UCLouvain
Institute of Condensed Matter and Nanosciences

IMCN

Prof. Mansour SHAYEGAN

Dept. of Electrical Engineering
Princeton University (USA)

http://ee.princeton.edu/people/faculty/mansour-shayegan

IMCN SEMINAR

« Probing Exotic States of Interacting 2D Electron Systems»

Thursday 25 April 2019 – 11:00 am
Auditorium LAVO51
Place L. Pasteur, 1, Louvain-La-Neuve

More information : Sophie HERMANS (sophie.hermans@uclouvain.be)
Benoît HACKENS (benoit.hackens@uclouvain.be)

UCLouvain
Institute of Condensed Matter
and Nanosciences

IMCN

Prof. Mansour SHAYEGAN

Dept. of Electrical Engineering
Princeton University

ABSTRACT

There has been a surge of recent interest in the physics of interacting 2D electrons in a large perpendicular magnetic field when they occupy a half-filled Landau level. The long ago proposed composite fermion (CF) picture, in which two magnetic flux quanta are bound to each electron to form a CF, explains many properties of the system. These include the compressible (metallic) behavior of the 2D system at filling factor $\nu = ½$, the existence of a Fermi sea with a well-defined Fermi wave vector, and the presence of fractional quantum Hall states as the filling deviates from $\nu = ½$. In this talk, I will highlight the results of several recent experiments, performed on very high mobility 2D electron and hole systems confined to GaAs/AlGaAs quantum wells, that probe CFs via measuring the geometric resonance of their cyclotron orbit diameter with the period of an imposed, unidirectional density modulation.

The data reveal several important phenomena: (1) An unexpected asymmetry of the CFs' Fermi wave vector for filling factors smaller and larger than $\nu = ½$, suggesting a subtle breaking of particle-hole symmetry. (2) Anisotropic Fermi contours for CFs that can be tuned by applying in-plane magnetic field or in-plane strain. The strain results are particularly intriguing as they imply that the CFs inherit a Fermi sea anisotropy from their (parent) zero-field particles through a simple relation. (3) I will also present CF geometric resonance measurements near the even-denominator fractional quantum Hall state at $\nu = 5/2$, providing direct proof for the existence of fully spin polarized CFs. This observation lends crucial support to the 5/2 fractional quantum Hall effect being a non-Abelian state and therefore of potential use for topological quantum computing.

BIOGRAPHY

Prof. Mansour Shayegan graduated from the Massachussetts Institute of Technology (MIT, USA) in 1981. He then obtained the PhD degree in the same institution under the direction of Prof. Mildred Dresselhaus, in 1983. After a research fellowship at the University of Maryland during 1984-1985, he has been a faculty member in the Department of Electrical Engineering at Princeton University, where he teaches physics and electrical engineering courses, and runs the Low-Dimensional Systems Lab.

Research in his group focuses on the fabrication and physics of low-dimensional semiconductor structures, with an emphasis on their electronic properties. This involves the growth of high-quality Gallium Arsenide/Aluminum Gallium Arsenide (GaAs/AlGaAs) heterostructures by molecular beam epitaxy, followed by various lithography techniques to realize various types of very clean (low-disorder) quantum-confined carrier systems.

These structures provide a crucial and important test bed for "many-body phenomena", observed at low temperatures and high magnetic fields, such as electron-hole phases in bilayer systems, or the crystallization of electrons at low density (Wigner crystal).
These physical phenomena originate from the interactions between charge carriers, and can become challenging to describe and understand when the dominant interaction between charge carriers becomes the Coulomb repulsion between the electrons.

Prof. Shayegan has won numerous awards, including a Princeton University Graduate Student Mentoring Award, Alexander von Humboldt Prize, and a Fulbright Fellowship. He was also the recipient of an Alfred P. Sloan Fellowship, an IBM Faculty Development Award, and a National Science Foundation Presidential Young Investigator Award.

Website: http://ee.princeton.edu/people/faculty/mansour-shayegan