Hanbury Brown and Twiss noise correlations in a topological superconductor beam splitter

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We study Hanbury-Brown and Twiss current cross-correlations in a three-terminal junction where a central topological superconductor (TS) nanowire, bearing Majorana bound states at its ends, is connected to two normal leads.

Relying on a non-perturbative Green function formalism, our calculations allow us to provide analytical expressions for the currents and their correlations at subgap voltages, while also giving exact numerical results valid for arbitrary external bias. We show that when the normal leads are biased at voltages V_1 and V_2 smaller than the gap, the sign of the current cross-correlations is given by -sgn(V1, V2). In particular, this leads to positive cross-correlations for opposite voltages, a behavior in stark contrast with the one of a standard superconductor, which provides a direct evidence of the presence of the Majorana zero-mode at the edge of the TS.

We further extend our results, varying the length of the TS (leading to an overlap of the Majorana bound states) as well as its chemical potential (driving it away from half-filling), generalizing the boundary TS Green function to those cases. In the case of opposite bias voltages, sgn(V1, V2)=-1, driving the TS wire through the topological transition leads to a sign change of the current cross-correlations, providing yet another signature of the physics of the Majorana bound state.

[1] T. Jonckheere, J. Rech, A. Zazunov, R. Egger, and T. Martin, Phys. Rev. B 95, 054514 (2017)