Seminar

Quantum simulations of dipolar XY model with Rydberg atom arrays

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Laboratoire Charles Fabry, Institut d'Optique Graduate School

Time: 15:00pm, March 26 2024 (Tuesday)
时间: 2024年03月26日 （周二）下午3:00
Venue: Room W563, Physics building, Peking University
地点：北京大学物理楼，西563会议室

Abstract

In this talk, I will present the experimental realization of the two-dimensional dipolar XY model using a programmable Rydberg quantum simulator. Our setup allows us to explore quantum many-body physics in regimes where numerical simulation becomes challenging. First, we demonstrate the adiabatic preparation of both the dipolar XY ferromagnetic and antiferromagnetic state. In the ferromagnetic case, we characterize the presence of a long-range XY order, a feature prohibited in the absence of long-range dipolar interaction [1]. Second, motivated by recent theoretical works [2,3], we explore the prediction that the two-dimensional dipolar XY model can enable the realization of scalable spin squeezing. Experimentally we demonstrate that quench dynamics from a polarized initial state lead to spin squeezing that improves with increasing system size up to a maximum of -3.5 ± 0.3 dB[4]. Third, we investigate the quench spectroscopy of the dipolar XY model and extract the dispersion relation from the time evolution of correlations [5]. Respectively starting from a ferromagnetic or an antiferromagnetic initial state, we get significantly different dispersion relations of the two phases, corresponding to $\sim\sqrt{(|k|)}$ and $\sim|k|$, demonstrating the importance of power-law interactions on the excitation spectrum of a many-body spin system [6]. Recently, we investigate on experimental measurement of quantum tomography on our platform and demonstrate the ability to prepare correlated states distinguished only by correlations of their chirality[7].

References

[1] C. Chen et al., Nature 616, 691–695 (2023).
[2] T. Comparin et al., Phys. Rev. Lett., 129(11), 113201 (2022).
[3] M. Block et al., arXiv:2301.09636.
[4] G. Bornet et al., Nature 621, 728–733 (2023).
[5] C. Chen et al., arXiv: 2311.11726.
[6] D. Peter et al., Phys. Rev. Lett., 109(2), 025303 (2012).
[7] G. Bornet et al., arXiv:2402.11056 (2024).

About the Speaker

Cheng Chen is currently a postdoctoral researcher in the "Quantum Optics – Atoms" group at Institut d'Optique Graduate School (supervisor: Antoine Browaeys). From 2011 to 2015, he studied at the University of Science and Technology of China and got a Bachelor's degree in physics. From 2015 to 2021, he pursued his Ph.D. at Tsinghua University, with Professor Li You and Associate Professor Meng Khoon Tey. Since September 2021, he has been a postdoctoral researcher working on experimental quantum simulation using Rydberg atom arrays in France. His current research interests are Rydberg atom arrays, the dipolar XY model, Quantum simulation, and quantum many-body systems.