PhD Position "Ultrafast Spin/Pseudospin Dynamics in 2D Materials"
(Bolotin group / Gahl group @ Freie Universität Berlin)

Group profile: The Bolotin lab (bolotingroup.com) specializes in quantum electronics and optoelectronics of two-dimensional materials. The key experimental techniques are electrical transport, strain engineering, photocurrent spectroscopy, and state-of-art nanofabrication. The group strives to understand fundamental quantum mechanical behaviors of these materials as well as to find their new applications. The Gahl group investigates ultrafast charge and spin dynamics at surfaces as well as fundamental processes in molecules at surfaces by time-resolved photoemission and optical spectroscopy.

Project description: Monolayer transition metal dichalcogenides (TMDs) are semiconducting materials that are only three atoms thin. These materials are currently at the forefront of condensed matter physics research because of their strong many-body and excitonic effects, unusual bandstructure, and sensitivity to external stimuli. TMDs are especially interesting for potential applications in ultrafast spintronics. The advantages include the possibility of optical manipulation of spin/valley degrees of freedom and facile tunability of spin properties via surface modification. Therefore, the main goal of this project is to investigate ultrafast spin dynamics in TMDs and at the interface between TMDs and metals. This, in turn, should pave the way towards TMD-based devices that use spin and other degrees of freedom as information carriers.

Job description: During the project, you will work in an active international team that is a part of a big research cluster (TRR) devoted to the study of ultrafast spin dynamics in advanced materials. Your main goal will be to develop new photocurrent-based techniques for studying the ultrafast dynamics of spin/pseudospin in TMDs and to discover new phenomena using that technique. Specifically, you will carry out the following tasks:

- **Nanoscale fabrication/strain engineering.** You will grow and produce various TMDs materials and develop strategies to pattern, electrically contact, or suspend them. You will develop advanced nanofabrication to control mechanical strain in TMDs.
- **Optoelectronic measurements.** You will develop a unique optoelectronic approach to probe ultrafast spin dynamics, the time-resolved photocurrent spectroscopy. The technique is expected to have a high spatial resolution and sensitivity. You will characterize the technique and compare its performance to more established approaches such as Kerr microscopy. You will use the technique to study the spin/pseudospin dynamics in TMD samples approaching the atomic dimensions. Finally, you will work to observe the influence of the predicted but hitherto unobserved strain-induced pseudomagnetic field on pseudospin dynamics in TMDs.
- **Theoretical modeling.** You will develop numerical and simple analytical models to guide the project and to interpret its results.

Desired/Required Experience:

- Master's degree in condensed matter physics or a related discipline. Fervent passion for all things ultrafast and nano
- Experience in nanofabrication or low-temperature/vacuum measurements is a big plus
- Experience in femtosecond laser spectroscopy, optics or electrical transport measurements/techniques, Labview or COMSOL programming experience are desirable but are not required

Please submit your application with reference code TRR227_B08_1_2 to Prof. Kirill Bolotin (kirill.bolotin@fu-berlin.de) or Dr. Cornelius Gahl (c.gahl@fu-berlin.de) until 03 May 2018.