Pis'ma v ZhETF, vol. 103, iss. 8, pp. 622 – 622


# Comment on "Photon-assisted electron transport through a quantum point contact in a microwave field" (Pis'ma v ZhETF 102(6), 417 (2015))

S. A. Mikhailov[1)], N. A. Savostianova

*Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany*

Submitted 20 February 2016

DOI: 10.7868/S0370274X16080129

In Ref. [1] a giant microwave photo-conductance of a two-dimensional electron gas (2DEG), having the form of a Hall bar with a tunnel point contact, Fig. 1a, was observed. According to [1], without irradiation the tunnel barrier height (controlled by the gate voltage) only slightly exceeds the Fermi energy of 2D electrons; microwaves increase their energy in the near-gate areas helping them to overcome or tunnel through the barrier. Recently, another interpretation treating the effect by the influence of microwaves on the barrier height has been proposed in Ref. [2]. According to this paper, the tunneling current grows due to multiphoton absorption processes. In this Comment we show that the model of Ref. [2] describes a situation completely different from the one studied in the experiment [1].

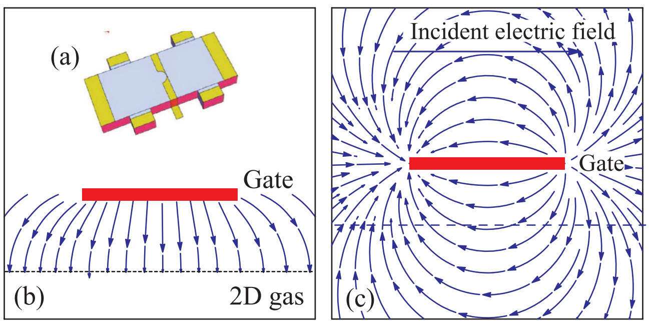


Fig. 1. (Color online) (a) – A structure studied in Ref. [1]. (b, c) – A side view of the electric field distribution in the model of Ref. [2] (b) and in the experiment [1] (c). In panel c the thick straight arrow symbolizes the uniform electric field of the incident wave; the thin curved arrows show the induced field due to the dynamic polarization of the gate stripe; the screening of the field by the 2DEG (the thin dashed line) is not taken into account in panel c

The authors of [2] consider an electron tunneling through a time-dependent potential $V(x,t) = [V + A_\omega \cos(\omega t)]/\cosh^2(ax)$. Physically this corresponds to the situation when an ac voltage is applied *between* the 2D layer and the gate; under the gate (at the position of the tunnel barrier) the microwave electric field is then *perpendicular* to the 2DEG, Fig. 1b. In contrast, in the experiment [1] microwaves are *normally incident* on the sample, leading to the ac electric field *parallel* to the 2D layer, Fig. 1c.

In the first case (Ref. [2]) the solution of the time-dependent Schrödinger equation,

$$\Psi_{\mathbf{k}}(t) \propto \sum_s J_s\left(\frac{A_\omega}{\hbar\omega}\right) e^{-i(E_{\mathbf{k}}+s\hbar\omega)t/\hbar}, \qquad (1)$$

shows that electrons absorp microwave quanta $\hbar\omega$ ($\sim 0.6{-}0.7$ meV in [1]) with the probability determined by the parameter $A_\omega/\hbar\omega$ ($J_s$ is the Bessel function). In Ref. [2] the authors took for $A_\omega$ an arbitrary value of 2 meV (in the experiment $A_\omega = 0$) and concluded that the leading contribution to the observed effect comes from few-photons absorption/emission processes.

In the second case the solution of the time-dependent Schrödinger equation for an electron in the parallel uniform ac electric field $E_0\cos(\omega t)$ gives

$$\Psi_{\mathbf{k}}(t) \propto \sum_s J_s\left(\frac{e^2E_0^2}{8m\hbar\omega^3}\right) e^{-i(E_{\mathbf{k}}+s\cdot 2\hbar\omega)t/\hbar}. \qquad (2)$$

It shows that electrons absorp double-energy quanta $2\hbar\omega$ with the probability determined by a much smaller parameter $e^2E_0^2/8m\hbar\omega^3$ ($\lesssim 10^{-2}$ under experimental conditions [1]). The physics in Refs. [2] and [1] is therefore completely different.

The results of the theory [2] are thus very interesting but unrelated to the experiment [1].

This work was supported by the European Union under the Program Graphene Flagship (# CNECT-ICT-604391).

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1)e-mail: sergey.mikhailov@physik.uni-augsburg.de