Layered magnetic materials have recently attracted a lot of research attention, as they were found to display new phenomena, very attractive for applications. In 2007 Albert Fert and Peter Grünberg were awarded a Nobel Prize in physics for the discovery of giant magnetoresistance (GMR) in multilayers - artificial stacks of bilayers composed of alternating thin slabs of magnetic and non-magnetic materials. The Nobel laureates have shown that in such artificial structures a small change of magnetic field strongly affects the electron transport, leading to significant changes in the resistance. This discovery has found immediate applications and started a new era of spin-based electronics. The condition for successful applications is the ability to artificially produce reproducible laminar structures consisting of few atomic layers and very well controlled interface quality.

As a next step, the researchers are now trying to replace the artificial bilayer stacks with the materials that display inherently laminar structure, where the atomically sharp interfaces are provided by nature. A very promising target is the rich family of newly re-discovered MAX phases, composed of the nanolaminated carbides and nitrides described by the general formula $M_{n+1}AX_n$ ($n = 1 - 3$), where M is a transition metal, A – an A-group element, and X is carbon or nitrogen. In 2001 a breakthrough report has shown that these materials display peculiar combination of ceramic and metallic properties such as high stiffness, oxidation resistance, machinability, and high damage tolerance, properties that were attributed to a mixture of strong M-X bonds and weaker M-A bonds. The attempts to add magnetism as a new functionality of these materials succeeded in synthesizing the first magnetic MAX phases in 2013. These were $(CrMn)_2GaC$ and $(CrMn)_2GeC$ quaternary compounds. Playing with different substitutions in these starting compositions, a magnetic response was subsequently obtained from other quaternary compounds, such as $(CrMn)_2AlC$ or $(MoMn)_2GaC$ as well as from the ternary Mn_2GaC. The ability to control the magnetic properties and promote future applications depends on the understanding of magnetic interactions between particular elements of this structure and this is still in the stage of infancy, in spite of the considerable worldwide efforts.

We propose to attack this problem by performing a comprehensive study on a wide range of magnetic MAX phases using the Nuclear Magnetic Resonance (NMR) technique. This experiment can provide a valuable insight into the local arrangement of magnetic moments, since the internal magnetic fields on nuclei probed in this experiment are determined mainly by the local magnetic moments and their mutual orientation resulting from the exchange interactions. In this project we shall first investigate the ternary compound Mn_2GaC, where the absence of chemical disorder in the M sublattice facilitates the interpretation of experimental data. Having arrived at the understanding of the magnetic interactions in this compound and the resulting magnetic structure, we shall extend our research to include quaternary compounds derived from the Mn_2GaC structure by introducing different substitutions on the M and on the A sublattice. Finally, we shall endavour to shed some light on the magnetic structure of the new magnetic MAX phases that are presently under development, e.g. the newly discovered nanolaminated chemically ordered in plane i-MAX and chemically ordered along perpendicular axis o-MAX families.