Deutsche Forschungsgemeinschaft
German Research Foundation

SPP 2244

SPP 2244 Kickoff

WELCOME TO THE KICKOFF MEETING

The mailing lists

- Main address: **dfg-spp2244@tu-dresden.de**
  - Contact for:
    - Networking funds
    - Gender equality measures
  - Also used to submit things for website:
    - Webcasts/events
    - Publications
- **spp2244-PI**: all PIs of the SPP
- **spp2244-office:** SPP office + steering committee
- **2dmp-spp2244:** everyone involved in the SPP

  ⇒ Subscription link: https://tud.link/866fyd

Timeline

- March 2018: Decision to go for the 2DMP SPP
- October 15, 2018: proposal submitted
- March 31, 2019: SPP 2244 is approved
- October 1, 2020: 1st funding period starts
- October 1, 2023: 6-month extension of 1st funding period
- **April 1, 2024: 2nd funding period starts**
- **March 31, 2027: SPP 2244 ends**

Timeline

- **If new SPP (whatever topic on 2D) in October 2027:**

  Approval: March 31, 2026

  Proposal: October 15, 2025

  Start of the process: March 2025

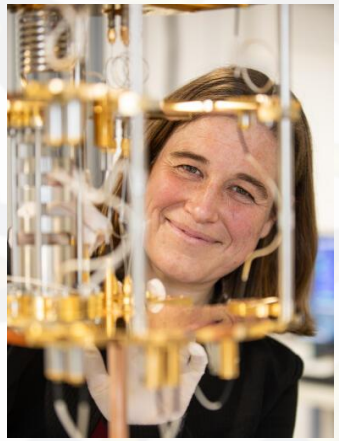
Steering Committee of the 1st funding period

- Prepare reports
- Review applications for Z-project funds
- Organize workshops and summer schools

Jaroslav Fabian

Janina Maultzsch

Christoph Stampfer



Ursula Wurstbauer

Thomas Heine (Coordinator)

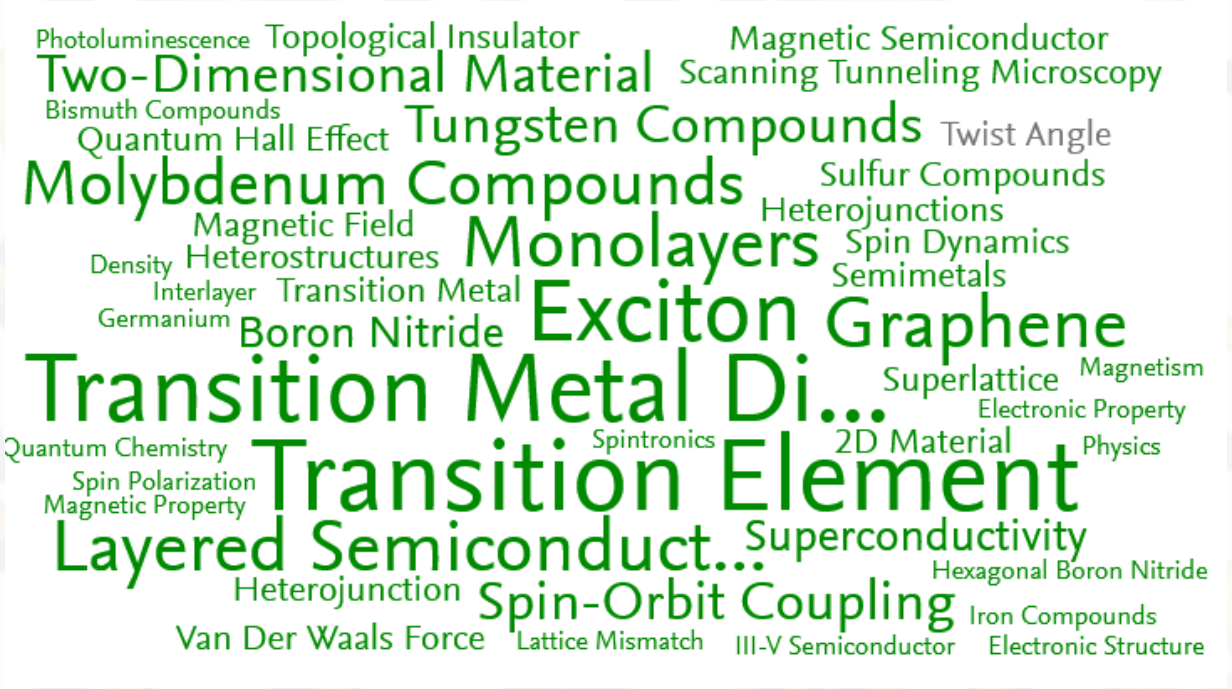
Hossein Ostovar (Student Representative)

