第72回トポロジカル物質科学セミナー
Topological Materials Science Seminar (72)

Geometrically tunable spintronic platforms

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Place: Room C325, Faculty of Engineering Building C, 3F, Dept. of Applied Physics, Hokkaido Univ.
Date: August 10 (Friday), 2018
Time: 10:00-12:00

Abstract: Low-dimensional semiconducting nanomaterials have proven to be an ideal playground for the generation and manipulation of topological quantum states, which are at present at the centre of an intensive investigation. Apart from the conventional geometries, the most recent advances in nanotechnology have demonstrated the possibility to create flexible semiconductor nanomaterials which are bent into curved, deformable objects ranging from semiconductor nanotubes, to nanohelices, etc. Motivated by the excitement in both topological states of matter and novel shape deformed nanostructures, we have explored the impact that nanoscale geometry [1] has on electronic, topological and superconducting properties of low-dimensional materials, showing the possibility to exploit the interplay between geometry, Rashba spin-obit coupling (RSOC) and superconductivity as a tool for the realization of novel platforms for spintronics and superconducting spintronics. By considering the paradigmatic example of quantum wires with RSOC, which are periodically corrugated at the nanometer scale [2], we show that geometric effects in low-dimensional nanomaterials can lead to metal-insulator transition and promote the generation of topological states of matter. Relevantly, such a system, under the application of a rotating magnetic field, can realize the Thouless topological pumping protocol in an entirely novel fashion [3]. We also show that, in shape deformed nanostructures, geometric curvature effectively acts like a spin-torque, twisting the electron spin, thus driving non-trivial spin textures, which in turn affect the electron spin interference in closed loop configurations [4]. We finally show that in the presence of superconductivity, the interplay between RSOC and shape deformations can lead to novel paths for an all-geometric manipulation of the superconducting state, both for spin-singlet and spin-triplet quantum configurations [5], as well as of the supercurrent in weak links between Rashba coupled superconducting nanowires with geometric misalignment [6].

[Acknowledgements: EU-FET OPEN project "CNTQC", grant agreement N. 618083 (http://www.nano2qc.eu/)]

References

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[4] Z.-J. Ying, P. Gentile, C. Ortix, M. Cuoco, Phys. Rev. B **94**, 081406(R) (2016).
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[6] Z.-J. Ying , M. Cuoco, P. Gentile, C. Ortix, 2017 16th International Superconductive Electronics Conference (ISEC), IEEE Xplore (2018)

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