Materials with Kagomé net structure are interesting for physicists due to their potential in creating magnetic frustration between its atoms. In conventional materials spins are arranged alternately in most favorable energetic layout (lowest energy). Considering the simplest geometric arrangement that creates a frustration – a triangle (fig. 1), we can notice that atoms in its corners are not arranged into pairs spin up and spin down. Third atom is unable to fit its spin to create lowest energy configuration – it remains „frustrated". Kagomé network is built from such repeated triangles in which, despite next spins create pairs, there is always one that is left „unsatisfied". Materials created in this manner may form new classes of materials e.g.: "spin ice" (in such compounds there is no magnetic ordering even at the absolute zero temperature, which is the case in conventional magnetic materials). Materials with the Kagomé structure can also show interesting electrical properties, as the geometrical arrangement produces peculiar electronic structure.

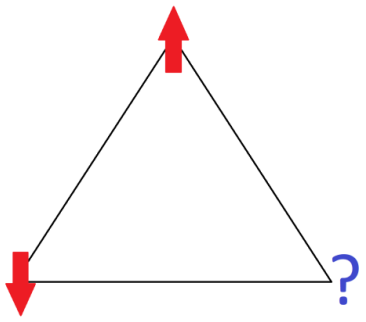

Figure 1 An example of geometric frustration. Atoms in a corners of a triangle with their spins marked with arrows.

The aim of the project is synthesis and physical properties examination of compounds with $BaFe_2Al_9$-type structure (1-2-9) in which Al atoms arrange themselves into Kagomé network (fig. 2). The plan is to introduce in position of atom with oxidation state of +2 (Ba in original structure – position „1") alkali earth metals (2nd group of periodic table) as well as rare earth metals: Sm, Eu, Tm Yb. Atom in Fe position (position „2") we propose elements from group 8, 9 and 10 of periodic table, and in place of Al (position „9") we want to introduce Ga and In. Additionally, to further explore the research range, we want to check if introducing other rare earth metals with oxidation state of +3 is possible.

There are not many compounds with $BaFe_2Al_9$-structure type reported in literature so far. One of them is $BaIr_2In_9$, which exhibits anisotropic thermal expansion behavior (increasing of one of its dimensions is higher than other ones). This mechanism is correlated with crystal structure, so it is likely a feature of other $BaFe_2Al_9$-structure type compounds. Other existing compounds from the family are KCo_2In_9 and KNi_2In_9. Potassium is an atom with oxidation state of +1, which is a premise that not only +2 oxidation state is preferable to create a stable structure.

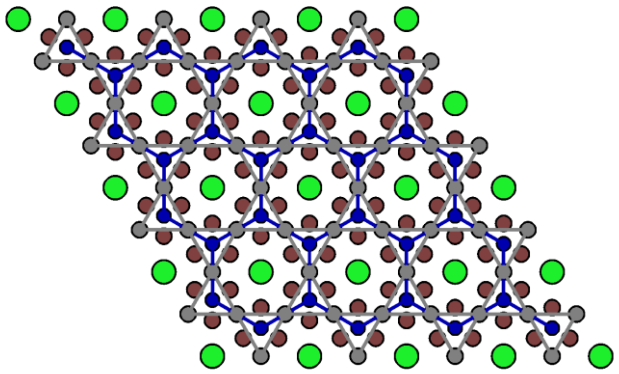

Figure 2 Kagomé net structure of atoms in Al(1) positions in *ab* plane (gray). Cations (Ba position) are marked as green, transition metal atoms (Fe position) form a honeycomb layer sandwiched between the Al(1) Kagomé planes. Al(2) atoms are shown in brown

Compounds with $BaFe_2Al_9$ – type of structure, due to their construction and variety of possible phases are a promising group for structural research. Their physical properties, which are not widely reported so far, give an opportunity to explore new materials having unusual physical properties. The studies of the $BaFe_2Al_9$ family can bring us closer to understanding basics of physical phenomena such as e.g. superconductivity and to find new materials for i.e. magnetic applications.