Student Representative

- Responsibilities:
  - Act as spokesperson of Ph.D. students in SPP
  - Help with organizing summer schools and soft skill courses
  - Participate in meetings of the Steering Committee
- 1st funding period: Hossein Ostovar
- Election for 2nd funding period at summer school in September

Statistics from the 1st funding period

- **32 projects with 60 total PIs**
  - **20 funded** + 12 associated projects
  - 18 consortia + 14 individual projects
  - 23 reported PhD students
- 205 publications (and counting)
  - In Nature Index journals: 106 (>50%)
  - With ≥ 2 PIs: 62 (30%)
  - Number of citations: ≈ 3000



Status of the 2nd funding period

- Proposals: **46 projects with total 76 PIs**
- Funded: **21 projects with 39 PIs**
  - Individual projects: 12
  - Consortia: 9
  - Continuing projects: 11
  - New proposals: 10
- Only 8% female PIs
- To date 3 associated projects

Success rate for the 2nd funding period

- 72% approvale rate for Pis already funded in the 1st period
- 67% for associated PIs
- 23% for PIs who were NOT in the 1st period (funded or associated)

Coordination Office (Z-Project)

- Facilitate collaborations
  - Mailing list
  - Summer schools
  - Workshops
  - Networking funds for PhD student exchange
- Support and monitoring of gender equality measures and early career support
- PP assistant is the first contact person in all aspects
- Monitoring progress
  - Update the website and feed social media
  - Report to DFG after 1st funding period
  - Prepare proposal for 2nd funding period

Program Assistant:
Florian Arnold

What is your role?

- Do excellent research
- **Publish and acknowledge the SPP**

“This project has been funded by Deutsche Forschungsgemeinschaft within the Priority Program SPP 2244 “2DMP” (Project No. xxx) “.

- Inform the SPP Office whenever you have a new paper published!
- Use the SPP logo for your posters and conference presentations
- Collaborate!

How can you profit from the SPP added value?

- SPP office
- Networking funds (PhD exchange program)
- Workshops and schools
- Gender equality measures
- Start-up funding for prospective young scientists

How to spend money

- PhD exchange program
  - Z-project pays accommodation and travel costs, traveler pays local costs
  - Send 1-page application to coordination office, approved by Steering Committee
- Gender equality funds
  - Send an application if this applies: *Solche Maßnahmen sind beispielsweise die Erhöhung der Anzahl der Wissenschaftlerinnen auf der Ebene der Projektleitung, die Weiterqualifizierung der im Forschungsverbund arbeitenden Nachwuchswissenschaftlerinnen (neben ihrer fachlichen Qualifizierung) für ihre wissenschaftliche Karriere oder die familien-freundlichere Gestaltung des Arbeitsplatzes "Wissenschaft".*
- Startup funding
  - 5 funded projects in 1st funding period, resulted in one becoming PI now
  - First call of 2nd funding period will open in 2025

