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Luttinger Liquid phase of chains of Rydberg atoms

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We study an effective model of chains of Rydberg atoms in which particles are created/annihilated three by three. The model provides a dual description of a commensurate-incommensurate transition out of a period-3 phase. A bosonization of the Hamiltonian combined with a RG analysis suggests the stability of a Luttinger Liquid phase separating a $\mathbb{Z}_3$-ordered phase and a disordered phase. Inside the Luttinger Liquid phase, DMRG simulations of the correlations of p hard-core bosons show a deviation at long distances from the well-known power law decay with an exponent proportional to p^2. We argue that this behavior is due to the non-conservation of the number of particles in the system. The flow equation method is applied to calculate the form of hard-core bosons operators in a basis that diagonalizes the Hamiltonian, while taking into account the Klein factors in the bosonization formulas. Close to zero filling, the system is believed to undergo a phase transition in the non-conformal Pokrovsky-Talapov universality class. We discuss a possible scenario where a Lifshitz point terminates the Luttinger Liquid phase along the Pokrovsky-Talapov transition line.