# Search for the Evidence of Orbital Order in Double Perovskite Material - $Ba_2NaOsO_6$

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## Introduction

$Ba_2NaOsO_6$ is a double perovskite material with a nominally cubic structure. It is known that the material orders ferromagnetically at 6 K [1] in zero magnetic field. It was recently proposed the existence of a specific class of quadrupolar order [2]. We have used NMR to investigate the evidence of this orbital order, which would naturally account for the unusual anisotropy of the ferromagnetic properties.

## Experimental

$^{23}$Na NMR data on single crystals of $Ba_2NaOsO_6$ were obtained using 17 T superconducting magnet with continuous flow cryostat at NHMFL. We have obtained spectra at various temperatures at 15 T and the angle dependency of the signal by using a single axis rotator mounted on the NMR probe.

## Results and Discussion

NMR spectra as a function of temperature at 15 T, with field applied to c-axis are plotted in Fig 1a. As evident in the figure, spectrum at high temperature paramagnetic phase splits into two groups of triplets as temperature decrease. These results are interpreted as the evidence for transition into the magnetically ordered state that is accompanied by the lattice distortions that break local cubic symmetry.

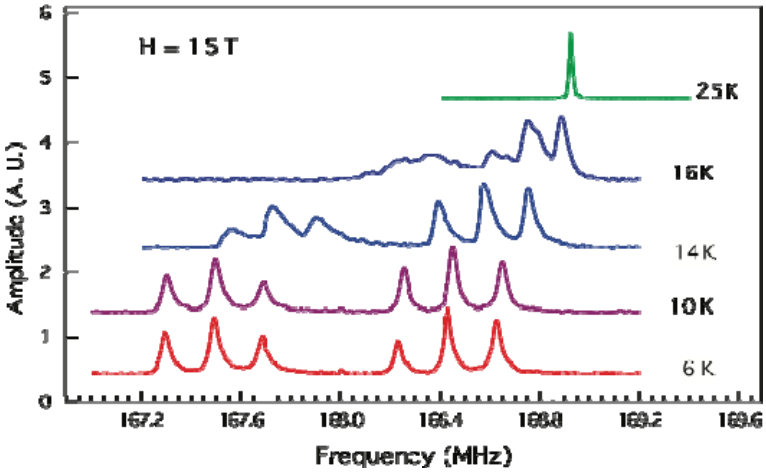


Fig 1. (a) Temperature dependency of Na NMR spectra for H applied along the c-axis. (Green single peak spectra is recorded in the paramagnetic phase. Complex spectra are observed in magnetically ordered state.

## Conclusions

The magnetic state in $Ba_2NaOsO_6$ is accompanied by lattice distortions that break local cubic symmetry.

## Acknowledgements

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## Reference

[1] A. S. Erickson et al., Phys. Rev. Lett. 99, 016404 (2007).
[2] G. Chen et al., Phys. Rev. B 82, 174440 (2010).