Towards quantum simulation of spin wave modes in quantum dot arrays

Tzu-Kan Hsiao[1,2]
Tien-Ho Chang[1], Chia-Hao Wei[1], Kim Chye Cheng[1], Jian-Chang Zeng[1], Fu-Yuan Gu[1], Yin-Chuan Lai[1], Jun-Yang Yuan[1], and Chi-Wei Lee[1]

[1]*Department of Physics, National Tsing Hua University, Hsinchu 300044, Taiwan*
[2]*Center for Quantum Science and Technology, National Tsing Hua University, Hsinchu 300044, Taiwan*

tkhsiao@phys.nthu.edu.tw

Electrostatically-defined quantum dot arrays are a natural and versatile platform for quantum simulations of Fermi-Hubbard and Heisenberg physics [1]. In particular, the development of control and readout techniques has facilitated simulations of quantum magnetism such as Nagaoka ferromagnetism [2], Heisenberg antiferromagnetic spin chains [3], and resonating valence bond states [4]. Nevertheless, these experiments mainly focus on measuring local spin correlations instead of long-range spin correlation, which can provide more insights.

Here we propose an experiment to study quantized spin wave (magnon) modes, which play an important role in spintronics and quantum information processing [5]. Their long-range spin order makes the spin waves a good candidate for observing long-range spin correlations. We will describe experimental methods for preparing and probing the quantized spin wave modes in accessible quantum dot simulators. The long-range spin order can be confirmed by measuring the spin correlation as a function of distance. Finally, we will report our progress in device fabrication and measurement setup for this project.

References

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Figures

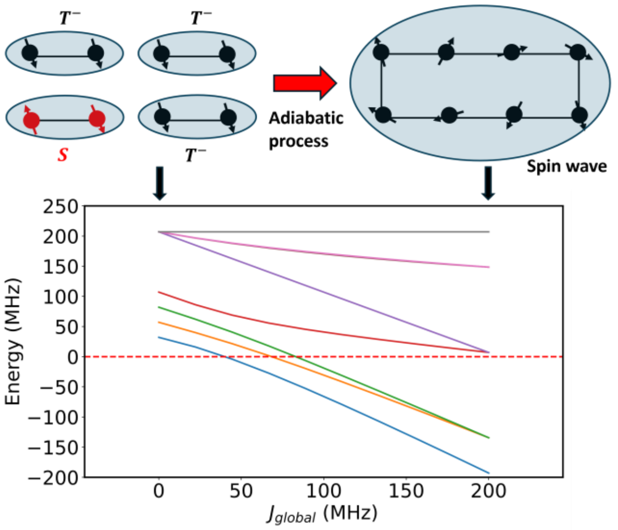

Figure 1: Top: As the system Hamiltonian is engineered from four decouple dimers to a ring, the eigenstates evolve from singlet-triplet product to spin wave states. Bottom: Energy spectrum of a subspace with seven down spins and one up spin.

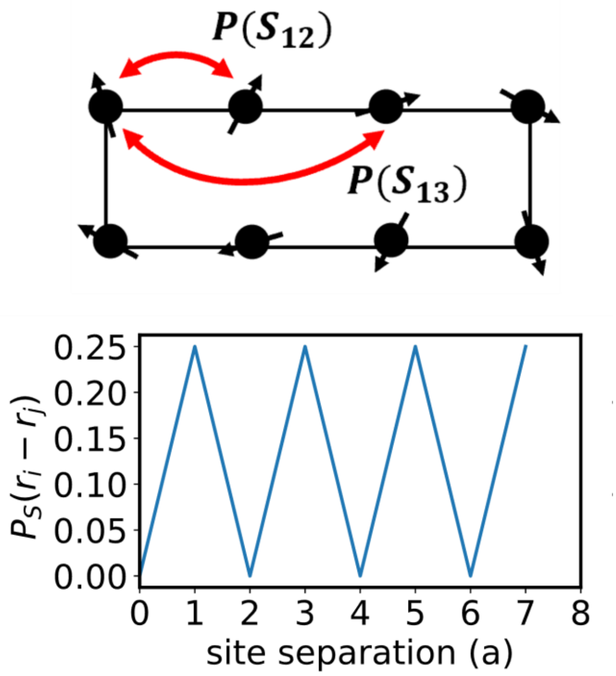

Figure 2: Top: Pauli-spin-blockade readout for spins in a spin wave state. Bottom: singlet projection probability as a function of site separation for the lowest spin wave state. The result shows the long-range spin correlation in the spin waves.