Data analysis of the magnetic susceptibility of Ce-based triangular magnets.

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Context:
In magnetic materials, magnetic moments localized on particular ions interact with each other and these magnetic interactions can lead to collective behavior of the magnetic moments, such as magnetic ordering. Magnetic order occurs when the magnetic moments form a regular pattern. We consider in this project materials harboring triangular lattices of the magnetic ion Ce$^{3+}$ such as KCeS$_2$ or CeCd$_3$As$_3$ [1]. The magnetic moments on the Ce$^{3+}$ ion come from a single ion in the electronic shell 4f. In these materials, all the magnetic interactions cannot be simultaneously satisfied resulting in the so called magnetic frustration. The magnetic frustration attracts our interests because it leads to the competition between various possible magnetically ordered and disordered states.

Measurements of the magnetic susceptibility are used to sense the magnetic properties of materials. The magnetic susceptibility is the response of materials to an applied magnetic fields, it provides valuable information on the magnetic moments and their interactions. In this project, we consider the modelization of the temperature dependence of the magnetic susceptibility of Ce-based triangular magnets. We will first consider the common Curie-Weiss law [2] and then use a more complex model taken from Ref.[3] to take into account the specific properties of the 4f electronic shell and the trigonal symmetry of the lattice. The results of the two computations will be compared to the experimental magnetization of KCeS$_2$.

Figure: Inverse magnetic susceptibility of CeCd$_3$As$_3$ for two different magnetic field directions [3]. The green lines are fits using the model from [3].

Methods:
- The student must use a software for calculation such as the free software Octave.
- The student will first model the temperature dependence of the magnetic susceptibility using the Curie-Weiss law and compare with the magnetic susceptibility of KCeS$_2$ in the temperature range 5K<T<20K.
- The student will improve the model of the temperature dependence of the magnetic susceptibility into the more sophisticated model proposed in [3] to model the magnetic susceptibility of KCeS$_2$ in the temperature range 20K<T<400K.
References:

