



Old Dominion University Department of Physics

Virtual Colloquium

**Tuesday, March 30, 2021
3:00 pm**

"Entanglement-Enhanced Optical Atomic Clocks: Engineering the new class of quantum devices"

**Dr. Pedrozo Penafiel
MIT**

Abstract: Optical atomic clocks are the most precise devices ever invented by human-kind. They are based on the precise determination of the transition frequency between two atomic levels. State-of-the-art optical clocks have reached astonishing fractional frequency stabilities of 1 part in 10^{18} . The main limitation these devices face is the so-called standard quantum limit (SQL), which arises from the quantum projection noise associated with the discrete nature of the measurement process in a system of independent particles. However, the SQL is not a fundamental limit and can be overcome when quantum correlations (entanglement) are engineered among the atoms. Overcoming the standard quantum limit in the optical domain has been one of the main challenges in quantum metrology in the last three decades. In this talk, I will show how we generate quantum entanglement in an ultra-narrow optical-clock transition and improve phase determination in a Ramsey protocol [1]. This result paves the way for using quantum resources to surpass the SQL and approach the Heisenberg Limit in quantum sensors. Quantum-enhanced sensors are projected to be a fundamental piece in the search for new physics, detection of Dark Matter, gravitational waves, and applications to geodesy, among others.

BIO: Edwin Pedrozo Peñafiel received his Ph.D. in Physics from the University of Sao Paulo (Brazil) in 2016, where he worked on double species Bose-Einstein condensation. Since 2016, he is a postdoctoral researcher at the MIT-Harvard Center for Ultracold Atoms. Since then, Edwin is leading one of the five groups of professor Vladan Vuletic at MIT. The main goal is to engineer exotic quantum states to improve quantum sensors' precision. He is interested in quantum science and engineering and developing the new generation of quantum-enhanced atomic clocks.

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Dr. Pedrozo Penafiel,

MIT

Topic: Colloquium - Dr. Edwin Pedrozo Penafiel (MIT)

Time: Mar 31, 2021 02:15 PM Eastern Time (US and Canada)

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