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Study on the Geometrically-frustrated Magnet $Ni_{1/2}Fe_{1/2}Ga_2S_4$

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We have investigated the spin-lattice relation in geometrical frustration by using an X-ray diffractometer (XRD), a superconducting quantum interference device (SQUID) magnetometer, and a Mössbauer spectroscopy. The crystal structure of the $Ni_{1/2}Fe_{1/2}Ga_2S_4$ studied here, was determined to be a 2-D triangular lattice structure of *P-3m1* with lattice parameters of $a_0 = 3.650$ Å, and $c_0 = 12.040$ Å. From the temperature dependence of the molar susceptibility in an applied high field of $H = 5$ T measured by using a SQUID magnetometer, $Ni_{1/2}Fe_{1/2}Ga_2S_4$ had a strongly antiferromagnetic behavior due to the Curie-Weiss temperature θ_W = -71.6 K. The freezing temperature at the onset of the spin-freezing transition was $T_f = 10.0$ K under a low field of $H = 100$ Oe, similar to a spin glass system, and the frustration parameter was f ($|\theta_W|/T_N$) = 3.25. From the Mössbauer spectrum at 4.2 K, we noticed a severely distorted 8-line shape coming from spin fluctuations and an incommensurate spin structure. The freezing temperature ($T_f = 10$ K) related to the electric spin disorder was different from the Néel temperature ($T_N = 22$ K) influenced by microscopic disorder of the nuclear spin due to a strained spin caused by the distorted lattice from geometrical frustration, as indicated in the Mössbauer spectra.

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