Searching for ultralight dark matter with trapped-ion interferometry

Thursday 27 March 2025 13:35 (15 minutes)

We explore how recent advancements in the manipulation of single ionic wave packets open new avenues for detecting weak magnetic fields sourced by ultralight dark matter. By leveraging the entanglement between the ion's spin and motional degrees of freedom, proposed trapped-ion matter-wave interferometers enable the measurement of the Aharonov-Bohm phase accumulated by the ion over its trajectory, which results in a parametric enhancement of the sensitivity to weak magnetic fields. Considering the relevant boundary conditions, we demonstrate that a single trapped ion can probe unexplored regions of dark photon dark matter parameter space in the 10^{-15} eV

 $lesssimm_{A'}$

 $lesssim 10^{-14}$ eV mass window. We also show how these table-top quantum devices will serve as a complementary probe of axion-like particle dark matter in the same mass window.

Author: BADURINA, Leonardo (California Institute of Technology)

Co-authors: BLAS, Diego (UAB/IFAE); ELLIS, Jonathan R. (King's College London); ELLIS, Sebastian

Presenter: BADURINA, Leonardo (California Institute of Technology)

Session Classification: SESSION 17: Direct detection Recent Developments II & New Concepts (CHAIR: Paul Hamilton -UCLA)