Contribution ID: **118** Type: **Invited**

Exploring quantum spin models with Rydberg atom arrays

Rydberg atoms in arrays of optical tweezers offer a new perspective for quantum simulation of many body problems. In this talk, I will give a brief overview about this platform and describe our efforts to control Rydberg interactions to explore different types of spin Hamiltonians. I will report on our recent implementations of the 2D Ising Hamiltonian [1] and the dipolar XY model [2] with more than 100 spins to study quantum magnetism. Furthermore, I will illustrate how the dipolar XY model can be used to generate scalable spin squeezing [3], which could be exploited for metrological applications. Finally, I will show our first steps to scale up the atom numbers in our platform by using a cryogenic environment [4].
References:
[1] Quantum simulation of 2D antiferromagnets with hundreds of Rydberg atoms, Scholl et al., Nature 595, 233 (2021).
[2] Continuous symmetry breaking in a two-dimensional Rydberg array, Chen et al., Nature (2023).
[3] Scalable spin squeezing in a dipolar Rydberg atom array, Bornet et al., arXiv:2303.08053
[4] Single atoms with 6000-second trapping lifetimes in optical-tweezer arrays at cryogenic temperatures, Schymik et al., Phys. Rev. Applied 16, 034013 (2021).

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