguerre-Gaussian laser modes. Physical Review A 45, 8185 (1992).

[3] Spektor, G., David, A., Bartal, G., Orenstein, M., Hayat, A., Spin-patterned plasmonics: towards optical access to topological-insulator surface states. Optics Express 23, 32759 (2015).

[4] O'Neil, A.T., MacVicar, I., Allen, L., Padgett, M.J., Intrinsic and Extrinsic Nature of the Orbital Angular Momentum of a Light Beam. Physical Review Letters 88, 053601(4) (2002).

[5] Jáuregui, R., Rotational effects of twisted light on atoms beyond the paraxial approximation. Physical Review A 70, 033415 (2004).

[6] Quinteiro, G.F., Tamborenea, P.I., Twisted-light-induced optical transitions in semiconductors: Free-carrier quantum kinetics. Physical Review B 82, 125207(10) (2010).

[7] Inglot, M., Dugaev, V.K., Sherman, E.Y., Barnaś, J. Optical spin injection in graphene with Rashba spin-orbit interaction. Physical Review B 89, 155411 (2014).