With the discovery of the mutagenic effect of pyrene at the beginning of the 20^{th} century, it seemed that the fate of polycyclic aromatic hydrocarbons (PAHs) was sealed. Yet, the subsequent discovery of fullerene and carbon nanotubes as well as organic field-effect transistors (OFETs) and organic light-emitting diodes (OLEDs) has made PAHs favored molecules for current advanced research. Their heterocyclic analogues possessing π-expanded structures have undergone a renaissance due to their high charge-carrier mobility, rendering these compounds immensely useful for organic electronics.

OLEDs and related technologies assert dominance in conventional display technologies. Further progress in this regard is, however, limited by the currently available materials. It is therefore critical that strategies towards the design and synthesis of transformative molecules manifesting better optical properties are developed. Helicenes are PAHs characterized by a convergent orientation of adjacent aromatic rings leading to a non-planar arrangement due to steric interactions. Carbo[n]helicene systems are characterized by their intrinsic chiroptical properties, such as circular polarized luminescence. These properties are of key importance for the further development of OLEDs and related technologies. It is obvious that further progress in this field can only be achieved *via* studies of longer and/or multiple helicenes, with appropriate synthetic methodologies to allow for full control over optoelectronic properties. Methods allowing access to these molecules do not currently exist and the key objective of this grant proposal is to develop them. We aim to prepare helical, conjugated, aromatic molecules based on heterocyclic building blocks, possessing a combination of heretofore unknown properties such as large fluorescence quantum yields and emission in the red and near-infrared region of the electromagnetic spectrum.

To achieve the project objectives, our study will be divided into three tasks. Initial research will be focused on the development of double helicenes, with two heterocyclic types of building units synthesized in parallel in order to minimize the risk factor. The critical step in the preparation of helicenes will be a photochemical reaction i.e. a process which requires photons to occur. Subsequent research will focus on the synthesis of longer helicenes comprising of electron-rich pyrrolopyrroles as donors. The complexity of synthesis will be increased over time to reach structurally elaborated multiple helicenes and the diastereoselective synthesis of curved architectures. Finally, fundamental photophysical studies will be performed followed by an advanced investigation of critical parameters. All obtained systems will be thoroughly investigated in this final stage. A particular focus will be on the impact of their structure on resultant photophysical properties allowing for the construction of a structure-function library for heterocyclic helicenes.

The expected direct results of this project will transform the synthetic chemistry of helicenes and simultaneously increase comprehension of how to manipulate and control photophysical parameters of highly curved aromatic molecules.

The long-term impact on the scientific community will encompass deepened understanding of the relationship between the structure of helical aromatic molecules and their optical characteristics. Answering the question of under what conditions such compounds can possess strong fluorescence, including the emission of circularly polarized light to improve the performance of OLED derived displays will propel the development of better materials for OLEDs as well as allowing for additional functionality such as stereoscopic displays (3D-displays).