Spin reorientation in multiferroic spinel $\text{Co}_{0.5}\text{Fe}_{0.5}\text{Cr}_2\text{O}_4$ with Mössbauer spectroscopy. B. Myoung$^1$ and C. Kim$^1$. 1. Physics, Kookmin University, Seoul, Republic of Korea

We have reported on magnetic properties of multiferroic spinel $\text{Co}_{0.5}\text{Fe}_{0.5}\text{Cr}_2\text{O}_4$, especially spin-ordering, spin-reorientation, and charge re-distribution. With the Rietveld refinements the crystal structure was determined to be a normal cubic spinel with space group $Fd-3m$ and with cation distribution of $[\text{Co}^{2+}_{0.3}\text{Fe}^{2+}_{0.5}]^A[\text{Cr}^{3+}_{0.2}]^B\text{O}_2^4$. It is remarkable that the Co and Fe ions exclusively enter into the octahedral ($A$) sites, while the Cr ions enter into the tetrahedral ($B$) sites. Fig. 1 shows the temperature dependence of the magnetization and magnetic hyperfine field $H_{hf}$ of $\text{Co}_{0.5}\text{Fe}_{0.5}\text{Cr}_2\text{O}_4$ by using SQUID magnetometer and Mössbauer analysis. Curie temperature, $T_C = 86$ K was decided by the temperature where $H_{hf} = 0$ (Fig. 1). Also, we have determined that conical spiral magnetic ordering temperature $T_S$ is 20 K due to the slope change of M-T curve around 20 K, which coincides with that of $H_{hf}$ curve, as shown in Fig. 1. Furthermore, the slope of the curve on electric quadrupole splitting $E_Q$ decreases above $T_S = 20$ K. This suggests that the change in $E_Q$ around $T_S$ comes from charge distribution due to the spin-relocation arising from distortion of each tetrahedral site around Fe$^{2+}$ ion above $T_S$. That is, $\text{Co}_{0.5}\text{Fe}_{0.5}\text{Cr}_2\text{O}_4$ has ferrimagnetic spin-order below $T_S$, while above $T_S$, there is conical-spiral spin ordering. Isomer shift value ($0.89$ mm/s $\leq \delta \leq 0.93$ mm/s) by Mössbauer analysis shows that the charge states are ferrous(Fe$^{2+}$) as $[\text{Co}^{2+}_{0.3}\text{Fe}^{2+}_{0.5}]^A[\text{Cr}^{3+}_{0.2}]^B\text{O}_2^4$ at all temperature range. $T_J$ temperature in Jahn-teller distortion is $T_J = 155$ K, since $E_Q$ decreases rapidly above $T_C = 86$ K and disappears around 155 K as shown in Fig. 2.


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![Fig. 1](image_url) FIG. 1. Temperature dependence of zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves under 1000 Oe and hyperfine field $H_{hf}$ of $\text{Co}_{0.5}\text{Fe}_{0.5}\text{Cr}_2\text{O}_4$ ranging from 4.2 to 300 K.