Aachen Graphene & 2D Materials Center

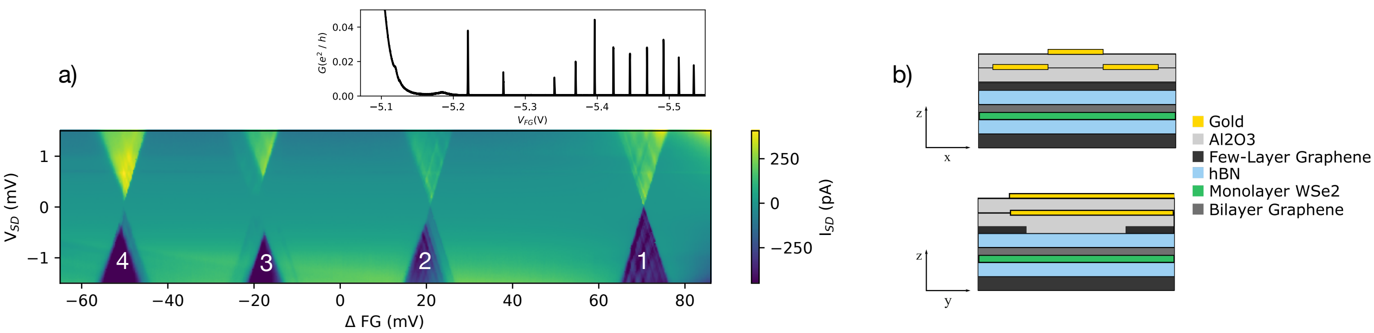
2D Materials and Quantum Device Group

RWTH AACHEN UNIVERSITY

Master Thesis:

Investigation of induced spin-orbit coupling in double quantum dots inside a bilayer graphene/WSe2 heterostructure

Motivation: The rapidly advancing field of two-dimensional materials has opened up new opportunities for exploring unique electronic and quantum phenomena. Bilayer graphene, with its intriguing band structure and tunable band gap, combined with transition metal dichalcogenides (TMDs) like WSe2, which possess strong spin-orbit coupling and strong light-matter interactions, forms an exciting heterostructure for fundamental and application-oriented research. This heterostructure exhibits layer selective proximity enhanced spin-orbit coupling, holding promising prospects for various quantum computing applications.



a) Transport measurement of a single quantum dot in the Coulomb blockade regime showing Coulomb resonances up to the first few charge carriers. b) Sketch of the schematic cross-section of the heterostructure. A split gate structure will be used to define a conducting channel, on top of which two finger gate layers will deplete and invert the polarity of the channel locally, define the double quantum dot, and tune its occupation and energy levels.

Aim of this thesis: *Your thesis goal would be to fabricate and investigate the transport properties of bilayer graphene/WSe2 double quantum dots to gain insight into the energy spectrum and deduce the nature and strength of the proximity-induced spin-orbit coupling of confined charge carriers, paving the way for future qubit operation in similar systems.*

Your tasks: Using exfoliation and dry transfer techniques, you will fabricate bilayer graphene/WSe2 heterostructures. You will then process those heterostructures using state-of-the-art semiconductor manufacturing techniques like electron-beam lithography, metal evaporation, and atomic layer deposition/etching techniques. Further, you will perform electronic transport measurements in cryogenic environments down to 20 mK and evaluate the obtained data with a programming language of your choice.

You will gain experience in the following topics:

- Quantum physics, electronic transport, quantum dots, 2D-materials
- Fabrication of state-of-the-art quantum devices based on 2D-material heterostructures
- Performing measurements in a dilution refrigerator
- Data evaluation and simulation using a preferred programming language (e.g., Python).

Furthermore, you participate in group seminars and journal clubs where you follow current developments in this field of research and discuss recent experiments.

Contact: For further information, please contact Hubert Dulisch (hubert.dulisch@rwth-aachen.de) or Katrin Hecker (katrin.hecker@rwth-aachen.de).
More information about our work can be found at stampferlab.org and www.graphene.ac