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Strong long-range interactions and geometrical frustration in subwavelength lattices

Non-local interactions are the key building block to allow for a spontaneous breaking of the translational symmetry. The latter represents one of the most fundamental symmetries in physics as it reflects the formation of periodic structures of mass and electric charge. Quantum matter with such a feature falls in the class of spontaneously symmetry broken (SSB) many-body phases with broken translational invariance. Their ubiquity in nature has made the investigation and creation of such states of matter of central importance. In this respect, quantum simulators made of ultracold magnetic atoms with large magnetic dipolar momentum (e.g., erbium) represent a promising and powerful resource. However, current setups only explore frustrated regimes with weak local interactions or regimes where quantum fluctuations are suppressed. To the best of our knowledge, there are no experimental schemes able to simultaneously realize long-range interactions and geometrical frustration.

Here we consider a possible alternative to current setups - a recently realized subwavelength lattice formed by a pair of counter-propagating lasers driving two photon Raman transitions in an ensemble of ultracold atoms. It was shown that one may precisely control the tunneling amplitude, range, and phase by tuning the detunings. One also achieves significantly stronger interactions in the proposed scheme due to its subwavelength nature. Thus, one may realize intriguing phases of matter, such as density waves and chiral superfluids. Our results show several possible scenarios may occur, depending on the lattice depth and detunings.

References

[1] R. P. Anderson et al., Phys. Rev. Research 2, 013149 (2020).
[2] D. Burba et al., Phys. Rev. A 107, 023309 (2023).

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