Braiding of Majorana Fermions in a Cavity

Mircea Trif [1] **and Pascal Simon** [2]

[1] *International Research Centre MagTop, Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland*
[2] *Laboratoire de Physique des Solides, CNRS, Univ. Paris-Sud, University Paris-Saclay, 91405 Orsay Cedex, France*

One dimensional p-wave (or topological) mesoscopic superconductors are known to host zero energy end modes known as Majorana fermions, i. e. particles that are their own antiparticle. These exotic objects are robust against local perturbations and, moreover, they obey non-Abelian statistics under braiding operations, thus recommending them as qubits for the implementation of a topological quantum computer. While most of the studies of these systems pertain to electronic transport, which is invasive by nature, photons give direct access to some of its exotic features such as the topological phase transition [1], the presence Majorana fermions [1,2], and the fractional Josephson effect [3,4], all in a non-invasive fashion. In this poster, I will show that also their exotic exchange statistics pertaining to their braiding can be imprinted into the electromagnetic field of the cavity [5]. Specifically, we study the dynamical process of braiding Majorana bound states in the presence of the coupling to photons in a microwave cavity. We show theoretically that the $\pi/4$ phase associated with the braiding of Majoranas, as well as the parity of the ground state are imprinted into the photonic field of the cavity, which can be detected by dispersive readouts techniques. These manifestations are purely dynamical, they occur in the absence of any splitting of the MBS that are exchanged, and they disappear in the static setups studied previously. Conversely, the cavity can affect the braiding phase, which in turn should allow for cavity controlled braiding

[1] Mircea Trif and Yaroslav Tserkovnyak, Phys. Rev. Lett. **109**, 257002 (2012).
[2] Olesia Dmytruk, Mircea Trif, Pascal Simon, Phys. Rev. B **92**, 245432 (2015).
[3] Olesia Dmytruk, Mircea Trif, Pascal Simon, Phys. Rev. B **94**, 115423 (2016).
[4] Mircea Trif et al., Phys. Rev. B **97**, 041415 (R) (2018).
[5] Mircea Trif and Pascal Simon, arxiv:1810.00799.