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Coulomb interaction-driven entanglement of electrons on helium

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The generation and evolution of entanglement in many-body systems is an active area of research that spans multiple fields, from quantum information science to the simulation of quantum many-body systems encountered in condensed matter, subatomic physics, and quantum chemistry. Motivated by recent experiments exploring quantum information processing systems with electrons trapped above the surface of cryogenic noble gas substrates, this talk will present an theoretical investigation of the generation of motional entanglement between two electrons via their unscreened Coulomb interaction. The model system consists of two electrons confined in separate electrostatic traps which establish microwave-frequency quantized states of their motion. We have computed the motional energy spectra of the electrons, as well as their entanglement, by diagonalizing the model Hamiltonian with respect to a single-particle Hartree product basis. The computational procedure outlined here can be employed for device design and guidance of experimental implementations. In particular, the theoretical tools developed here can be used for fine tuning and optimization of control parameters in future experiments with electrons trapped above the surface of superfluid helium or solid neon.

The talk is based on the paper "Coulomb interaction-driven entanglement of electrons on helium" by Beysengulov, Schøyen, Bilek, Flaten, Leinonen, et al. [1], which is currently under review.

[1] https://arxiv.org/abs/2310.04927

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