1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: *Concepts of non-umpolung in organocatalysis based on N-heterocyclic carbenes – cascade reactions with the use of acylazoliums*

1.1. Project goal

The aim of the project is the exploration of important and challenging NHC-catalyzed enantioselective reactions. Special attention will be focused on the domino processes and the generation of multiple stereogenic centers.

- Stereoselective formation of cyclopenta[c]quinolin-4-ones through NHC-catalyzed cascade reactions of malonate derivatives with α,β-unsaturated acylazoliums,
- Stereoselective annulation of *in situ* generated α,β-unsaturated acylazoliums enals with isatin-derived iminomalonates *via* cascade reactions for the construction of functionalized spiro-heterocyclic isatin-fused bicylic lactones,
- Enantioselective synthesis of isoxazolo[4,3-c]quinolin-3(1H)-one *via* a formal asymmetric sequencing of Michael/Mannich/lactonization reactions of acylazoliums with N-phenylmethanimine oxide derivatives.

1.2. Outline

Over the last decade asymmetric organocatalysis has grown rapidly to become a very powerful strategy for the synthesis of enantiomerically enriched compounds.[1-3] It represents an attractive alternative to metal catalysis, and in some cases, offers unparalleled transformations. Despite unquestioned advantages of this methodology, there are still many limitations related to substrates reactivity and catalyst activity.[4-5] Based on these strategies, in this PhD project, methodologies for the synthesis of new chiral heterocyclic compounds derived from cyclopenta[c]quinolin-4-one, isoxazolo[4,3-c]quinolin-3(1H)-one and isoxazolo[4,3-c]quinolin-3(1H)-one skeletons will be developed. These structural motifs are present in a variety of biologically active natural products and numerous pharmaceuticals. The project will result in the development of new efficient organocatalytic processes *via* carbene catalysis, expanding the scope of asymmetric synthesis and opening new applications.

The project is part of research funded by the National Science Center as part of the Sonata Bis program

1.3. Work plan

Planning a suitable substrate synthesis path based on known scientific databases. Synthesis of substrates necessary for the implementation of the main tasks of the project. Development of an organocatalytic pathway to target products. Optimizing the reaction conditions in terms of process efficiency as well as enantiomeric excesses. Characterization of the obtained reaction products, HPLC, ATR-IR, MS, NMR, preparation of support for publication.

1.4. Literature

1. Flanigan D. M., et al., *Chem. Rev.* **2015**, *115*, 9307
2. Rafiński Z., Kozakiewicz A., Rafińska K. *ACS Catalysis*, **2014**, *4,* 1404
3. Rafiński Z. *Catalysts*, **2019**, *9*, 192.
4. Mondal S. Yetra S. R. Mukherjee S. Biju A. T. *Acc. Chem. Res.* **2019**, *52*, 2, 425
5. Bugaut, X. Glorius, F. *Chem. Soc. Rev.* **2012**, *41*, 3511.

1.5. Required initial knowledge and skills of the PhD candidate

Good knowledge of organic chemistry
Predispositions and strong motivation for scientific work (regularity and timeliness)
Independence in achieving the set research goals, at the same time the ability to work in a group.)

1.6. Expected development of the PhD candidate's knowledge and skills

Acquiring advanced skills in optically active synthetic materials
Advanced knowledge in design and synthesis of architecture complex molecular structures
Learning of the spectroscopic methods and the laboratory work
Development of analytical thinking
Personal development as young scientist