Contribution ID: **36** Type: **Invited talk**

Hamiltonian engineering using Bragg matter-wave interferometers in an optical cavity

Tuesday 3 September 2024 14:00 (40 minutes)

Cavity-QED systems have emerged as a powerful platform for generating highly entangled states, with significant implications for both quantum metrology and quantum simulation. A particular setting that has gained great interest for Bragg matterwave interferometry, and thus inertial navigation and fundamental science, is an array of free-falling atoms inside a cavity where one can encode a pseudo-spin ½ degree of freedom using a pair of selected momentum states, which are coupled by the cavity photons.
I will show this system not only is suitable for the generation of a spin exchange Hamiltonians via two photon processes, but also arbitrary collective tunable Heisenberg XYZ models without the need of Floquete engineering. This can be done via cavity-mediated four-photon or higher photon interactions with two dressing lasers in a high finesse cavity. In particular I will report on how to dynamically generate the so-called two-axis counter-twisting model, a special type of collective XYZ model proposed more than 30 years ago for the fast generation of spin squeezed states that saturate the Heisenberg bound. In general I will discuss why this system opens a unique pathway for the use of momentum states for quantum enhanced interferometry and quantum simulation.

References

Momentum-exchange interactions in a Bragg atom interferometer suppress Doppler dephasing
Luo C., H. Zhang, V.P.W. Koh, J.D. Wilson, A. Chu, M.J. Holland, A.M. Rey, and J.K. Thompson, Science 384, 551-556 (2024).

Hamiltonian Engineering of collective XYZ spin models in an optical cavity: From one-axis twisting to two-axis counter twisting models
Chengyi Luo, Haoqing Zhang, Anjun Chu, Chitose Maruko, Ana Maria Rey, James K. Thompson, arXiv:2402.19429

Short bio (50 words) or link to website

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Relevant publications (optional)

Career stage

Professor

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Track Classification: FINESS