SPP 2244 Module: Gender Equality Measures in Research Networks

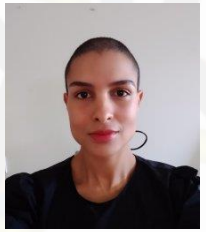
- Family friendly work policy
  - Student helper (SHK)/laboratory assistant for female scientists during pregnancy or nursing periods
  - home office equipment for daily work arrangements and for participation in network events
  - childcare costs during conferences and workshops
- Training and Coaching
  - soft skills training
  - conflict management, personal management
- Encouraging young women to pursue a science degree
  - participation at Girl's days (presentation and demonstration costs)
  - promoting "Women in Science" conferences (i.e. DPG Physikerinnentagung)

SPP 2244 Module: Networking funds

- PhD exchange program
- ~1 exchange opportunity per PhD student
- Z-project supports accomodation and travel costs
- Co-financing (student‘s project pays for local costs)

SPP 2244 Module: Start-up funding

- Aim: support young investigators to follow their own research idea, related to physics in 2D vdW [hetero]structures
- Call for Proposals in 2nd and 3rd year
- Funded in 1st funding period: Dr. Pedro Soubelet, Dr. Bárbara Rosa, Dr. Emeline Nysten, Dr. Swarup Deb, Dr. Bo Han





SPP 2244 Module: Project-Specific Workshops

- **SPP 2244 related workshops:**
  - Kick-off meeting (Spring 2024)
  - Mid-term report colloquium (Autumn 2025)
  - International conference (Spring 2026)
- **Summer schools (each including complementary training):**
  - 2024: Advanced experimental and theoretical control of electronic states in matter, hosted by Thomas Weitz, Göttingen
  - 2025: Polaritons and spectroscopic methods, hosted by Patryk Kusch, Berlin
  - 2026: Satellite event of final workshop (t.b.d.)

Information on 2nd funding period

- Starting on April 1, 2024
- Ends on March 31, 2027

- Funding increased from 6.7 to 7 Mio. €

- Final report after 2nd funding period:
  - Virtual journal of research articles
  - Articles must be open access and peer-reviewed
  - Article done = reporting duty done

Research Areas

Six-years vision

Research Area A: 2D semiconductor heterostructures

- external control of parameters (gating, strain, twist angle, magnetic field, optical excitations, thermal gradients)
- mobility and direction dependent charge, spin and thermal transport.

Research Area B: Control and manipulation of excitons in 2D vdW [hetero]structures

- stabilization, flux, and dissociation of excitons,
- interlayer charge transfer,
- creation of exotic phenomena (Bose-Einstein-condensates).

Research Area C: Realization of new topological effects

- quantum spin Hall effect and topologically protected quasiparticles (e.g. Majorana fermions)
- topological states of matter (high temperature superconductivity and ferromagnetism in 2D)

As witnessed by the recent discoveries of totally unexpected novel phenomena, it is very likely that yet unforeseen effects will be found within the course of this SPP, which is one of its strong motivations.

Research Objectives

Fundamental research goal: To explore and to deeply understand the physical phenomena in 2D vdW materials that are emerging from interlayer interactions, moiré superstructures and/or proximity effects.

Objective 1: To explore the impact of interlayer interactions on the electronic properties and transport properties in 2D vdW materials.

Objective 2: To investigate the optical properties emerging from interlayer interactions in 2D vdW materials.

Objective 3: To study collective and correlated phenomena leading to exotic effects in 2D vdW materials.

Research Area A: Electronic Properties and Transport

Objective: To explore the impact of interlayer interactions on the **electronic properties** and **transport properties** in 2D vdW materials.

