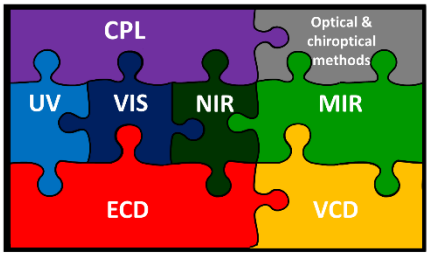
DEVELOPMENT OF STRATEGIES FOR ENHANCING CHIROPTICAL PROPERTIES IN FUNCTIONAL METAL COMPLEXES INSPIRED BY NATURE

Chirality, or the non-identical nature of an object and its mirror image, is omnipresent in nature, both on the macroscopic and microscopic levels. This phenomenon plays a fundamental role in the natural and physical sciences, as **most chemical compounds in living organisms are chiral**, meaning they exist in only one form or variation among two or more possible options. Therefore, it can be said with certainty that the properties of chiral molecules influence most life processes.

In recent years, **the phenomenon of chirality** has found increasingly broad applications **in modern technologies**. The properties of chiral materials are utilized in optoelectronics (such as OLED), sensors, imaging technologies, modern security features for banknotes, and advanced optical filters controlling light polarization.

The goal of our project is to develop effective strategies to enhance chiroptical properties, i.e., properties that are the direct macroscopic manifestation of chirality originating from the microscopic world, such as **circular dichroism (CD) and circularly polarized luminescence (CPL)**. Our main research tool will be CD spectroscopy, which examines the absorption differences in circularly polarized light absorption by chiral molecules, complemented by CPL spectroscopy, which describes the emission of circularly polarized light by these molecules.



UV ultraviolet, **VIS** visible light, **NIR** near-infrared, **MIR** mid-infrared, **E/V CD** electronic/vibrational circular dichroism, **CPL** circularly polarized luminescence

In this project, we will aim to focus on a deep understanding and maximization of chiroptical properties in precisely designed complexes of **d- and f-block metals** in the periodic table. These complexes include structural motifs found in nature, such as terpenes and steroids, allowing for a thorough investigation of their unique interactions with circularly polarized light. This will enable us to work on optimizing their functional properties, which are crucial for new technologies. The use of natural products in our studies will facilitate a better understanding of how chirality influences the properties of newly designed molecules.

Despite significant progress in this field, many unknowns remain regarding **the factors that enhance the chiroptical signal, both in terms of absorption and emission**. Our research will involve an innovative, holistic approach that allows the analysis of chiroptical properties not only in solutions but also in the solid-state. The project envisions the use of advanced chiroptical methods across a wide spectral range (from UV through near IR to middle IR), supported by quantum mechanical calculations. This will make it possible to achieve exceptional chiroptical properties in the designed metal complexes.

The innovation of our project lies in **overcoming the typical limitations encountered in chiroptical analysis**, which will enable the creation of new, highly functional materials. We expect that the results of our research will contribute to the development of new chiral security inks, affordable sources of circularly polarized light, and advanced optical materials. Our project will not only provide new knowledge in the field of chiroptical spectroscopy and the study of chiral compounds but also introduce practical, *ready-to-use* solutions and methodologies that will be applicable in further research on chiral metal complexes.