# Space Quantum Sensor for Ultralight Dark Matter

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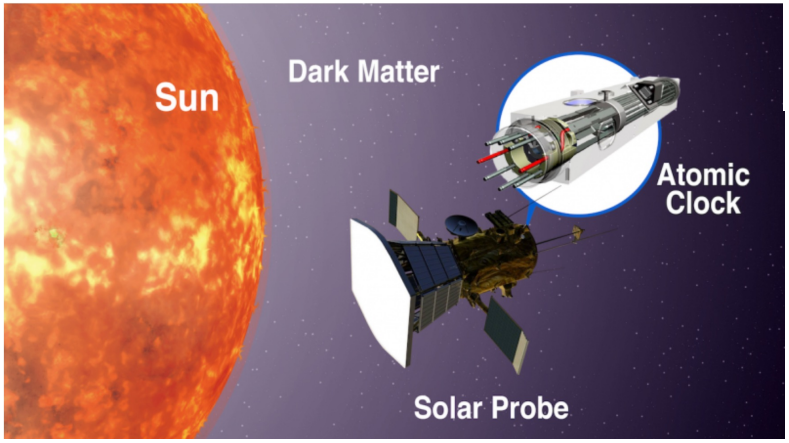
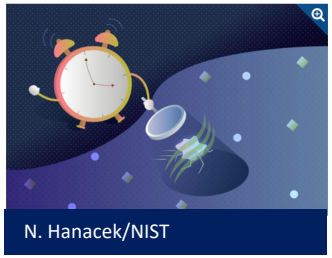
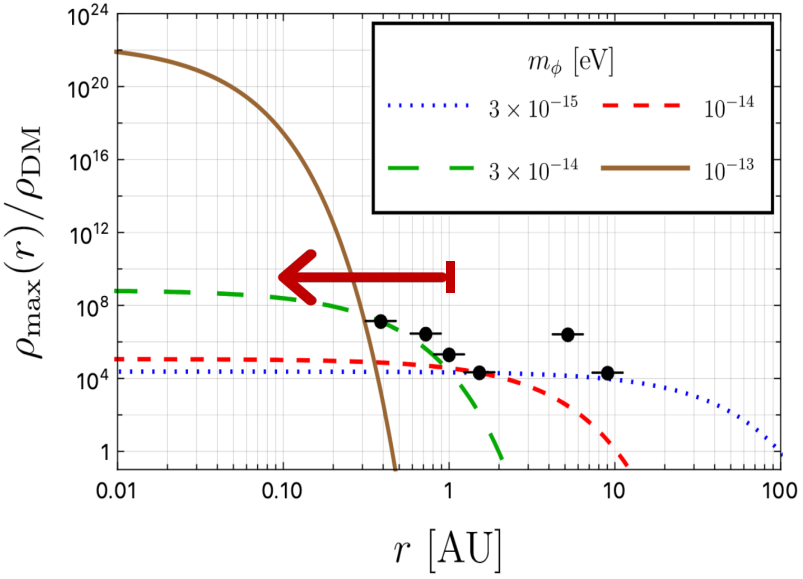
**Tsai**, Eby, Safronova, Nature Astronomy (2022) 2112.07674, featured by DOE Office of Science

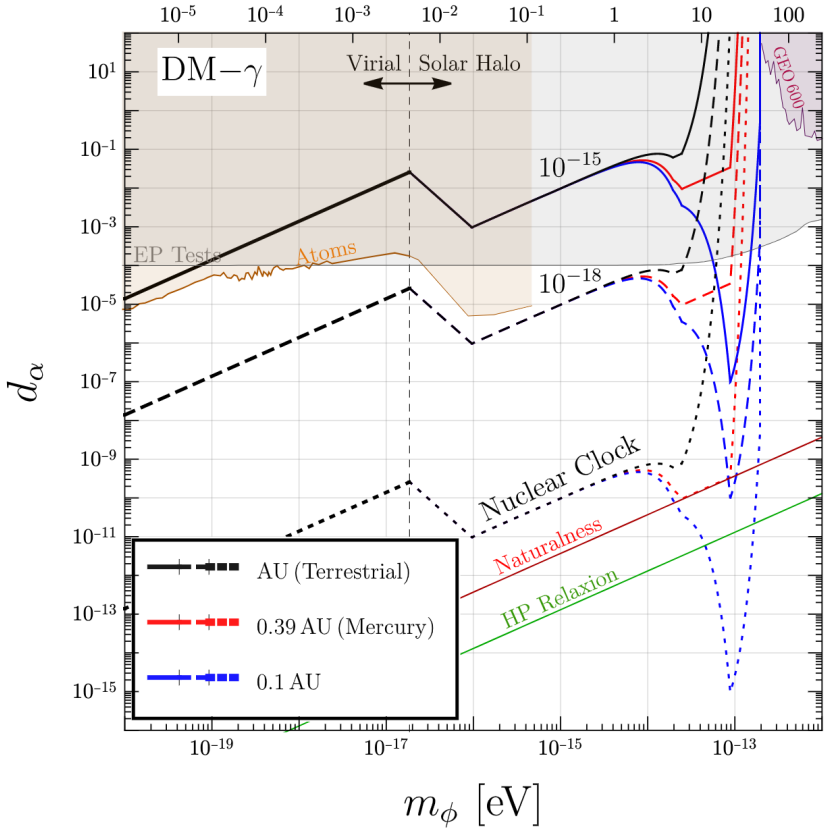
Propose **a two-clock comparison experiment** onboard **future solar probes**




$$\phi(t,\vec{x}) = \phi_0 \cos(m_\phi t - \vec{k}_\phi \cdot \vec{x} + \dots).$$
$$\omega \simeq m_\phi.$$
$$\mathcal{L} \supset \left(\frac{\sqrt{\pi} d_\alpha}{2M_P}\right) \phi F_{\mu\nu} F^{\mu\nu}$$

