



Contribution ID: 130

Type: **Invited/Keynote talk**

Experiments on mass and momentum-entangled pairs of ultracold He* atoms

Monday 1 December 2025 14:00 (30 minutes)

Nonlocal entanglement between pair-correlated particles is a highly counter-intuitive aspect of quantum mechanics. While the rigorous Bell's inequality framework has enabled the demonstration of such entanglement in photons and atomic internal states, no experiment has yet involved motional states of massive particles. Here we report the experimental observation of Bell correlations in motional states of momentum-entangled ultracold helium atoms, with entanglement generated via s-wave collisions. Using a Rarity-Tapster interferometer and a Bell-test framework, we observe atom-atom correlations sufficient to violate a Bell inequality. A theoretical proposal is also discussed for how this system could be extended to an entangled state of different mass atoms generated between ^3He and ^4He collisions. This would potentially open new avenues for studying gravitational effects in quantum states.

Author: HODGMAN, Sean (The Australian National University)

Co-authors: Mr ATHREYA, Yogesh (The Australian National University); Mr KANNAN, S (The Australian National University); Mr YAN, Xintong (The Australian National University); Prof. TRUSCOTT, Andrew (The Australian National University); Prof. KHERUNTSYAN, Karen (University of Queensland)

Presenter: HODGMAN, Sean (The Australian National University)

Session Classification: Focus Session: Ultra-cold atoms and quantum technology

Track Classification: Focus sessions: Ultracold Atoms and Quantum Technology