Project P1504 Valleytronics in Strain-Engineered Graphene

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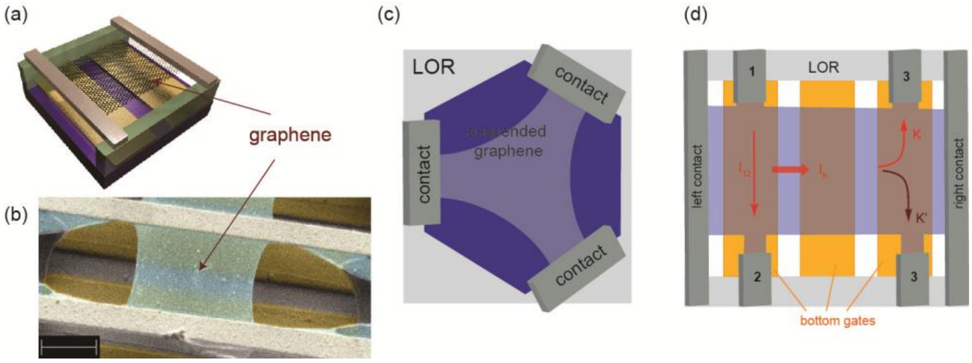
In the present project we aim to study strain effects in suspended graphene. It has been proposed that certain strain patterns can result in very large pseudo-magnetic fields giving rise a sort of Zeeman splitting acting on the so-called valley degree of freedom. The valley degree is a special feature of graphene and can be seen as a pseudo-spin.
This project is based on our recent work on ultraclean suspended graphene that shows all signatures of ballistic transport. We have demonstrated multi-path quantum interference in graphene cavities (Nature Communications 4, 2342 (2013)) guiding of graphene electrons with the aid of magnetic and electric fields (Nature Communications 6, 6470 (2015) and Nano Letters 2015), in both cases exploiting gate-defined p-n junctions. The goal of the project is sketched in the figure below. Special graphene shapes and gate structures will be used to define an appropriate strain field. In addition, we will try to induce valley polarization by strain pumping using rf fields.



(a) Schematics of suspended graphene and (b) an image of an actual device. (c) One version of shaped graphene that will allow for a trigonal strain pattern ideal for the generation of valley splitting. (d) shows a way to detect valley current using the inverse valley-Hall effect. In this case valley polarization shall arise from either pumping or Hall effect.

We look for a highly motivated student who is keen to explore fundamental aspects of quantum devices. You will design and fabricate your own devices using state-of-the-art micro- and nanofabrication technologies. You will measure your devices in cryogenic systems down to millikelvin temperatures. Electric measurements range from DC to up to 6 GHz radio-frequency including modern cryogenic circuitry (for example rf-resonators) and cold amplifiers.