MARTIN GMITRA

Institute of Experimental Physics SAS

Project number
IM-2021-42

Project duration
1. 4. 2022 - 31. 3. 2027

"The IMPULZ programme represents a unique opportunity to start independent specialised research at a high level in the Slovak research environment with further career development and achievement of a competitive degree, which has the possibility to be further supported by a prestigious European foreign grant."

BIOGRAPHY

Martin Gmitra received his PhD from Pavol Jozef Šafárik University in Košice in 2004, followed by Marie Curie postdoctoral fellowship in prof. Jozef Barnaś group working on current induced magnetization reversal in nanodevices relevant for spintronics applications.

During his second postdoctoral fellowship in prof. Jaroslav Fabian group was pioneering first-principles calculations of proximity induced magnetic exchange and spin-orbit coupling effects in graphene embedded in van der Waals heterostructures. Since 2018 he worked as an independent researcher and lecturer at the Institute of Physics, Pavol Jozef Šafárik University in Košice responsible for the implementation of the density functional theory at the Department of Theoretical Physics and Astrophysics. Since 2022 he is working as IMPULZ fellow responsible for building Qmlab, theory and experimental joint research laboratory at the Institute of Experimental Physics, Slovak Academy of Sciences. The QMlab aims to develop technological and research know-how in fundamental physical properties of two-dimensional materials with a focus on quantum computation utilizing topological superconductivity aspects.

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Topological Superconductivity in Quantum Two-Dimensional Devices

The project focuses on the research of van der Waals two-dimensional materials with a focus on new quantum mechanical phenomena induced by spin-orbit couling and its interplay with magnetism, topology and superconductivity. For this purpose, a new quantum materials research laboratory will be established with a close link between theoretical expertise in spin-orbit coupling and experimental expertise in superconductivity.

Research will focus on investigation of the electronic properties of prepared heterostructures in the normal and superconducting phases using scanning tunneling microscopy and magnetotransport measurements. Theoretical studies will focus on first-principles electronic structure calculations, quasiparticle interference spectra, and transport properties in order to interpret the measured data and guide further experimental research. The studied systems will then be used to design possible device implementations exploiting topological aspects of superconductivity relevant to quantum computation.

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PUBLICATIONS

1. Han, W., Kawakami, R., Gmitra, M. et al. Graphene spintronics. Nature Nanotech 9, 794–807 (2014). https://doi.org/10.1038/nnano.2014.214

2. Gmitra, M., Konschuh, S.,Ertler, C., Ambrosch-Draxl, C. and J. Fabian. Band-structure topologies of graphene: Spin-orbit coupling effects from first principles. Phys. Rev. B 80, 235431 (2009). https://journals.aps.org/prb/abstract/10.1103/PhysRevB.80.235431

3. Gmitra, M and J. Fabian. Proximity Effects in Bilayer Graphene on Monolayer WSe2: Field-Effect Spin Valley Locking, Spin-Orbit Valve, and Spin Transistor. Phys. Rev. Lett. 119, 146401 (2017). https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.119.146401

4. Zollner, K., Gmitra, M. and J. Fabian. Swapping Exchange and Spin-Orbit Coupling in 2D van der Waals Heterostructures. Phys. Rev. Lett. 125, 196402 (2020). https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.125.196402

5. Krempaský, J., Nicolaï, L., Gmitra, M., Chen, H., Fanciulli, M., Guedes, E.B., Caputo, M., Radović, M., Volobuev, V. V., Caha, O., Springholz, G., Minár, J. and J. Hugo Dil. Triple-Point Fermions in Ferroelectric GeTe. Phys. Rev. Lett. 126, 206403 (2021). https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.126.206403