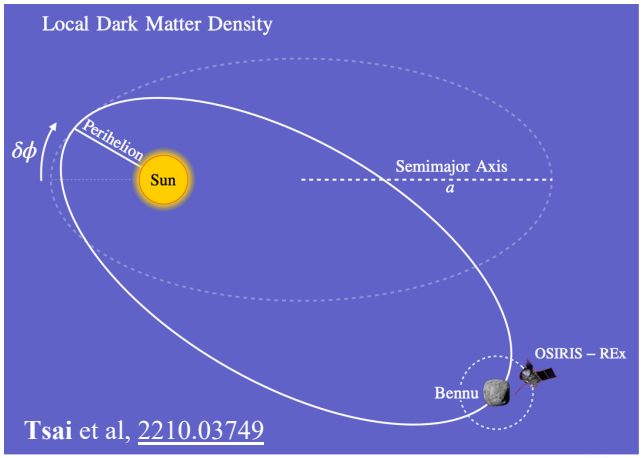


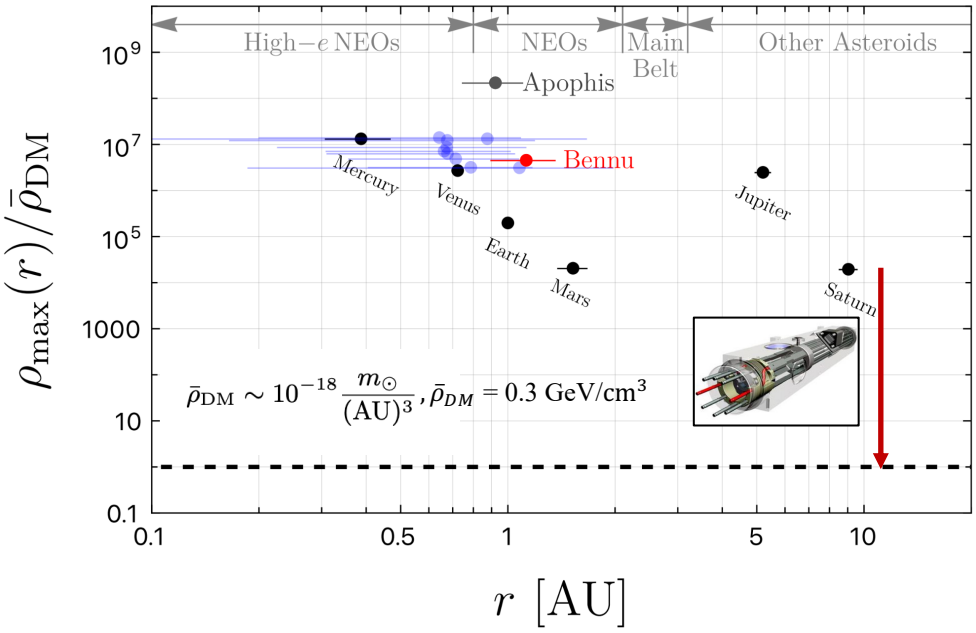



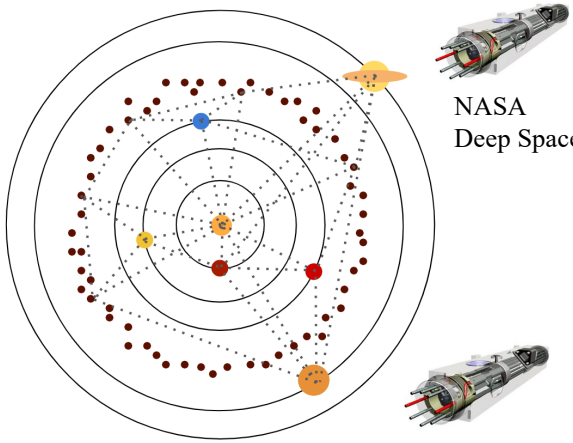



# **Precision Tracking by Quantum Sensor:** Study Local Dark Matter, CvB, & Hidden Fifth Forces

1. **Tsai** et al, https://arxiv.org/abs/2210.03749
2. **Tsai** et al, JCAP (2023), https://arxiv.org/abs/2107.04038



NASA
Deep Space Atomic Clock

Using the the **Asteroid Tracking Network (ATN)** for Fundamental Physics

1. Study **astrometry & precessions**
2. Can study **local dark matter density**, **cosmic background neutrinos**, and **long-range fifth forces**
3. Increase precision with **quantum sensors** (e.g., with quantum clocks onboard of space missions)

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