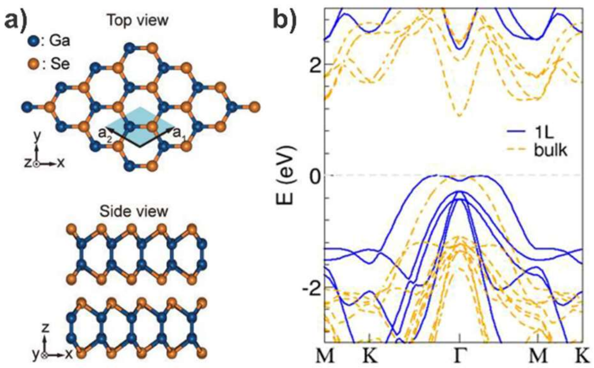
MSc topic on "Exciton Physics of 2D layered Gallium Selenide (GaSe): An attractive atomically thin semiconductor"

In contrast to the widely studied graphene and transition metal dichalcogenide (TMD) family of 2D layered semiconductors (MoS_2, $MoSe_2$, WS_2, WSe_2), the group-III monochalcogenides (III-MCs) $M_{III}X$ (M_{III}∈{In,Ga} and X∈{S,Se,Te}) are much less investigated but show remarkable physical properties and technological applications [1]. In particular, the bandgap of III-MCs can be tuned over the infrared to the ultra-violet spectral range as a function of layer thickness and the switch to direct gap as the number of layers increases from a single to a few (typically 3-7) layers is reported [2]. In our group, we study the intriguing chemical, electronic, optical and vibrionic properties of III-MCs materials. The aim of this project is to study the optical emission of mechanically exfoliated 2D Gallium Selenide (GaSe) obtained by standard industrial growth methods and compare it with films newly synthesized in our lab by molecular beam epitaxy (MBE).
You will learn how to create 2D devices by exfoliation and subsequent encapsulation, which is the process of covering a 2D materials of interest with another insulating 2D material for environmental protection. You will then develop a solid knowledge of fundamental spectroscopy by analyzing the excitonic lines from photoluminescence spectra in a cutting-edge laboratory. Additionally, you will correlate the results with differential reflectivity measurements and Raman spectroscopy in order to evaluate the absorption and band structure and the crystallographic structure, respectively.
While working on the project, you will learn about how to create and investigate devices with a new material, earn a deep understanding of recombination processes in 2D materials and develop data analysis and programming skills.

We are seeking highly motivated, hardworking students with an inclination for technical and optical lab work. Some experience with optical spectroscopy, 2D materials, cleanroom fabrication, scripting (Python) will be beneficial but not essential.

If you are interested to become part of our research team, please send your CV, transcript of your records and Bachelor thesis to Dr. Eugenio Zallo (eugenio.zallo@wsi.tum.de), Marco Dembecki (Marco.Dembecki@wsi.tum.de) and Prof. Jonathan J. Finley (finley@wsi.tum.de).



(a) Top and side view of the GaSe crystal. The unit cell is indicated with a light-blue box.
(**b**) Energy band plots of monolayer and bulk GaSe along the high symmetry k-points.
Figure readapted from [3].

[1] H. Cai, et al., "Synthesis and emerging properties of 2D layered III-VI metal chalcogenides", Appl. Phys. Rev. 6, 041312 (2019).
[2] D. A. Bandurin, et al. "High electron mobility, quantum Hall effect and anomalous optical response in atomically thin InSe", Nat. Nanotech. 12, 223–227 (2017).
[3] X. Li, et al. "Controlled Vapor Phase Growth of Single Crystalline, Two-Dimensional GaSe Crystals with High Photoresponse", Sci. Rep. 4, 5497 (2015).