Density-Dependent Transport of Rydberg Excitations: Quantum Gauge Fields and Topological Phases

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Recent experiments have demonstrated that spin-orbit coupling in Rydberg atoms can give rise to density-dependent Peierls phases associated with the transport of Rydberg spin excitations in atom arrays [1]. This nonlinear hopping provides a natural way for the implementation of a variety of non-trivial spin systems ranging from topological lattice models to lattice gauge theories, anyon physics and spin liquids. Two specific models will be discussed in more detail, a one-dimensional zig-zag ladder and a two-dimensional honeycomb lattice. Here the competition between density-density interaction, linear and nonlinear transport and frustration gives rise to a variety of interesting phases and phenomena. In the zig-zag model effective quantum gauge fields emerge leading current vortices. In the honeycomb model we find some evidence for a bosonic quantum Hall phase.

References

[1] V Lienhard, P Scholl, S Weber *et al.*, Phys. Rev. X **10**, 021031 (2020)