The main goal of the project is to experimentally study highly unusual magnetic properties of several gadolinium-containing garnets, primarily Gd₃Ga₅O₁₂ (GGG), Gd₃Al₅O₁₂ and Gd₃Te₂Li₃O₁₂. Although the compounds have been known for decades, it has only recently been realized that the particular way in which the Gd ions form a crystal structure, described as a hyper-kagome lattice, is crucial in order to understand their magnetic behaviour. The structure consists of corner-sharing triangles with the Gd ions forming 10-site loops, shown in colour on the left. In GGG, the loops are responsible for a hidden order in a spin-liquid phase in zero field, as identified by the powder neutron diffraction analysis [1]. They are also responsible for the appearance of the flat modes in the excitation spectrum in higher magnetic fields [2].

This project will address all important and yet completely open questions: What is the nature of field-induced ordering in the garnets? What interactions are responsible for the selection of a particular magnetic state among many other possibilities? Can the signatures of the multi-spin correlations be found in other compounds?

We will use neutron scattering as a main tool in our investigations, in particular on single crystal garnet samples.