

Are two drops of water really identical? It all depends on how carefully we examine them. Although at first sight there is no way of telling them apart, a (much) closer inspection would certainly show that they consist of a different number of molecules. Their apparent indistinguishability is only a result of the limitations of our everyday experiences.

The true indistinguishability can be observed in the quantum world. It is a feature of the elementary particles such as electrons and photons. This project aims to investigate its consequences.

The research we will conduct will describe the connection between the indistinguishability and other nonintuitive predictions of the quantum mechanics: contextuality and entanglement. Aside from being incredibly interesting from the scientific point of view, these two phenomena might potentially be used to construct a quantum computer, which could solve some problems much faster than its classical counterpart. We would like to know if the indistinguishability could help this endeavor. To find out, we will look for its new algorithmic applications.

Apart from that we are interested in the interactions between indistinguishable particles. We will try to describe them as simply as possible. We hope that this will allow us to develop better intuitions about the restrictions stemming from the quantum formalism.

In a bigger picture, indistinguishable particles are key elements in many active fields of physics and engineering. They are used, for instance, to encrypt and transmit information or to perform precise measurements. Potential results of this project may be useful in all these applications.