Quantum spin models with long-range interactions and tunnelings: A quantum Monte Carlo study.

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Abstract

We use a quantum Monte Carlo method to investigate various classes of 2D spin models with long-range interactions at low temperatures. In particular, we study a dipolar XXZ model with U(1) symmetry that appears as a hard-core boson limit of an extended Hubbard model describing polarized dipolar atoms or molecules in an optical lattice. Tunneling, in such a model, is short-range, whereas density-density couplings decay with distance following a cubic power law. We investigate also an XXZ model with long-range couplings of all three spin components - such a model describes a system of ultracold ions in a lattice of microtraps. We describe an approximate phase diagram for such systems at zero and at finite temperature, and compare their properties. In particular, we compare the extent of crystalline, superfluid, and supersolid phases. Our predictions apply directly to current experiments with mesoscopic numbers of polar molecules and trapped ions.

References

[1] M. Maik, P. Hauke, O. Dutta, J. Zakrzewski and M Lewenstein, arXiv:1206.1752v1 (2012)