Contribution ID: **146** Contribution code: **MOCO3** Type: **Contributed Oral**

# Proposal for a Quantum Free Electron Laser Driven by Ultracold Electrons

*Monday, 22 August 2022 15:10 (25 minutes)*

Operation of a Quantum Free-Electron Laser (QFEL) could provide fully coherent X- and gamma-rays in a compact setup. Imperative to experimental realization is allowing for decoherence of either spontaneous emission or space-charge to take place, having opposing constraints [1]. Here, for the first time, we discuss a comprehensive QFEL model that takes into account both decoherence effects. Then, we use this model to investigate the ultracold electron source (UCES) [2] as a potential QFEL electron injector. The UCES, based on near-threshold photoionization of laser-cooled and trapped atomic gas, has the unique property of allowing highly charged electron bunches to be extracted while maintaining ultralow transverse emittance. We find that the ultracold electron bunches meet the stringent requirement for potential QFEL operation with commercially available laser systems.

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**Session Classification:** FEL Theory

**Track Classification:** FEL Theory