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Mössbauer Study of Electric Quadrupole-driven Anisotropic Interaction for FeV$_2$Se$_4$

Sam Jin Kim$^1$, Ju Hong Kang$^1$, Bae Soon Son$^1$, Jungbum Yoon$^2$, Myung-Hwa Jung$^2$, and Chul Sung Kim$^1$*

$^1$Department of Physics, Kookmin University, Seoul 136-702, Korea
$^2$Quantum Material Research Team, Korea Basic Science Institute, Daejeon 305-333, South Korea

*Corresponding author: cskim@kookmin.ac.kr, Phone: +82 2 910 4752, Fax: +82 2 910 5170

Recently chalcogenides spinel are interested for various magnetic properties. Colossal magnetocapacitive multiferroic properties have been reported for Cd-Cr spinel [1]. Orbital freezing and orbital glass state in Fe-Cr spinel were studied by specific heat measurement[2]. Incommensurate disordered spin-dimer state in charge ordered system are shown Cu-Ir sulphur spinel [3]. Also strongly correlated spin-orbit coupling was suggested for ferrimagnetic selenide compounds [4]. Various kinds physical phenomana are reported on chalcogenides spinels. In this report, we present microscopic interaction mechanism on FeV$_2$Se$_4$.

FeV$_2$Se$_4$ has been studied with Mössbauer spectroscopy, XRD (x-ray diffraction), and magnetization measurems. Crystallographic structure, cation distribution, anion positions were determined by Rietveld refinement of Fullprof program. Crystal symmetry is found to be monoclinic space group of $I2/m$ [Fe (2a); Cr(4i); S(4i(u,0,w)] with its lattice constants, $a_0 = 6.152\,\text{Å}$, $b_0 = 3.458\,\text{Å}$ and $c_0 = 11.726\,\text{Å}$.

Mössbauer spectra of FeV$_2$Se$_4$ show severely distorted asymmetric 8-line shape below 85 K, denoting large orbital contribution. While, it shows a quadrupole doublet above 85 K, of which value decreases with increase of temperature. It is noticeable that, in the temperature region 85 K $\leq T \leq$ 300 K, the ratio of intensity of the two line $R_q = A_1/A_2$ increases rapidly from 1 to 1.30, where $A_1$, $A_2$ correspond to Mössbauer absorption area of the quadrupole splitting for lower and higher energies, respectively. We interpret that it is closely related to the anisotropic atomic vibration for an iron atom in FeV$_2$Se$_4$. Also, it accords with the result of XRD refinement, slightly distorted local environment of the Se ions along c-axis.

REFERENCES