

Magnetism in materials

Solution - Week 11

Let's suppose that you have a crystal, and you already know the following properties :

- The structure is cubic and the atoms are linked by an oxygen on the z axis.
- The magnetic moment per atom is $\mu = 2.2\mu_B$ and is along the z-axis
- The lattice structure parameter is $a = 5\text{\AA}$

But you do not know in what configuration the magnetic moments get ordered. You conduct an $\mu - \text{SR}$ experiment. You know that the muons will stop and decay near the oxygen atom, at $R = 1\text{\AA}$ in the xy plane. You measure a $\mu - \text{SR}$ frequency $f = (190 \pm 20)\text{MHz}$.

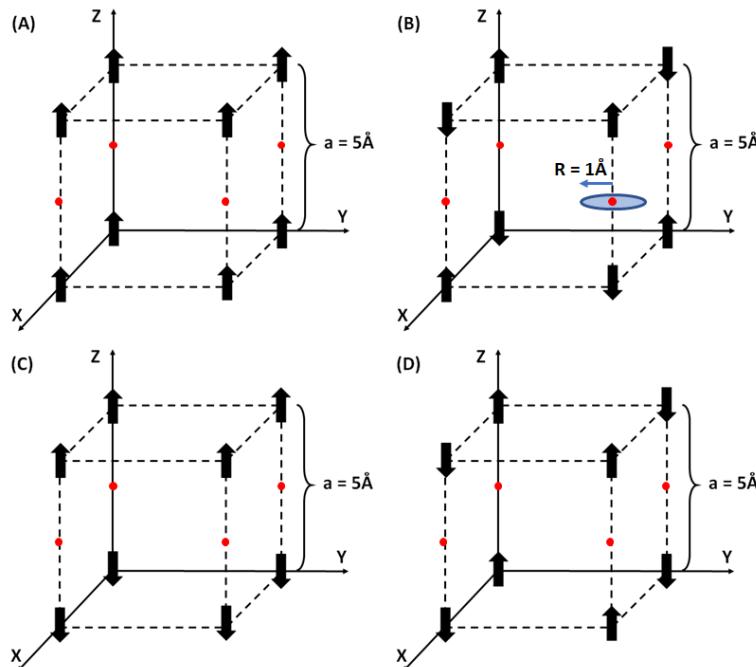


Figure 1: The different possible interaction. The red dot represent the oxygen. (A) ferromagnetic. (B)-(C) antiferromagnetic. On (B) the possible locations of the muons are represented.

1. What is the magnetic B field around the oxygen ?
2. It is possible to estimate the field in a cubic lattice by just adding the dipole field. The script `Dipole_sum.ipynb` perform the sum of the magnetic field generated at the muon position by the dipoles on N shells of unit cells around the muon position. Increase the number of shells considered in the calculation until you see that the results of the calculation converges. Use this result to determine the magnetic order in the crystal.