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Quantum synchronization of ultracold atoms with dipole-dipole interactions in an optical lattice[1] BIHUI ZHU, JILA, JUAN RESTREPO, Department of Applied Mathematics, CU Boulder, ANA MARIA REY, MURRAY HOLLAND, JILA — Ultracold atoms confined in an optical lattice have been utilized as a powerful platform to study versatile many-body physics both experimentally and theoretically. A recent research focus has been the novel phenomena that would emerge with long-range interactions, which become especially important for atomic clocks where ultrahigh precision can amplify these effects. We develop theoretical models treating the two-level atoms as oscillators and study the synchronization of phases among a large ensemble of atoms coupled by dipole-dipole interactions, where the effect of geometry becomes relevant. We investigate the onset of synchronization and the related phase diagram, and further discuss the parameter regime for potential experimental observation using ultracold atoms such as Strontium. By applying different numerical methods, eg., quantum trajectories and truncated Wigner approximations to compare with the mean-field results, we also explore the underlying role of quantum fluctuations.

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