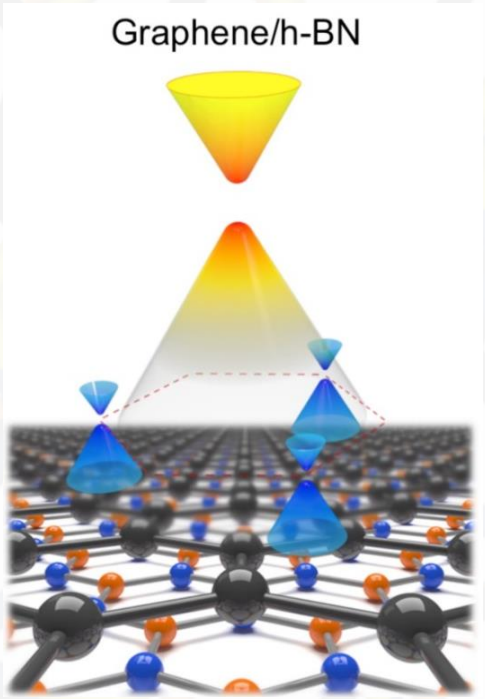
In **Research Area A** electronic properties and transport will be investigated. Besides the **electron and phonon band structure** we aim at studying **transport of charges** and **spins** as well as **thermal transport**, considering the **valley degree of freedom** and **electron-phonon coupling**. Emphasis is also given to high mobility 2D semiconductors, which have prospects for electronic device applications.

Specific research directions to be pursued should include:

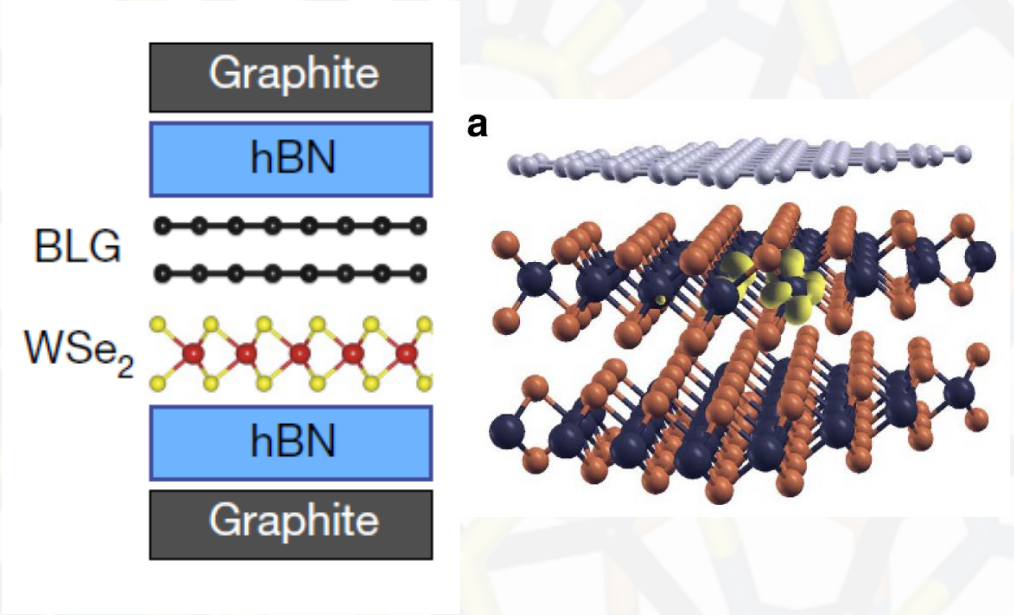
a) Tailoring **electronic properties** of vdW heterostructures
b) **Charge and spin transport** in vdW heterostructures with well-controlled **proximity effects**
c) **Vertical transport** in artificial vdW heterostructrues with functionalized interfaces

