Chiral molecular magnets - control of the UV-vis light absorption using magnetic field

Abstract for the general public – Dawid Pinkowicz

Light-matter interactions are fundamental and of great importance for scientists involved in advanced optical research or photonics as well as in our everyday life. For instance, the mechanism of vision – our ability to see – relies on one of the most basic phenomena – absorption of light followed by photoisomerization of a molecule called retinal. Generally the physics behind light absorption by molecules/solids is not only well understood but also extremely useful. Absorption of light can result in photochemical reactions like silver halide reduction in traditional photography or generation of electrical current in photovoltaic cells. However, some related phenomena are still quite mysterious like **the influence of the magnetic field on the absorption of light – the subject of the proposed research**. It is believed that this particular magneto-optical phenomenon called magneto-chiral dichroism (MChD) occurring in magnetized chiral compounds may hold the key to the understanding of the homochirality of all life on Earth and provide an answer to the question: why only L-amino acids build proteins and only D-sugars build RNA and DNA in living matter? Moreover, MChD effect might play an important role in developing magnetic field-enhanced asymmetric catalysis or the **construction of advanced magneto-optical information storage and processing devices.**

The project "Chiral molecular magnets - control of the UV-vis light absorption using magnetic field" **focuses on the design and preparation of suitable molecular materials that will show very strong magneto-chiral dichroism** due to the exceptional combination of strong optical activity and large intrinsic magnetization of the material – the title chiral molecular magnets (CMMs). CMMs can be constructed using organic and inorganic molecules and ions as building blocks. The selection and preparation of the suitable "molecular bricks" as well as the design and synthesis of the target "architectures" is based on methods developed by supramolecular, coordination and organometallic chemistry. The compounds developed within the proposed research will be fully characterized using a range of physical techniques including structure determination and magnetic properties analysis. Selected candidates will be tested for the presence of the natural circular dichroism, magnetic circular dichroism and MChD effect using a unique state-of-the-art MChD spectrophotometer (its assembly is one of the major goals of the project).

The potential social and scientific impact of the project is three-fold: (i) it will inspire further study in the field of magnetization-enhanced enantioselective catalysis leading to cheaper and more advanced drugs, (ii) it will provide additional insight into the homochirality of life puzzle and (iii) it will result in ground-breaking discoveries related to light-matter interactions enabling new possibilities of controlling solid matter by photons. This in turn will enable the construction of smart multifunctional materials and devices with the ability for fast information processing and non-volatile information storage operated by electromagnetic, electric and magnetic field.