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Synthesis and magnetic properties of geometrical frustration system \( \text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4 \)

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We have investigated crystallographic and magnetic properties for \( \text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4 \) by x-ray, Mössbauer spectroscopy, and superconducting quantum-interference device (SQUID) magnetometry. X-ray analysis for polycrystalline \( \text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4 \) indicates trigonal structure with space group P-3m1. Fig 1. shows the temperature dependence of susceptibility \( \chi \) in zero-field-cooled (ZFC) and field-cooled (FC) magnetization under 100 Oe for \( \text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4 \). The magnetic behavior shows an antiferromagnetic character with Curie-Weiss temperature, \( \theta_W = -149 \) K and the strong frustration factor, \( f = 5.63 \) defined as \( |\theta_W|/T_N \). The effective moment was obtained to be \( \mu_{\text{eff}} = 4.34 \mu_B \), which has almost same result of calculation, \( \mu_{\text{eff}} = 4.41 \mu_B \) with only assuming spin contribution. The Mössbauer spectra show severely distorted 8-line shape due to large electric quadrupole interaction at 4.2 K. The charge state of Fe ions is ferrous (Fe\(^{2+}\)) as characterized by isomer shift \( \delta = 0.60 \) mm/s at room temperature.

![Graph of susceptibility vs. temperature](image)

Fig 1. The susceptibility for SQUID magnetometer data, under \( H = 100 \) Oe, and zero-field-cooled (ZFC) and field-cooled (FC) curve for \( \text{Ni}_{0.3}\text{Fe}_{0.7}\text{Ga}_2\text{S}_4 \).