Research Area A: Electronic Properties and Transport

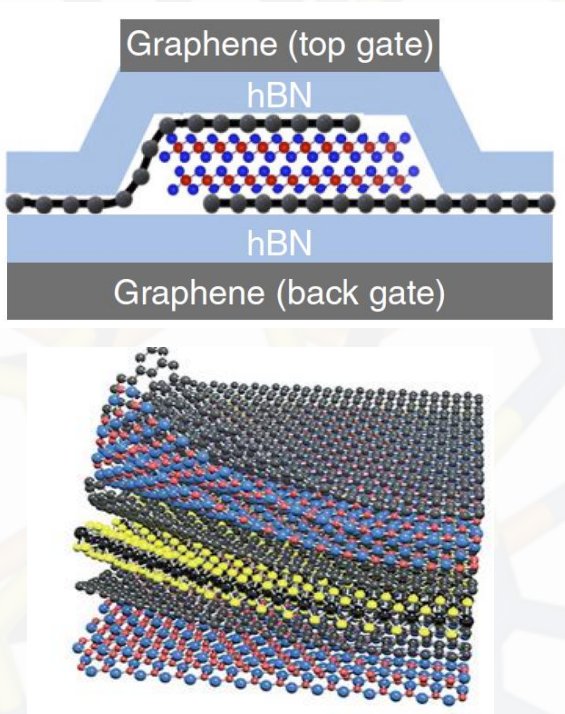
Research area A addresses the impact of **interlayer interactions** on the **electronic properties** and **transport properties** in 2D van der Waals materials. This includes, for example:



Moiré physics and tailored properties



Proximity effects and strong interlayer coupling



Vertical charge and spin transport

Research Area B: Optical and optoelectronic effects

- **Objective:** Understanding of **interlayer optical excitations** and their interplay with **intralayer excitons** (stabilization, flux, and dissociation of excitons, interlayer charge transfer and many body phenomena)

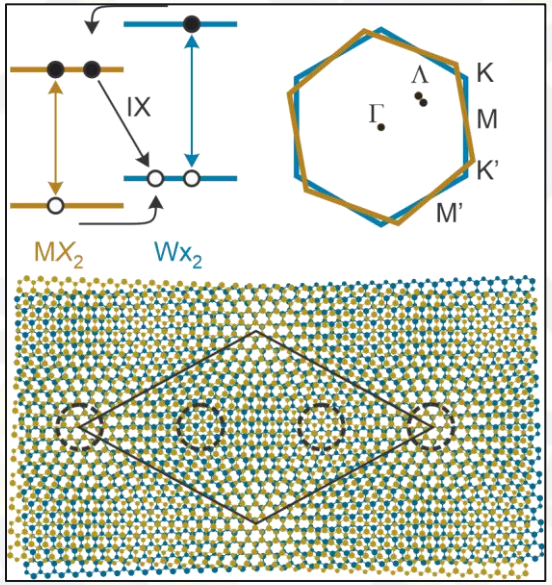
Research Area B focuses on **optical and optoelectronic** effects in vdW heterostructures and twisted layers. These include **interlayer** optical excitations, in particular **excitons** and **exciton complexes**, **spin-valley interactions**, and **their dynamics**, as well as controlled coupling to external **(photonic) structures.**

Specific research directions to be pursued should include:

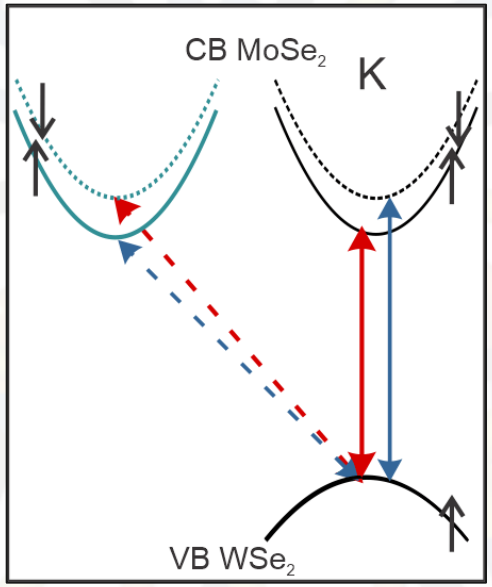
a) **Interlayer excitons**
b) **Spin- and valley physics**
c) **Interaction with with external structures**

