Magnetization processes and magnetocaloric effect of the Ising model on the octahedral lattice

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The magnetocaloric effect and magnetization processes of the extended Ising model on the 3-dimensional octahedral lattice are studied by the classical Monte Carlo method with Metropolis algorithm. It is shown that different combinations of antiferromagnetic and ferromagnetic nearest-neighbor interactions J_1 and J_2 (in particular $J_1 = -1$, $J_2 = 1$ and $J_1 = -1$, $J_2 = -1$) lead to the fundamentally different magnetic behaviors at nonzero temperatures, despite the fact that zero-temperature magnetization curves have exactly the same form. The reason is that the spin configurations forming zero-temperature magnetization plateaus for both $J_2 = -1$ and $J_2 = 1$ are different, and different are also their temperature evolutions (controlled by calculations of in-plane and inter-plane sublattice magnetizations), which lead to different results for the magnetic entropy change (the magnetocaloric effect). Due to this fact a much higher positive entropy change is observed for the ferro-antiferromagnetic system compared to the pure antiferromagnetic system.