Πανεπιστήμιο Κύπρου

The Department of Physics at the University of Cyprus
is organizing a seminar on

Tuesday, 10 of May 2016, time 5:30 p.m.

Room B228, Building 13, New Campus

Speaker:

Dr. Thierry Champel
CNRS researcher at LPMMC
(Laboratoire de Physique et Modélisation des Milieux Condensés)

"An Introduction to the vortex theory of the quantum Hall effects"

After a general introduction on the phenomenology of the integral and fractional quantum Hall effects, I shall focus my talk on the microscopic mechanism responsible for the remarkable transport properties of two-dimensional electron gases in high magnetic fields, namely the vanishing of the longitudinal (dissipative) resistance accompanied by the formation of plateaus of the Hall resistance.

Our understanding of the quantum Hall effects is essentially based on the existence of two kind of electronic states : localized states in the bulk which mostly do not contribute to transport properties and delocalized chiral states circulating close to the sample edges. The edge states resulting from the presence of a confining potential and the bulk states reflecting the underlying intrinsic disorder potential are usually not described on the same footing at the theoretical level, the difficulty being the treatment of a smooth disorder potential within a quantum mechanical framework. I shall expose the key physical principles behind the construction of the so-called vortex theory that we developed during the past years, which provides a solution to this issue. Then, recent experiments on the local density of states in the integral quantum Hall regime, which shed light on the genuine localization mechanism taking place in real systems, will be quantitatively analyzed with the help of the vortex theory.

In the final part of the presentation, I shall evoke our recent (rather exotic) generalization of the vortex theory in the presence of strong electron-electron interactions, which is crucially based on the idea that a similar localization mechanism takes place in the fractional quantum Hall regime. As will be developed, this scenario leads us to the consideration of new solutions to the Schrödinger equation in the frame of the bicomplex algebra, which generalizes the concept of complex numbers to the four-dimensional space. Remarkably, these bicomplex eigenstates embody a complete fusion of the individual electronic cyclotron motions via a novel kind of topologically-protected entanglement.