At the time Dirac was formulating the quantum theory of the electron, there lived another scientist who made a permanent mark in history, although his name was not widely recognized until recently. Interestingly, this scientist, as quickly as he appeared, so quickly disappeared. Almost a century has passed since his mysterious disappearance, but his legacy is still alive. We are talking about Ettore Majorana, who in 1937 published a groundbreaking paper presenting the theoretical basis for the existence of fermions, i.e. particles with half-spin like the electron, which are also their antiparticles.

Although the existence of Majorana fermions is still a subject of scientific discourse, at the beginning of this century it turned out that similar objects can be produced in the form of quasiparticles in suitably prepared nanostructures. Such quasiparticles, known as Majorana bound states, have become of great interest to condensed matter physicists and quantum computing scientists due to discoveries in the field of topological properties of matter. In mathematics, topology is the field that deals with properties that do not change as a result of continuous mathematical transformations of objects. In solid-state physics, topology also plays an important role, but in the context of the electron structure of different types of materials. Thus, we can distinguish, for example, topological insulators or topological superconductors. One-dimensional counterparts of the latter are just great candidates for hosting Majorana bound states. Such states are characterized by the equivalence of creation and annihilation operators describing them, additionally, they appear in pairs, and they are not following the Fermi-Dirac statistics, which distinguishes them from ordinary fermions. ***The above properties make them an interesting example of exotic quasiparticles.*** Such states form at the ends of a one-dimensional topological superconductor (Majorana wire), and their existence leads to the appearance of an anomalous increase in the zero-voltage charge conductance.

Majorana wires and their interaction with attached artificial atoms and molecules is the subject of the present project. In particular, it is planned to analyze the transport properties of the double quantum dot system coupled to Majorana bound states. A new aspect for existing studies will be the consideration of the effect of spin-dependent transport on the conductance of hybrid one- and zero-dimensional systems. The study of spin-dependent quantum transport has a long tradition in the field of spintronics, which continues to attract the interest of leading researchers from around the world, but in the context of interaction with topological Majorana states, it has not been explored very intensively so far.

These artificial atoms or molecules can be represented by quantum dots. These are already well understood zero-dimensional objects in which the electron is confined in all three spatial dimensions. Despite they are well understood, quantum dots are still an important point of interest for physicists. One important area is quantum transport and in particular, the Kondo effect, whereby at low temperatures, on the order of single kelvin, there is an increase in electrical conductance between electrodes that are connected by a quantum dot. This effect is revealed in the presence of strong electron correlations, such as the Coulomb interaction. This increased conductivity in the low-temperature limit reaches a constant value of $2e^2/h$. A more complicated structure is the double quantum dot, which will be the subject of our study. Such an object allows the exploration of further interesting physical phenomena, one of which is the two-stage Kondo effect. As a result, the presence of the second quantum dot suppresses the low-temperature conductivity maximum and thus blocks electron transport between contacts.

It turns out that in the presence of a topological superconductor, the Kondo and Majorana physics begin to compete with each other, changing the conductivity characteristics of the double quantum dot system. The interaction with the Majorana bound state causes the conductance to increase again at low temperatures but limits it to ¼ of its total value. We want to focus on this issue when spin-polarized ferromagnetic electrodes are the source of electrons. We know from previous studies that the presence of a topological nanowire introduces spin polarization on a quantum dot, so we are curious about the effects resulting from the presence of magnetism in the system. ***As part of the planned tasks, our goal will also be to provide new knowledge regarding thermoelectric effects, such as thermal conductivity and the Seebeck effect.*** We believe that this contribution will provide a better understanding of the interaction of electron correlations with the topological properties of matter. This is currently an important research problem with potential relevance to topics including topological quantum computing or spin nanoelectronics.