



**Yi Xu**

Prof. Andriy Nevidomskyy group

July 26, 2024, Friday

4 PM, SST 300

## **Simulating Spin Dynamics of Frustrated Magnets using Projected Entangled Pair States**

### **Abstract:**

Dynamical properties such as spin excitations are crucial in the exploration of exotic phases in various quantum materials. However, simulating such dynamical properties turns out to be challenging when both frustration and quantum fluctuation both play important roles, promoting the emergence of various exotic phases such as quantum spin liquids. Spin-1/2 triangular lattice Heisenberg model is one representative example where the linear spin wave theory fails to provide a legitimate description.

Here, motivated by the recent experimental study on a quantum Ising magnet  $K_2Co(SeO_3)_2$  where spectroscopic evidence of zero-field supersolidity is presented [1, 2], we present our numerical attempts [3] to simulate the excitation spectrum of the corresponding microscopic XXZ model for the compound, using the recently developed excitation ansatz of infinite projected entangled-pair states (iPEPS). We map out the ground state phase diagram and compute the dynamical spin structure factors across a range of magnetic field strengths, focusing especially on the two supersolid phases found near zero and saturation fields. Our simulated excitation spectra for the zero-field supersolid “Y” phase are in excellent agreement with the experimental data – recovering the low-energy branches and integer quantized excited energy levels  $\omega_{n=nJ_{zz}}$ . Additionally, we identify characteristics of the high-field supersolid “ $\Psi$ ” phase in the simulated spectra, to be compared with future experimental results.

Towards the end of the talk, I will briefly discuss several different triangular lattice compounds [4-6], and also the strengths of our method compared to other numerical works [6-8].

- [1] T. Chen, A. Ghasemi, J. Zhang, L. Shi, Z. Tagay, L. Chen, E.-S. Choi, M. Jaime, M. Lee, Y. Hao, H. Cao, B. Winn, R. Zhong, X. Xu, N. P. Armitage, R. Cava, and C. Broholm, arXiv:2402.15869.
- [2] M. Zhu, V. Romerio, N. Steiger, S. D. Nabi, N. Murai, S. Ohira-Kawamura, K. Yu. Povarov, Y. Skourski, R. Sibille, L. Keller, Z. Yan, S. Gvasaliya, A. Zheludev, arXiv:2401.16581.
- [3] YX, J. Hasik, B. Ponsioen, A. H. Nevidomskyy, arXiv:2405.05151
- [4] J. Xiang, C. Zhang, Y. Gao, W. Schmidt, K. Schmalzl, C.-W. Wang, B. Li, N. Xi, X.-Y. Liu, H. Jin, G. Li, J. Shen, Z. Chen, Y. Qi, Y. Wan, W. Jin, W. Li, P. Sun, and G. Su, Nature 625, 270 (2024).
- [5] J. Ma, Y. Kamiya, Tao Hong, H. B. Cao, G. Ehlers, W. Tian, C. D. Batista, Z. L. Dun, H. D. Zhou, and M. Matsuda, Phys. Rev. Lett. 116, 087201 (2016)
- [6] R. Chi, Y. Liu, Y. Wan, H.-J. Liao, and T. Xiang, Phys. Rev. Lett. 129, 227201 (2022).
- [7] R. Chi, J. Hu, H.-J. Liao, and T. Xiang, arXiv:2404.14163.
- [8] Y. Gao, C. Zhang, J. Xiang, D. Yu, X. Lu, P. Sun, W. Jin, G. Su, and W. Li, arXiv:2404.15997

### **Bio:**

Yi Xu is a graduate student from the group of Prof. Andriy Nevidomskyy from the Department of Physics and Astronomy. His research interests include frustrated magnetism, exotic phases of matter including quantum spin liquids, and quantum criticality.

*Snacks and Coffee will be served during the event. Wine & cheese will be served after the talk. Everyone is welcome to stay around after the seminar for further informal discussions.*