Heterobimetallic Dy-Cu coordination compound as a classical-quantum ferrimagnetic chain of regularly alternating Ising and Heisenberg spins

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A classical-quantum chain composed of regularly alternating Ising and Heisenberg spins is rigorously solved by considering two distinct local anisotropy axes of the Ising spins. The ground-state phase diagram and magnetization curves are examined depending on a spatial orientation of the applied magnetic field. The phase diagram totally consists of four distinct phases and a few macroscopically degenerate points, where an outstanding coexistence of perfect order and complete disorder occurs within the so-called 'half-fire, half-ice' state. The zero-temperature magnetization curves generally exhibit a smooth dependence on a magnetic field owing to a canting angle between two coplanar anisotropy axes of the Ising spins, which enforces a misalignment of the magnetization vector from a direction of the applied magnetic field. It is evidenced that the investigated spin-chain model reproduces magnetic features of the heterobimetallic coordination compound Dy(NO)$_3$(DMSO)$_2$Cu(opba)(DMSO)$_2$. The heterobimetallic polymeric complex Dy(NO)$_3$(DMSO)$_2$Cu(opba)(DMSO)$_2$, which will be hereafter referred to as Dy-Cu, involves 1D chain of exchange-coupled Dy$^{3+}$ and Cu$^{2+}$ ions as a magnetic backbone. Consequently, the polymeric compound Dy-Cu can be regarded as an experimental realization of the spin-1/2 Ising-Heisenberg chain with regularly alternating Ising and Heisenberg spins, which capture a magnetic behavior of highly anisotropic Dy$^{3+}$ and almost isotropic Cu$^{2+}$ magnetic ions, respectively. The high-field magnetization data reported for the powder sample of this polymeric coordination compound generally display a substantial smoothing on account of a powder averaging.