Experimental discovery of the quantum Hall effect (QHE) which take place only in two dimensional electron gas (2DEG) – is one of the most exciting discoveries of condensed matter physics of XX century [1]. The phenomenon is found to exhibit a very high precision independently on the host materials in which 2DEG is implemented. Thus, it's measurements is currently used in various National Metrology Institutes [2]. However, metrological applications require stringent experimental conditions: very low temperatures (at T = 1.5 K) and high magnetic fields (>5 T). Despite the long time from QHE discovery, these important problems are still unsolved. Only a few years ago it has been demonstrated that graphene can operate as a quantum Hall resistance standard (QHRS) with the required quantization accuracy of a few part per billion, at more relaxed experimental conditions — magnetic fields of 3.5 T [3]. However, not only graphene is a material in which the large Landau levels energy gaps and Dirac like energy spectra can be obtained. In particular, HgTe quantum wells (QWs) are the structures in which the two-dimensional confinement can be tailored the way to obtain the graphene like band structure [4].

In order to achieve a required precision of QHE measurements, large Landau Levels splitting must be achieved at low magnetic fields. Simultaneously, both conditions of μB> 1 and Landau level splitting Δ >100 $k_B T$ must be achieved. In the case of the Dirac massless fermions, the position of n-th Landau level is described by the relation:

$$E_n = \mathrm{sgn(n)} v_F \sqrt{2\hbar neB},$$

where B — a perpendicular magnetic field and v_F — Fermi velocity. As can be seen, v_F is an important parameter determine the splitting of Landau levels.

This project is a basic research project, where the scientific objective is to investigate the band structure and physical properties in the new two-dimensional structures having Dirac fermion band structures. The main goal of this project is to study effects that are responsible for increase of the Fermi velocity of the carriers and for the resistance quantization accuracy in HgTe/HgCdTe structures with massless Dirac fermions. Thanks to these research we want to answer the basic science questions: i) whether accuracy of the quantization for resistance standards at low magnetic field (B<1 T) may be achieved in HgCdTe class materials and ii) how the physical behavior of the band structure versus strain.

Timeliness and novelty of the proposed research comes from recently developed graphene like materials science. However, the precision of the quantization in HgTe quantum wells at which Dirac like energy spectra are realized, have not been studied until now.

Therefore we expect that the project will have ***very high impact on the research field and discipline*** because it will answer the main questions: i) whether accuracy of the quantization of the order 10^{-9} at low magnetic field (B<1 T) may be achieved in HgTe quantum wells structures with massless Dirac fermions; ii) how the physical behavior of the band structure versus strain.

We expect also important outcome from the point of view their future applications. We believed that our results will pave the way towards new competitive resistance standards using HgTe/CdHgTe quantum wells with graphene like band structures. Therefore research proposed in the project may have important ***economic and societal impact***. Results obtained from the research will serve as underline for preparing the doctoral dissertation and will be presented on the domestic and international conferences.

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