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**Time reversal invariant topological superconductors in one dimension: how to realize them and what can they do for you**

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Time-reversal invariant (TRI) topological superconductors are exotic superconductors that support anomalous protected edge states. These states are electronic analogues of the B phase of superfluid $^3$He. In one spatial dimension, a TRI superconductor carries a Kramers pair of Majorana zero modes at each end. In this talk, I will discuss setups to realize this phase in spin-orbit coupled quantum wires, in proximity to conventional superconductors. The topologically non-trivial phase can be stabilized either by coupling the wire to two superconductors with a phase difference of $\pi$ between them, or spontaneously, due to repulsive interactions in the wire. In the former case, the system is a natural realization of a fermion parity pump, switching the local fermion parity of both edges when the relative phase between the superconductors is changed adiabatically by $2\pi$. I will show that a gapless TRI topological phase with exponentially localized edge states can exist even if the superconductor used to induce pairing is one-dimensional, and superconducting long-range order is destroyed by long-wavelength fluctuations. If time allows, I will talk about the signatures of the TRI phase in noise correlation experiments, and compare it to the the case of a time reversal breaking phase with a single Majorana zero mode at the ends.

References: A. Keselman, L. Fu, A. Stern, and E. Berg, PRL 111, 116402 (2013); A. Haim, A. Keselman, E. Berg, and Y. Oreg, PRB 89, 220504(R) (2014); A. Haim, E. Berg, F. von Oppen and Y. Oreg, arXiv:1411.0673.