

DESCRIPTION FOR THE GENERAL PUBLIC

Discoveries of Integer Quantum Hall Effect (1981, Nobel prize 1985) and next of Fractional Quantum Hall Effect (1982, Nobel prize 1998) open the intensive studies of two dimensional multiparticle systems exposed to strong magnetic field towards searching of unconventional quantum behavior not occurring in 3D. In 2D Hall systems appear exotic quantum particles like anyons besides ordinary bosons and fermions known from 3D reality. Moreover in 2D appear also other quantum beings like composite fermions or composite anyons completely unknown in 3D space. Discovery of graphene (Nobel prize 2010) highly accelerated studies in the field of planar systems. Recently, in graphene there were observed series of fractional quantum states in magnetic field which cannot be explained upon the conventional model of so-called composite fermions, commonly used in the framework of Hall system physics.

In the present project the new theory for Fractional Quantum Hall Effect is proposed basing on the deep topological background of the related two dimensional interacting many-particle systems. The proposed model elucidates the heuristic assumption of the previous conventional theory of composite fermions and, moreover, goes beyond the reach of former theory. The newly formulated topological approach allows for natural explanation of all controversial experimental observations of the Fractional Quantum Hall Effect including the recently noticed unusual related effects in graphene, monolayer and bilayer.

The better insight into the nature of fractional quantum Hall states in 2D systems is of a large importance because quantum Hall effects are not peculiar material properties but are rather a class of universality of 2D multiparticle systems. The unconventional quantum effects are encountered not only in usual semiconductor 2DEGs and in graphene but also in theoretical studies of so-called fractional topological Chern insulators and in planar optical lattices. Significance of the Fractional Quantum Hall Effect is supported also by plans of construction of large decoherence free topological quantum computer employing as information carriers of so-called non-Abelian anyons related to fractional quantum Hall states in 2D.