Axial chirality, a key stereogenic element, is widely observed in natural products and often determines the pharmacological properties in biologically active molecules (e.g., Maxi-K channel openers, (R)-streptonigrin). Among them, axially chiral biaryls are recognized as one of the basic chiral units of ligands, catalysts, and other valuable reagents.

The extraordinary usefulness and promising potential of chiral axial systems and the significant progress in their synthesis in recent years have made the production of atropisomeric molecules an extremely topical topic in synthetic chemistry.

In principle, all asymmetric catalytic methods (initially) developed for constructing central chiral molecules can be adapted to the asymmetric construction of atropisomers. Most of these methods are based on transition-metal-catalysts. Nevertheless, it has been shown that organocatalysis can be a useful tool for the construction of biaryl, heterobiaryl, and non-biaryl atropisomers. Organocatalytic conditions are typically non-toxic, selective, and highly tolerant of air and moisture. The preparation of chiral functional molecules (including atropisomers) by organocatalysis is, therefore an attractive choice.

Enantioselective catalytic reactions are the main direction of modern organic synthesis. Most of the currently used selective catalysts contain environmentally harmful heavy metals such as ruthenium, rhodium, iridium, and palladium. Due to the high toxicity, the content of these elements in the final product must be at a very low level (several ppm), which is associated with difficulties in purification and costs. For this reason, catalytic systems that do not contain transition group metals and show high catalytic activity are sought.

N-Heterocyclic carbenes (NHC) represent the most widely known family of nucleophilic carbenes. NHCs are widely known as excellent ligands in transition metal catalysis. In addition to the ability to form carbenoids, interest in the role of nucleophilic carbenes as organocatalysts has increased significantly in recent years. Organocatalysis is an attractive alternative to classic organic transformations, often much less economical and environmentally friendly. It is worth emphasizing that organocatalysis is included in the canon of synthetic methods, gaining the highest recognition from the Nobel Committee in 2021. N-Heterocyclic carbenes are used as organocatalysts promoting the formation of new connections by inverting the polarity of the reactant (umpolung reaction). In addition to high reactivity and selectivity, NHCs are widely recognized as safe for the environment. The reason for this is their low toxicity, and reactions with their participation take place under very mild conditions.

The essence of the Project is a comprehensive study of important and demanding enantioselective reactions catalyzed by N-heterocyclic carbenes (NHC), including the development of synthetic strategies based on atropoenantioselective cycloaddition. Particular attention will be focused on the use of properly designed heterocyclic nucleophiles, e.g. uracil or benzothiazinone derivatives.

The presented Project is a modern direction of research and is a contribution to domestic and global projects in the field of the so-called "asymmetric catalysis". Our research will allow us to develop new effective organocatalytic processes using a synthetic strategy based on the activation of substrates with N-heterocyclic carbenes. Such processes are particularly important from the point of view of asymmetric synthesis and potential applications.