Research Area B: Optical and optoelectronic effects

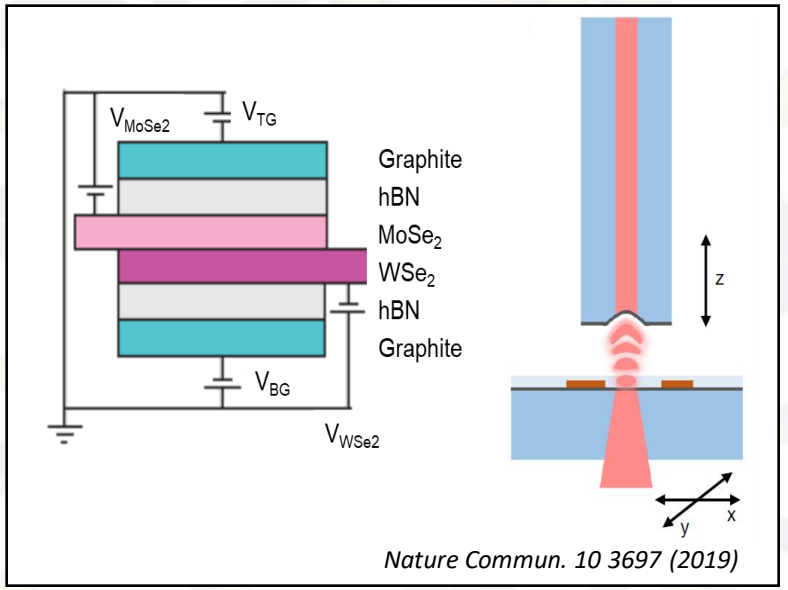
Research area B addresses the impact of **interlayer interactions** on **excitons, trions**, **spin-and valley-physics** in the presence of **twist angle** and with **external stimuli** in 2D van der Waals material stacks. This includes, for example:



Interlayer excitons & moiré excitons



Spin and valley physics



Electric / magnetic fields & external cavities

Research Area C: Collective and correlated phenomena

- **Objective:** Investigating **magnetism**, **correlations**, and **superconductivity** in 2D heterostructures, including **topological** ordering in the presence of proximity **spin-orbit coupling**. A variety of **spin dynamics** phenomena will be explored.

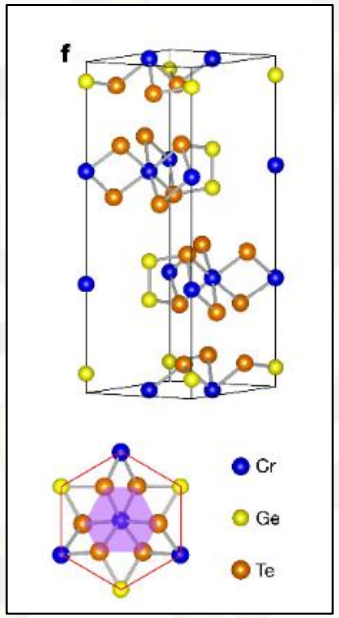
Research Area C addresses collective and correlated phenomena. Many of those have been discovered only very recently and possibly the list will extend in the forthcoming years. To date, it includes **superconductivity, magnetism, and Mott insulators**.

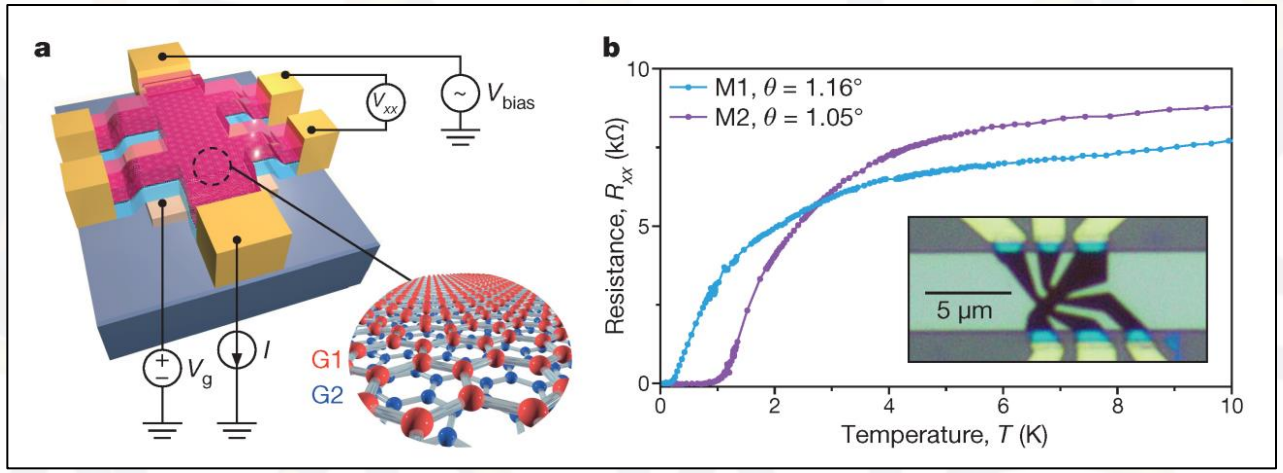
Specific research directions to be pursued should include:

