Ground states of a system of classical spins on an anisotropic triangular lattice and the spin-liquid problem in NiGa$_2$S$_4$ and FeGa$_2$S$_4$ compounds

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It is shown that the ground states of a system of classical spins on an anisotropic triangular lattice with interactions within an elementary triangular plaquette can be constructed by minimizing the energy of a single plaquette. Even in the case when all three angles between plaquette spins are different, there exist five global ground-state configurations with equal energies. The most complex of these is an incommensurate four-sublattice conical spiral structure. Our results may shed some new light on the experimentally observed spin-liquid-like disorder in NiGa$_2$S$_4$ and FeGa$_2$S$_4$ where a four-sublattice spin structure were observed.

Figure I: An example of four-sublattice spin configuration on an anisotropic triangular lattice. The angles between neighboring spins are equal to $\alpha$, $\beta$, and $\gamma$. The cones for different sublattices are depicted in different colors. Within each sublattice, the spin structure is a simple spiral conical structure but on a triangular lattice with doubled lattice periods. The axes of all the cones are parallel.