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Magnetism in the two-dimensional dipolar XY model

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Motivated by a recent experiment on a square-lattice Rydberg atom array realizing a long-range dipolar XY model [Chen et al., Nature (2023)], we numerically study the model's equilibrium properties. We obtain the phase diagram, critical properties, entropies, variance of the magnetization, and site-resolved correlation functions. We consider both ferromagnetic and antiferromagnetic interactions and apply quantum Monte Carlo and pseudo-Majorana functional renormalization group techniques, generalizing the latter to a U(1) symmetric setting. Our simulations open the door to directly performing many-body thermometry in dipolar Rydberg atom arrays. Moreover, our results provide new insights into the experimental data, suggesting the presence of intriguing quasi-equilibrium features, and motivating future studies on the non-equilibrium dynamics of the system.

Ref :
[1] B. Sbierski, M. Bintz, S. Chatterjee, M. Schuler, N. Y . Yao, L. Pollet, arXiv:2305.03673 (2023)

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