Project 6.4. Topological phase transition in semiconductor nanostructures based on indium gallium nitride

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Background:

Topological insulators are a new class of semiconductor materials having an energy gap in the bulk electronic band structure and metallic states on the boundary, occurring due to the nontrivial topology of the bulk states. The discovery of the topological phase transition between the normal insulator state and the topological insulator in quantum wells built either from mercury telluride and cadmium telluride or indium arsenide, gallium antimonide and aluminum antimonide is one of the most important achievements of recent years in condensed matter physics. The search for other quantum structures, in which the topological phase transition can be generated, has become one of important research directions in many leading centers around the world. One of promising candidates for realization of the two-dimensional topological insulators are quantum wells built from indium nitride and indium gallium nitride, in which the presence of the built-in electric field can lead to a subband inversion, causing a nontrivial topology of the band structure. Introducing additional quantum confinement enables to obtain topological quantum dots having ringlike, spin-polarized edge states which can be utilized in many applications in spintronics and quantum computation.

Aim:

The aim of the project is to conduct a theoretical study of the topological phase transition in quantum wells and quantum dots based on indium gallium nitride. The study will take into account the influence of the quantum confinement on the bulk and edge states as well as the effect of the external electric field and external mechanical stresses. The results of the calculations will enable determination of the properties of the nontrivial topological states and their potential application.

Requirements:

A person, who has completed a master's degree in physics or a related field and has predispositions to work in theoretical or computer physics, is recommended for the implementation of the project.