The doctoral dissertation focuses on the design and synthesis of innovative fluorophores based on the structure of Thioflavin T, considering their potential applications in bioimaging and amyloid plaque detection. The research particularly emphasizes structural modifications aimed at improving photophysical properties, such as fluorescence quantum yield, Stokes shift, and the positioning of absorption and fluorescence bands. A key modification of molecules was the introduction of a BF_2 group, which allowed for the rigidifying the skeleton and enhancement of its photophysical properties.

The studies demonstrated that the introduction of electron-donating or electron-accepting substituents into the structure of fluorophore significantly affects their photophysical properties in solutions. However, the complexity of this issue is reflected in the multidimensional nature of property changes, where various factors, such as the type of substituents, their placement, and intermolecular interactions, must be considered. The conducted research confirmed that even minor structural modifications can lead to unexpected changes in photophysical properties, which is crucial when designing new compounds.

The analysis of the influence of environmental polarity, viscosity, and aggregation on the photophysical properties of fluorophores showed that controlling photophysical parameters is challenging and requires a cautious approach during the design of fluorescent dyes. The most significant findings of this work include the demonstration that strengthening the donor character of substituents can lead to substantial shifts in absorption maxima without affecting fluorescence quantum yield. Additionally, structural changes in the substituent can induce phenomena such as aggregation-induced emission (AIE), which opens new application possibilities.

The results obtained in this study have not only a cognitive value in the field of photophysics of organic compounds but also a practical one, as evidenced by collaborative research outcomes with other research groups confirming the usefulness of the designed fluorophores for amyloid studies. The achieved research goals indicate that designing organic fluorophores remains challenging, particularly in the context of accurately predicting fluorescence quantum yield. Further studies must also consider factors critical for biomedical applications, such as toxicity and the ability to penetrate biological membranes. Additionally, the results presented in this dissertation may serve as a starting point for formulating design strategies for fluorophores based on other structural cores.

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