New avenues to superconducting materials

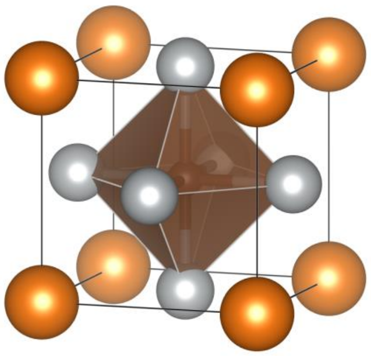
Superconductors are materials that show absolutely no electrical resistance at all below a certain temperature, called the superconducting critical temperature. In other words – an electrical current traveling in a loop of wire made of such a material could travel in the loop forever and not lose any energy. Superconductors are used in modern technologies for example in magnetic resonance imaging (MRI) machines, in which electrical currents traveling in a loop produce a large magnetic field. New superconductors afford the opportunity to explore new kinds of science in solids, but importantly also present the opportunity to discover a material that may someday have widespread real world uses.

Superconductors are discovered in various ways. By testing hundreds of samples in solid chemical systems made of three or more elements reacted together, by modification of existing compounds through chemical doping, or by inducing changes in their crystal structures, for example by applying extreme high pressures.

The aim of the project is to develop new avenues for discovery of superconducting materials. One of those avenues is based on compounds where the element aluminum is a major constituent. Our experience shows that there are several structural mechanisms that stabilize clusters of aluminum atoms in solids, clusters that we hypothesize could lead to superconductivity. In this project we will design routes to synthesize new compounds based on clusters formed by aluminum atoms, with the purpose of making new superconductors.

A parallel objective of the project is to develop methods for the synthesis of new compounds with the so-called *antiperovskite* crystal structure type, a structure type that is known to house important superconductors. The starting point of this parallel research path will be compounds with $AuCu_3$-type crystal structure, a crystal structure in which there are unfilled octahedra in an infinite three-dimensional array. Filling the space in the centers of the octahedra a small atoms such as boron, carbon and nitrogen will change these materials to the target *antiperovskite* type crystal structure, and, we hypothesize will generate new superconductors.

Antiperovskite $MgCNi_3$



$AuCu_3$