DOCTORAL PROJECT PROPOSAL
DOCTORAL SCHOOL OF EXACT AND NATURAL SCIENCES
NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
GRANT PROCEDURE

Project title (in English)		
The synthesis and optimization of properties of fluorophores towards their multiphoton absorption		
Project title (in Polish)		
Synteza i optymalizacja właściwości fluoroforów w celu dostosowania ich absorpcji wielofotonowej		
Project submitter/Contact person		
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	Faculty of Chemistry organizational unit	
Suggested supervisors and mentors		
1) main supervisor		
prof. dr hab. inż. Borys Ośmiałowski degree/title, first and last name	borys.osmialowski@umk.pl e-mail, phone number	
	Faculty of Chemistry organizational unit	
	field:	chemistry
2) auxiliary supervisor		
…… degree/title, first and last name	…… e-mail, phone number	
	…… organizational unit	
	field:	

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

Project title: The synthesis and optimization of properties of fluorophores towards their multiphoton absorption

1.1. Project goals

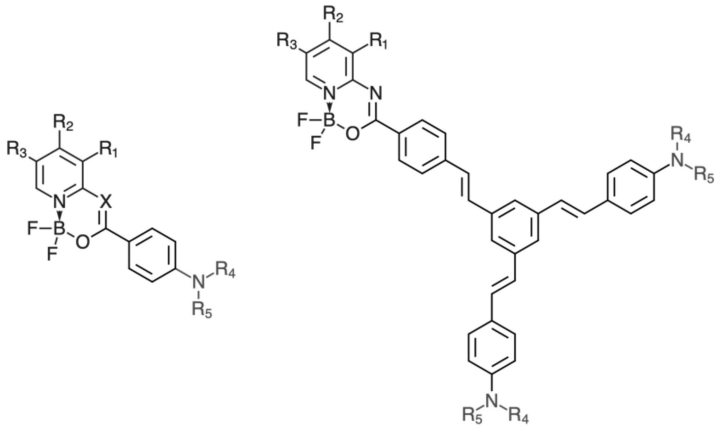
The main goal of the project is to synthesize a series of fluorescent dyes and study their properties.

1.2. Outline

The main motivation is to learn how to tune the properties of new dyes obtaining high luminescence quantum yield, absorption and emission in needed spectral window and to influence the charge-charge transfer properties upon excitation. The mentioned charge-transfer properties should influence multiphoton absorption of studied dyes and, thus make the dyes suitable for bioimaging in deeper parts of tissues.

1.3. Work plan

The work on the topic is based on design of the structure of molecules that will carry the substituted electron acceptor (in blue, below) and variable donor part (in red).



That will warrant the possibility of charge transfer in ground and excited states. The degree of the charge transfer will be tuned using various, conjugated spacers joining acceptor and donor parts (in black). The dyes will be synthesized in organic chemistry laboratories and then a palette of processes will be applied to separate and purify luminophores to the highest possible level. For pure compounds their structure will be confirmed by instrumental methods, and, at this point, the measurements are planned. The photophysical properties of dyes will be recorded and based on results further optimization of the molecular structure will be applied. Moreover, the stability and the tendency to undergo photoisomerization will be studied to obtain full information about photochemical processes that could complicate the application of dyes in bioimaging.

1.4. **Literature** *(max. 10 listed, as a suggestion for a PhD candidate)*

Chem. Rev. 2003, 103, 10, 3899-4032
Phys. Chem. Chem. Phys., 2016, 18, 28198-28208
Chemical Physics 1997, 219, 341-351

ACS Omega 2023, 34, 30939-30948
Angew. Chem. Int. Ed. 2009, 48, 3244-3266
New J. Chem., 2007, 31, 496-501

1.5. Required initial knowledge and skills of the PhD candidate

The candidate should be experienced in the organic synthesis with a special emphasis on purification of organic compounds. The ability to work with instruments in photophysical laboratory is highly desirable as this is a crucial part of the project.

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

It is expected that the candidate will gain special skills when implementing the project. Those are:

a) Ability to synthesize new compounds with the emphasis on multistep reactions and separation/purification of the final products.
b) Ability joined with structural characterization of organic compounds, confirmation of the structure of final products and mid-products used in next steps of the synthetic paths.
c) The skills related to work in photophysical laboratory including absorption, emission and optimization of the structure of molecules to obtain assumed characteristics of dyes.
d) Understanding the structure-properties relations for future work in the field of dyes.
e) The skills joined with the non-covalent interactions of dyes and change of their properties upon interactions with amyloids and their aggregates.