L4G SEMINAR: Quantum devices in graphene

KLAUS ENSSLIN

May 24, 2023
16:00 to 17:00
Seminar Room

Abstract:
We demonstrate high quality gate-defined quantum dots in bilayer graphene and investigate their potential for charge, spin and valley qubits. In magic angle twisted bilayer graphene we use the suprconducting pahse to study Josephson junctions and SQUIDs.
Quantum dots have emerged as one of the contenders for a future quantum information processor. Bilayer graphene is now established as a material that allows high quality bi-polar Coulomb blockade measurement, time-dependent transport measurements and first relaxation time measurements. In contrast to the more conventional GaAs and Si-based systems, several exiting and unexpected observations in graphene have been explained by the peculiar graphene bandstructure, which is gate-tunable, the additional valley degree of freedom, and spin-valley coupling. Here we demonstrate shell filling of electronic states in graphene quantum dots and derive the spin and valley Hund rules for the first 24 carriers occupying the quantum dots. Lifetimes of single single spins are measured using the Elzermann read-out. For two carriers occupying a single or double quantum dot we find a complex charge stability diagram with transitions governed by Pauli spin and/or valley blockade. Using these two carrier states we measure spin lifetimes of about 50 ms and valley lifetimes approaching 1s.
In superconducting graphene fabricated using two layers twisted by the magic angle we investigate Josephson junctions as well as a SQUID, where the critical current in the two arms can be independently controlled by gate electrodes.

Bio:
Klaus Ensslin has been Professor of Solid-?State Physics at ETH Zurich since October 1995. Klaus Ensslin studied physics at the University of Munich and at ETH Zurich. After completing his doctoral dissertation at the Max Planck Institute in Stuttgart, he was a postdoc at the University of California in Santa Barbara, USA. From April 1991 until September 1995 he worked at the University of Munich. His habilitation thesis was awarded a prize from the University of Munich. In 1995 he received the Gerhard Hess prize of the German Science Foundation promoting outstanding young researchers. In 2020 her received the Edison Volta Prize of the European Physical Society.
The primary research interest of Klaus Ensslin lies in the physics of mesoscopic systems. The

electronic properties of novel semiconductor nanostructures are investigated using material control down to the atomic scale. One important goal is the ever increasing control and improved understanding of the quantum properties of electrons in nanostructures.

Hosted by: Frank Koppens & Adrian Bachtold