# Field Effect Transistor. Majorana Fermion Detection and Transport Properties

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Recently, experimental nanodevice having a hybrid superconductor/semiconductor structure for topological superconducting performance have dominated the condensed matter physics scene that seeks the detection of Majorana fermion[1,2]. In this work we will compute transport properties as current and conductance by which we identify the signature of zero modes of Majorana (fermions of Majorana in solid state). Such a signature is characterized by a conduction resonance, i.e. by a conductance peak, in a region of zero bias. To study the transport properties we use a device composed of a quantum dot coupled by two metal electrodes and connected laterally by a Kitaev[3] chain of $N$ sites. We will use the Green functions of non-equilibrium (Keldysh formalism). Then we derive the formula of the electric current from Meir-Wingreen[4], and finally, we obtain the formula for the current similar to the Landauer-Büttiker formula, in the case of equilibrium situations. Given these formalisms and using an adequate matrix formalism to use the computational calculation, we obtained the graphs of the currents and conductance that define the system under study. The characteristic curve $I$-$V$ of the system identifies Majorana modes and the study of the resonance in the conductance will show a behavior of the system analogous to the behavior of the current in a field effect transistor. The current of Majorana thus found suggests a denomination appropriate to the one under study: Majorana's field effect transistor.

## References

**1 V. Mourik *et al.*,** *Signatures of Majorana Fermions in Hybrid Superconductor-Semiconductor Nanowire Devices*, Science **336,** 1003. (2012).

**2 S. Nadj-Perge *et al.*,** *Observation of Majorana Fermions in Ferromagnetic Atomic Chains on a Superconductor.* Science. **346**, 602-607. (2014).

**3 A.Y. Kitaev**, *Unpaired Majorana Fermions in Quantum Wires*. Physics-Uspekhi. **44**, 131-136. (2001).

**4 Y. Meir e N. S. Wingreen,** *Landauer Formula for the Current Through an Interacting Electron Region*. Physical Review Letters. **68**, 2512-2515. (1992).