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Long and short-range interactions, phase transitions and crossovers of dipolar spin ice on Cairo lattice

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We performed the Metropolis calculations of the thermodynamic properties of the system of dipoles on a 2D pentagonal Cairo lattice and revealed two explicit peaks in the temperature behavior of the heat capacity. This system is a sort of spin ice, which was experimentally studied in [Phys. Rev. Materials 3, 104402, 2019].
The low-temperature peak is due entirely to long-ranged dipole-dipole interactions between the vertically and horizontally directed spins, while all other, including nearest-neighbor dipole-dipole interactions are fully compensated (internal energy is 0).
We show the temperature behavior of the correlations between dipoles at different distances.
Models with a radius limited to the nearest neighbors lead to macroscopic degeneration of the ground state and the absence of a phase transition, since the configuration of the ground state phase is not defined.

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