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Crystal lattice vibrations and their coupling with magnetic correlations in (Cu,Co)Sb_2O_6

Damaris T. Maimone (PG), Eduardo Granado (PQ).

Abstract
In this work, the magnetic low dimensional systems (Cu, Co)Sb_2O_6 were studied. One of the motivations for this study is the understanding of the anomalous behavior in the reported magnetic susceptibility measurements. We studied these compounds through a spectroscopic technique capable of providing us information about the magnetic correlations and exchange interactions in first neighbors, namely Raman spectroscopy. In particular, we investigated the spin-phonon coupling for the Raman active modes of $CuSb_2O_6$ and performed preliminary measurements in $CoSb_2O_6$.

Key words: Low-dimension magnetism, Raman Spectroscopy, spin-phonon coupling.

Introduction

Low dimensional systems have been thoroughly studied both experimentaly and theoreticaly, due to their peculiar magnetic properties. In this work, we studied the magnetic low dimensional systems $CoSb_2O_6$ and $CuSb_2O_6$. Even though these compounds present a similar crystal structure, their magnetic susceptibility (MS) show different magnetic behaviors. It is possible to notice that the substitution of Co per Cu drives the change of magnetic structure from antiferromagnetic(AFM) bidimensional[2] to AFM one dimensional[1]. This anomalus behavior in the MS is still an open question. In this work we investigated these compounds through a spectroscopic technique capable of providing us the information about spin correlations and exchange interactions in first neighbors. The technique used here was Raman spectroscopic, that is sensitive to the lattice vibrations and their coupling with magnetic correlations. The spin-phonon coupling manifests as a change in the vibration frequencies due to a modulation in the magnetic energy. If one follows the phonon energies as a function of temperature it is possible to obtain information about the spin correlations.

Results and Discussion

For the Cu-based sample, it was reported a structural transition at T=380K[1], where it goes from monoclinic (P21/n) to tetragonal (P42/mnm). Using Raman spectroscopy we could also see the transition, signed as a division of the peak at 648 cm-1 (T=400K) into two peaks 635 cm-1 and 678 cm-1 (T=296K), as shown in Fig.1.

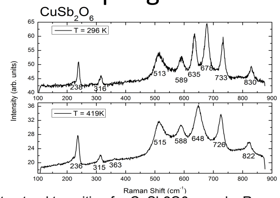

Fig.1: Structural transition for CuSb2O6 seen by Raman spectroscopy.

In order to follow the frequency as a function of temperature and then investigate the spin correlations, we took several spectra at different temperatures. The result for two different peaks are shown in Fig.2. It is possible to see an anomaly near T=100K, which we ascribe to the spin-phonon coupling.

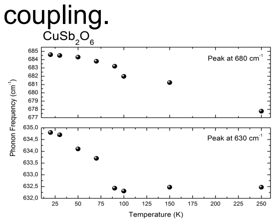

Fig.2: Following the frequency as a function of temperature to see the spin correlations and then the anomaly for CuSb2O6.

Conclusions

Raman scattering measurements were performed on $CuSb_2O_6$. The structural transition at 380 K manifests as a splitting of the phonon peak at 648 cm-1 into two peaks. Anomalies in some phonon frequencies were observed below ~100K, which we ascribed to a spin-phonon coupling. These results indicate interesting physics for these compounds, which are being investigated in more detail during my Masters dissertation work.

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References

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