Secteur des Sciences et Technologies

Invitation à la soutenance publique de thèse de

Monsieur Sébastien TOUSSAINT

Master ingénieur civil physicien

Pour l'obtention du grade de Docteur en sciences de l'ingénieur et technologie

« Scanning gate tuning of mesoscopic transport in quantum-ring networks»

qui se déroulera

le vendredi 05 octobre 2018 à 15h00
Auditoire SUD 09
Place Croix du Sud
1348 Louvain-la-Neuve

Membres du jury :

Prof. Benoît Hackens (UCL), supervisor
Prof. Vincent Bayot (UCL), supervisor
Prof. Bernard Piraux (UCL), chairperson
Prof. Jean-Christophe Charlier (UCL), secretary
Prof. Thomas Ihn (ETH Zurich, Switzerland)
Prof. François Peeters (UAntwerp, Belgium)

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During the last few years, scientists have been studying smaller and smaller objects presenting various astonishing properties. Nowadays, sophisticated fabrication techniques allows to build objects down to the nanometer scale. Among the plethora of nano-objects, those conducting electricity attracted a great deal of attention with interesting transport properties such as electrical conductance quantization, electron interferences, single charge effects etc. This thesis aims to study puzzling electron transport signatures emerging as electrons flow through nanoscale electrically-conducting networks patterned within two-dimensional electron systems (2DES), where charge transport occurs in the ballistic and coherent regime at low temperature. These networks, constituted from connected nanowires, exhibit peculiar electrical conductance variations that we managed to associate with electron interferences within individual one-dimensional wires and two-dimensional ballistic electron scattering. Local-scale data on electronic transport were collected with scanning gate microscopy (SGM) - a near-field technique where an electrostatically biased nanoscale conductive tip, scanned in the vicinity of the network, is used to tune the electrostatic potential felt by electrons crossing the network. SGM allowed us to decrypt electron transport mechanisms at the local scale, to demonstrate the presence of an unidimensional electron interferometer in the network and to pinpoint a charge injection mechanism analogous to the two-dimensional Rutherford scattering, in the case of electron scattered inside a solid state semiconducting device. The latter mechanism was also reproduced using tight-binding transport simulations where we modeled carefully the tip-induced potential and the disorder potential encountered by electrons in the 2DES. In turn, this work provides useful tools in the perspective of building 'electron optics' devices, where a local modulation of the electrostatic potential enables, on one hand, to control Fabry-Pérot electron resonances and, on the other hand, to redirect the electron flow in a similar way as an optical lens curves light rays, allowing to study Rutherford-like ballistic scattering mechanisms.