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**Fermionic and Majorana Bound States in Hybrid Nanowires With Rashba and Synthetic Spin-Orbit Interactions<sup>1</sup>**  
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I will present recent results on exotic bound states with non-Abelian braid statistics in one-dimensional condensed matter systems. Majorana fermions can emerge in a variety of setups in which either Rashba or synthetic spin-orbit interaction (SOI) is present. Here, I will discuss candidate materials such as semiconducting Rashba nanowires [1-3], graphene nanoribbons [4], atomic magnetic chains or magnetic semiconductors [5]. The topological phase in the presence of a non-uniform SOI hosts fermionic bound states inside the proximity gap [6]. They are localized at the junction between two wire sections characterized by different directions of the SOI vectors, and they coexist with Majorana bound states localized at the nanowire ends. At the same time, much effort is invested in identifying systems that host even more exotic quasiparticles, parafermions. In my talk, I will a setup consisting of two quantum wires with Rashba spin-orbit interactions coupled to an s-wave superconductor, in the presence of strong electron-electron interactions [7] that hosts time-reversal invariant parafermions. [1] J. Klinovaja and D. Loss, Phys. Rev. B 86, 085408 (2012). [2] J. Klinovaja, P. Stano, and D. Loss, Phys. Rev. Lett. 109, 236801 (2012). [3] D. Rainis, L. Trifunovic, J. Klinovaja, and D. Loss, Phys. Rev. B 87, 024515 (2013). [4] J. Klinovaja and D. Loss, Phys. Rev. X 3, 011008 (2013); J. Klinovaja and D. Loss, Phys. Rev. B 88, 075404 (2013). [5] J. Klinovaja, P. Stano, A. Yazdani, and D. Loss, Phys. Rev. Lett. 111, 186805 (2013); B. Braunecker and P. Simon, Phys. Rev. Lett. 111, 147202 (2013); M. Vazifeh and M. Franz, Phys. Rev. Lett. 111, 206802 (2013). [6] J. Klinovaja and D. Loss, arXiv:1408.3366. [7] J. Klinovaja and D. Loss, Phys. Rev. B 90, 045118 (2014).

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