Fermionization in optical quasicrystals and one-dimensional bosonic hard rods

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Quasicrystals, a fascinating class of materials with long-range but nonperiodic order, have revolutionized our understanding of solid-state physics due to their unique properties at the crossroads of long-range-ordered and disordered systems. The quantum simulation of quasicrystals in synthetic quantum matter systems offers a unique playground to investigate these systems with unprecedented control parameters. It is shown that there exists a Mott phase in the strongly interacting regime, accompanied with a fermionization phenomenon [1, 2, 3]. The strong repulsive interaction makes particles separated in space, resembling free fermions. However, due to the existence of some annular traps, the spatial separation does not apply to those subsystems, leading to an energy shift on the equation of state. It turns out that those annular traps can be modelized as one-dimensional systems consisting of some hard rods. We give the exact solution of one-dimensional quantum hard rods and thermodynamics. Correlation functions are compared with Luttinger liquid theory.

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