The United Nations Emissions Gap Report 2018[1] gives no doubt that in order to slowdown the climate warming the emission of greenhouse must be significantly reduced. In 2017 the total annual greenhouse gases emissions reached record value of 53.5 gigatons which is an increase of 0.7 compared to 2016. The goal is to keep temperature increase below 1.5°C, but this mean that greenhouse gases emission in 2030 must be reduced by about 55% compared to 2017[1]. This reduction can be achieved not only by changing the industry and energy production to more environmental friendly power plants or factories, but also by lowering the consumption of energy. The development of energy-efficient technology in different areas ( from heavy industry through automobile industry up to electronics) is widely observed. Recently, more ecologic and efficient cooling technology are objects of special interest. This is not surprising if we consider the residential consumption of electricity in United States of America in 2016. The electricity for space cooling, refrigerators and freezers cover 26.3% of total consumption. Moreover, most of cooling devices uses 1,1,1,2 tetrafluoroethane as a refrigerant, which is safe for the ozone layer (in contrast to previous refrigerant gas dichlorodifluoromethane), however its global warming potential (GWP, a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide[3]) is high on the level of 1300[3] (GWD for $CO_2$ equals 1).

In this context magnetocaloric effect (MCE), a magneto-thermodynamic phenomenon in which the magnetic material changes its temperature as a consequence of varying the magnetic field, is an object of great expectations. The MCE does not need greenhouse gases and is thought to be more efficient. In 2015 a collaboration of Haier, Astronautic Corporation of America and BASF introduce a prototype of refrigerator which revel a 35% improvement compare to compressor technology. Although the technology readiness level (TRL) of MCE is quite high (TRL=5/6), there are still fundamental problems that need to be solved. For instance, two new caloric effects have been recently introduced - the rotating magnetocaloric effect (RMCE) and the magnetic barocaloric effect (MBCE).

The aim of the research project is to study new types of magnetocaloric effect (MCE) - the rotating magnetocaloric effect (RMCE) and the magnetic barocaloric effect (MBCE), in molecular magnets. Both of them have been scarcely studied in magnetic molecular compounds. However, some of previous results suggest that certain types of molecular magnets (i.e. SMM - single molecule magnets, SCO- spin crossover compounds) has unique properties that can be important in improving and better understanding of RMCE and BCE. The goal is to understand better the fundamental aspects of both caloric effects. Therefore, the project will be focused on influence of the structure, chemical composition, dimensionality and magnetic properties (particularly magnetic anisotropy) on caloric properties in molecular materials. The project has an experimental character - selected molecular magnets will be synthesized and comprehensive characterize by:

- structural methods in ambient and high pressure conditions;
- magnetic measurements with conventional, angle resolved and high pressure magnetometry;
- heat capacity techniques in ambient and high pressure conditions

The RMCE part of the project will be studied with 2D and 0D compounds with significant anisotropy. In the MBCE task we will focus on 3D molecular magnets, with phase transition to long range magnetic order, and SCO, in which the spin state transition occur.

The aim of the project is not only to characterize caloric and magnetic properties of selected compounds, but also to obtain universal rules and conclusions which can be applied in the field of magnetic solid-state cooling. These findings can be used to determine new directions in research of molecular magnets and magnetic caloric effects. Additionally, we are planning to prepare guidelines for chemist and material scientist for synthesis of new magnetocaloric compounds.

The project is important for development of low temperature cryo-coolers technology, which can be cheaper and more efficient than devices used currently (Helium 3 or dilution refrigerators). What is more, the study of MBCE for SCO compounds will answer whether these bistable compounds have potential for commercial cooling applications. Although the project deals with basic science problems, we believe that our findings will be useful in further development of RMCE and MBCE research.