The spin-1 two-dimensional J_1-J_3 Heisenberg model on a triangular lattice

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Motivated by the experimental data for $NiGa_2S_4$, the spin-1 Heisenberg model on a triangular lattice with the ferromagnetic nearest- and antiferromagnetic third-nearest-neighbor exchange interactions, $J_1 = -(1-p)J$ and $J_3 = pJ, J > 0$, is studied in the range of the parameter $0 \leq p \leq 1$. Mori's projection operator technique is used as a method which retains the rotation symmetry of spin components and does not anticipate any magnetic ordering. For zero temperature several phase transitions are observed. At $p \approx 0.2$ the ground state is transformed from the ferromagnetic spin structure into a disordered state, which in its turn is changed to an antiferromagnetic long-range ordered state with the incommensurate ordering vector $Q \approx (1.16, 0)$ at $p \approx 0.31$. With growing p the ordering vector moves along the line Q-Q_1 to the commensurate point $Q_1 = (2\pi/3, 0)$ which is reached at $p = 1$. The final state with an antiferromagnetic long-range order can be conceived as four interpenetrating sublattices with the 120° spin structure on each of them. We compare these results with the exact-diagonalization data obtained by the SPINPACK code.