Frustrated Heisenberg spin models defined on a kagome-lattice strip*

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The quest for exotic quantum states in simple yet realistic spin models remains a challenge in the field of quantum magnetism. In this respect, the Heisenberg models defined on one-dimensional cuts from the kagome lattice (strips) represent intriguing spin systems exhibiting, as a rule, macroscopically degenerate classical ground sates. Using both large-spin semiclassical as well as exact-diagonalization numerical techniques, we analyze the quantum phase diagrams of uniform- and mixed-spin Heisenberg kagome strips containing five spins in the unit cell (S, $\sigma_i = \sigma$, $i = 1, 2, \cdots, 4$), which are placed on the central (S) and on the end (σ) sites of the unit-cell spin cluster. For the uniform-spin system ($S = \sigma = \frac{1}{2}$), we (i) re-examine the previously established phase diagram close to the boundary of the critical spin phase–i.e., the GS of a Heisenberg chain with an effective site spin $\frac{3}{2}$)–and (ii) extend the phase diagram by including the case of ferromagnetic nearest-neighbor $S - \sigma$ exchange bonds. For the mixed-spin $(S, \sigma) = (1, \frac{1}{2})$ system, we demonstrate that the critical spin-$\frac{3}{2}$ and spin-$\frac{5}{2}$ phases in the uniform case transform to Haldane-type gapped phases with effective site spins 1 and 3, respectively.

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