Nearly half a century has passed since P. W. Anderson published in *Science* his seminal paper *More is Different*. In this paper Anderson discusses the hierarchical structure of science and puts forward the conjecture that the knowledge of behavior of a few particles cannot be extrapolated to predict the behavior of more complex systems. This straightforwardly leads to the conclusion that with increasing the system's complexity, some completely new properties may emerge. In fact, over recent decades we have witnessed several astonishing discoveries, with topologically protected states of matter (Nobel awarded to Thouless, Haldane and Kosterlitz in 2016) being a very important example. Such states are very robust against local perturbations, since they are protected by symmetry, and can extend over entire sample. This makes them very promising for quantum spintronics and quantum computation and, in fact, puts their investigations in the forefront of nowadays physics. Besides, topological materials also constitute an excellent playground for more fundamental research. In particular, it turns out that the long-searched Majorana fermions, i.e. particles that are their own antiparticles, predicted by Ettore Majorana already in 1937, can emerge at the ends of topological superconducting wires as zero-energy quasiparticles.

The Majorana quasiparticles and their interactions with strongly correlated low-dimensional systems are the central object of interest of this research project.

The emergence of Majorana quasiparticles at the ends of topological superconducting nanowires can be confirmed by performing transport spectroscopy experiments, where their presence gives rise to a zero-bias peak in the differential conductance of the device. Moreover, Majorana quasiparticles can also affect the transport behavior of side-attached zero-dimensional systems, such as quantum dots, where the leakage of Majorana modes results in fractional value of the conductance. In fact, such hybrid, coupled zero and one-dimensional systems provide an exceptional opportunity to test fundamental interactions between topologically-protected states of matter and various electronic correlations, such as the ones leading to the Kondo effect. The Kondo effect emerges when a magnetic impurity interacts with continuum of states and its signature is an additional resonance in the local density of states of the impurity. The studies of the interplay between the Kondo and Majorana physics have been so far mainly restricted to relatively simple models. Nevertheless, since to understand the behavior of real systems minimal descriptions are not necessarily sufficient, it is important to address the question of what are the transport properties of considered hybrid systems, where more exotic Kondo phenomena can emerge.

The main goal of this project is therefore to develop theoretical understanding of signatures of the interplay between Majorana quasiparticles and strong electron correlations, such as those giving rise to various Kondo effects, in both electric and thermoelectric transport.

Our investigations will be performed by using the state-of-the-art numerical and analytical methods, which will be appropriately adapted to determine the transport behavior of considered hybrid systems. These methods include, among others, the density-matrix numerical renormalization group method – the approach known for its accuracy in determining the transport properties of nanostructures, or the Keldysh nonequilibrium Green's function formalism.

By using the combination of both analytical and numerical methods, we will be able to present new and reliable results for transport properties of devices composed of one-dimensional topological superconductors coupled with quantum dots, focusing on strong correlations and the interplay between the Majorana and Kondo physics. The execution of the project will thus contribute to the general development of topological nanoelectronics, shedding in particular new light on transport properties of coupled quantum dot-Majorana systems. The project is also expected to stimulate further theoretical and experimental endeavors in the field of topological superconducting nanostructures, involving zero and one-dimensional systems.