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Лаборатория теоретической физики

СЕМИНАР ПО ТЕОРИИ КОНДЕНСИРОВАННЫХ СРЕД

Очередное заседание семинара состоится

5 июля (вторник), в 16:00
в аудитории им. Блохинцева и в Zoom
https://us02web.zoom.us/j/88660481447?pwd=OOqfPsSJkijbxsavp0Rhzt3jkZa_qu.1
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Spinful hard-core bosons on a ring: a promising two-level system

Kesharpu Kaushal K. (BLTP JINR), Kochetov Evgenii A.

Motivation: Recent technical progresses in trapping of individual cold atoms and ions on a microfabricated structure using optical tweezers and Paul traps allow one to create large number of ring like structure on a single substrate. In fact, the total number of particles and their positions can be controlled with high fidelity and accuracy in these rings. It motivated us to consider the system of *spinful* hard-core bosons on a ring of *L* sites away from thermodynamic limit. Although, some works have already been done to find the energy spectrum of hard-core bosons on a ring, but most of them are related either to the *spinless* hard-core bosons on a ring, or to the spinful bosons on *N×N* plaquettes. But explicit work on spinful bosons on a ring is still missing. Hence, we calculated the energy levels and the ground state energies of *N* spinful hard-core bosons on a ring of *L* sites, corresponding to the periodic and antiperiodic boundary condition, away from the thermodynamic limit ($N < L$ is finite and countable). We also considered the effect of magnetic field on the ground state energies and energy levels.

Results: We found that, for the periodic boundary condition the ground state is ferromagnetic ($S=N/2$; S is the total spin of the ring: $S=\sum_{i=1}^{N} s_i$) only for $N=2,3$. However, for the antiperiodic boundary condition only for $N=3$ the ground state is ferromagnetic. For all other N the ground state is either a mixture of ferromagnetic and non-ferromagnetic phases ($S=N/2-1$, $N/2-2$, …), or a mixture of only non-ferromagnetic phases. Interestingly the single spin flipped state ($S=N/2-1$) is available only for even $N = 2, 4, \ldots$ with antiperiodic boundary condition. We also observed that, by applying appropriate low magnetic field ($\Phi_B \sim \Phi_0$) the ferromagnetic phase may be made the ground state. This behavior is periodic with period $\Phi_B = L\,\Phi_0$; here, Φ_0 is the magnetic flud quantum.

Physical application: We propose few experiments for realization of this system using spinor bosons and optical tweezers, as well as, using Paul traps and ions of spinor bosons. We discuss the possible applications of the spinful bosonic ring in quantum computers and quantum simulations.

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