



Contribution ID: 30

Type: **not specified**

Into the Elusive Universe – Probing Dark Matter with Precision Space Missions and Quantum Sensors

Monday 2 June 2025 10:00 (30 minutes)

Dark matter, neutrinos, and gravity interact feebly with the rest of the Standard Model particles, yet govern how the Universe evolves and operates. Together, they are the elusive parts of the Universe that have profound implications for particle physics, astrophysics, and cosmology. In this talk, I will use the planetary-defense mission, OSIRIS-REx, and the precision tracking data of the dangerous (potentially hazardous) asteroid Bennu, to establish new constraints on the gravitational interaction of dark matter in the solar system [1]. I will also utilize the ultra-precision astrometric data to set world-leading constraints on cosmic neutrino over density and hidden fifth forces.

Furthermore, I propose a space mission concept with quantum clocks (inspired by the NASA Deep Space Atomic Clock, DSAC) onboard a future solar probe (inspired by the Parker Solar Probe) to search for ultralight dark matter bound to the Sun [2]. Such a mission would allow us to probe theoretically motivated wave-like/fuzzy dark matter models with distinctive cosmic evolutions and particle-physics consequences. These works are in close collaboration with NASA JPL, ESA, and NIST, aiming to shed new light on the deepest questions of the Elusive Universe.

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Session Classification: UK-APP