CEA – Saclay, 91191 Gif-sur-Yvette Cedex
Service de Physique de l'Etat Condensé - UMR 3680

Soutenance de thèse

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Ramiro H. Rodriguez

Nanoelectronics Group (GNE)

"Relaxation of quasiparticles injected above the Fermi sea of a Quantum Hall edge channel"

The one-dimensional, chiral and dissipationless edge channels of the quantum Hall effect form the electrical analogue of optical fibers, allowing the implementation of electron quantum optics experiments where one coherently manipulates the trajectories of single electronic wave packets. A recent series of experimental and theoretical works have put into light strong effects of decoherence and energy relaxation caused by interactions with quasiparticles present in neighboring edge channels, capacitively coupled to the edge channel in which the experiment is performed. This coupling leads to new eigenstates challenging the usual representation of excitations in the quantum Hall effect.

We have experimentally investigated the energy relaxation of quasiparticles emitted at a well-defined energy in a quantum Hall edge channel, in presence of a second edge channel co-propagating along the former. Our setup relies on a pair of electrostatically defined quantum dots, used as energy-resolved *emitter* and *detector*. Our results, obtained at filling factor 2 of the quantum Hall effect, show that although the propagation over submicron lengths leads to sizable energy relaxation, a small portion of quasiparticles are not affected by energy relaxation even at relatively high energies, up to 150 µeV. Additionally, we investigated simultaneously the charge current and the heat current propagating in the edge channel while relaxation takes place. Surprisingly, we observe that the amount of energy lost during propagation is markedly larger than expected, suggesting that relaxation mechanisms towards external degrees of freedom play an important unexpected role in electron quantum optics experiments.

Furthermore, we have experimentally demonstrated that the relaxation of the quasiparticle peak injected in the outer edge channel can be strongly suppressed by decoupling the edge channel of the neighboring inner co-propagating edge channel. Clear signatures of a reduced relaxation rate have been observed both in the decaying amplitude of the quasiparticle peak and in the amount of energy leaking out of the edge channel.