Most of the living matter is made up of molecules that have the property that they differ from their mirror image. Hands have a similar property: although they are mirror images, they differ because, for example, the left glove does not fit the right hand. This property, chirality (derived from the Greek χειρ − hand), can be examined using spectroscopic methods, mainly optical ones. One of the limitations of optical methods is that the interpretation of results is difficult when a sample of an examined chemical is contaminated or it contains a mixture of several chiral molecules. Spectroscopic methods based on magnetic interactions, such as nuclear magnetic resonance spectroscopy (NMR), can be used in such cases due to good signal separation, however, those that are currently used require chemical modification of the sample and they are limited to selected classes of chemical compounds.

The aim of the project is to create a new spectroscopic method, in which the use of an additional electric field affects the interaction between atomic nuclei (so-called indirect and direct spin-spin interactions) in such a way that it would be possible to distinguish enantiomers of a chiral molecule. The proposed method is non-invasive and applicable to a larger number of chemical compounds than that can be investigated by optical methods. It could be used in fundamental research in the field of biology and medicine and in quality control of production of active pharmaceutical ingredients, since frequently one of the enantiomers has a distinctly different effect on the patient’s body than the other enantiomer.

The predicted effects of the interaction between the magnetic moments of the atomic nuclei placed in the electric field have a small amplitude compared to those observed in typical NMR measurements, hence the samples for which the magnitude of the effects are relatively large will be found on the basis of the results of quantum mechanical computations of nuclear properties. In order to observe these predicted effects, an experimental setup with high sensitivity which generates a strong electric field oscillating with radio frequency will be built. The design and construction of this experimental setup will be carried out in cooperation with leading foreign research institutions in France, Germany and the United States.