

## Seminar Fizičkog odsjeka

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Vrijeme (s.t.)

Mjesto

ponedjeljak 03. 07. 2017., 10:00 h

predavaonica F201, II.kat

# Magnetic Proximity Effects: From Graphene and Topological Insulators to Majorana Fermions

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Proximity effects can transform a given material through its adjacent regions to become superconducting, magnetic, or topologically nontrivial. The intuition about the proximity effects is well derived from the superconducting case, known for 85 years [1]. Superconducting properties can leak out from a superconductor into a neighboring normal region which by itself would not be superconducting [2]. Remarkably, superconducting proximity effects can attain orders of magnitude longer lengths than for magnetic proximity effects that are usually neglected in bulk materials. However, in monolayer van der Waals materials, such as graphene or transition metal dichalcogenides, the situation can be drastically different, even short-range magnetic proximity effects exceed their thickness [3,4]. We show that gate-tunable magnetic proximity effects in graphene heterostructures lead to the magnitude and the sign change of the spin polarization of the density of states in graphene [3]. While proximity effects are usually considered equilibrium phenomena (zero bias), in a simple topological insulator/ferromagnet junction we predict they are also responsible for unexplored nonequilibrium properties, including a novel Hall effect [4]. An interplay between superconducting and magnetic proximity effects can lead to the formation of emergent Majorana bound states which are neither Fermions, nor Bosons. Instead, exchanging these states yields a non-commutative phase, a sign of non-Abelian statistics and non-local degrees of freedom considered to implement fault-tolerant quantum computing [5]. We will discuss novel two-dimensional (2D) platform to realize braiding of Majorana bound states [6] and how it can overcome the limitations of typical proposals relying on 1D structures [7,8].

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[4] B. Scharf, G. Xu, A. Matos-Abiague, and I. Žutić, arXiv:1704.07984, preprint

[5] C. Nayak et al., Rev. Mod. Phys. 80, 1083 (2008)

[6] G. L. Fatin, A. Matos-Abiague, B. Scharf, and I. Žutić, Phys. Rev. Lett. 117, 077002 (2016); A. Matos-Abiague, J. Shabani, A. D. Kent, G. L. Fatin, B. Scharf, and I. Žutić, Sol. Stat. Commun. 262, 1 (2017)

[7] V. Mourik, et al., Science 336, 1003 (2012)

[8] S. Nadj-Perge, et al., Science 346, 602 (2014)