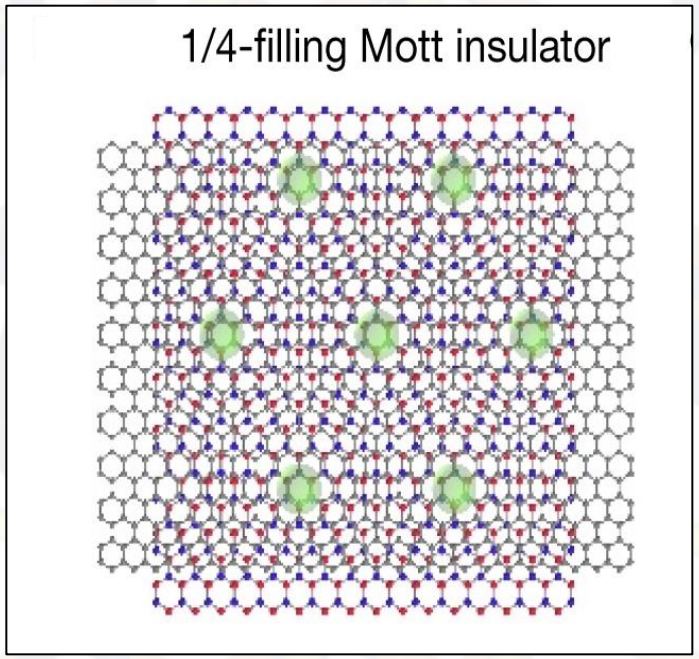
a) **2D magnetic crystals heterostructures**
b) **Correlations and superconductivity**

Research Area C: Collective and correlated phenomena

Research area C addresses the impact of **interlayer interactions** on the **electronic correlations**, **superconductivity**, **collective phenomena**, and **topological effects** in 2D van der Waals materials. This includes, for example:







Magnetism **Superconductivity** **Mott insulators**

Common Research Area

(via PhD student and postdoc exchange program)

experimental methods:

- advance methodologies for the **vdW assembly** with increasing complexity from stacked bilayers to **rotationally aligned multilayer** vdW stacks
- develop database for optimized **cleaning and post-preparation** annealing
- design and provide universal platforms suitable to apply **external stimuli** such as strain, electric or magnetic fields and to modify dielectric environments
- collect and share figures of merit and experimental fingerprints that are suitable to efficiently determine the **interfacial quality** of vdW heterostructures and the coupling strength between individual layers.

Common Research Area

(via PhD student and postdoc exchange program)

theoretical methods:

- parameters for effective, low-energy tight-binding Hamiltonians determined and validated by comparison with ab initio theory (DFT, GW)
- techniques for the derivation of appropriately screened interaction terms in a material-realistic manner
- advanced many-body techniques

Common Research Area
(via PhD student and postdoc exchange program)

travel funds for PhD student / PostDoc exchange

- research stays (1-2 weeks) of PhD students within another group

exchange of materials

- processed materials (from exfoliation, growth)
- assembled vdW stacks
- samples in device configuration