

Oscillation Constraints on Scalar Dark Matter-Induced Neutrino Mass

Kierthika Chathirathas, Sabya Sachi Chatterjee, Thomas Schwetz
arXiv: 2608.06460

MU Days
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Ultralight Scalar Dark Matter and Neutrino Masses

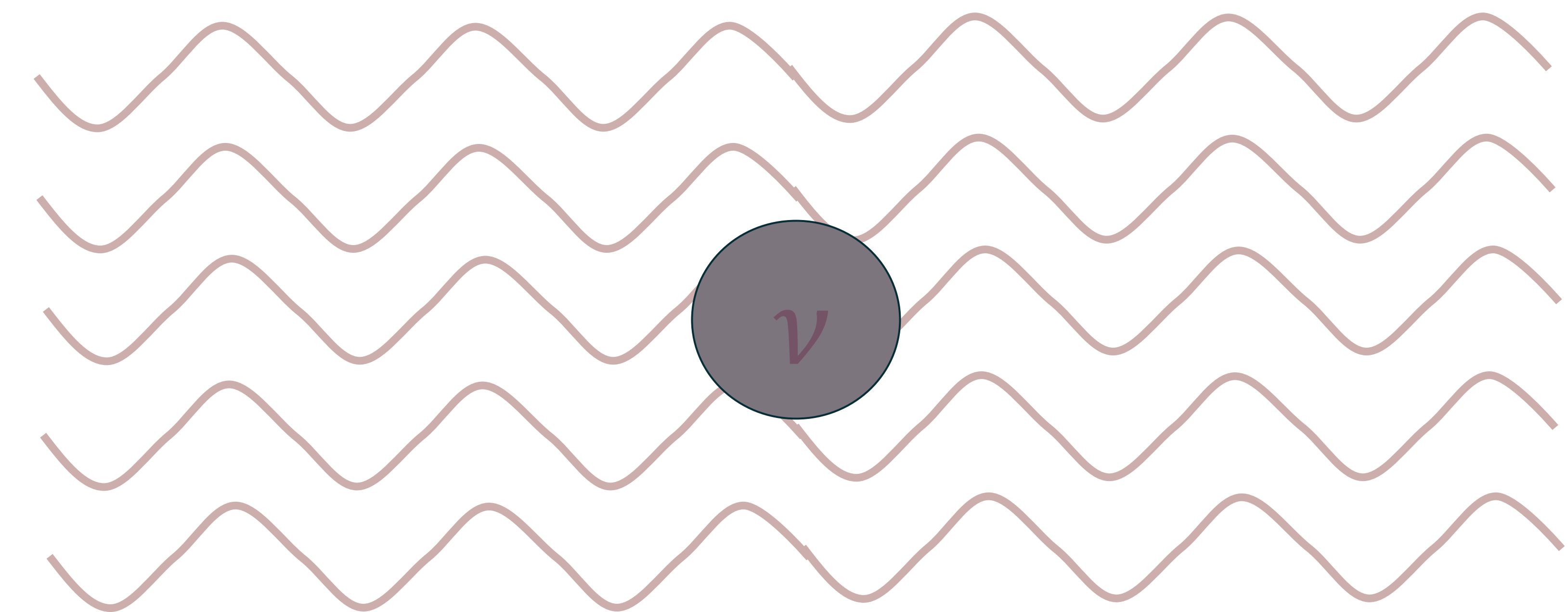
- **Dark matter:**

- Ultralight (pseudo-)scalar field with $m_\phi \leq 10^{-8}$ eV
- Virialised galaxy halo $\rightarrow$ random phase model

Centers et al.
[Nat. Commun. 12 (2021) 7321]

- **Coupling to neutrinos:**

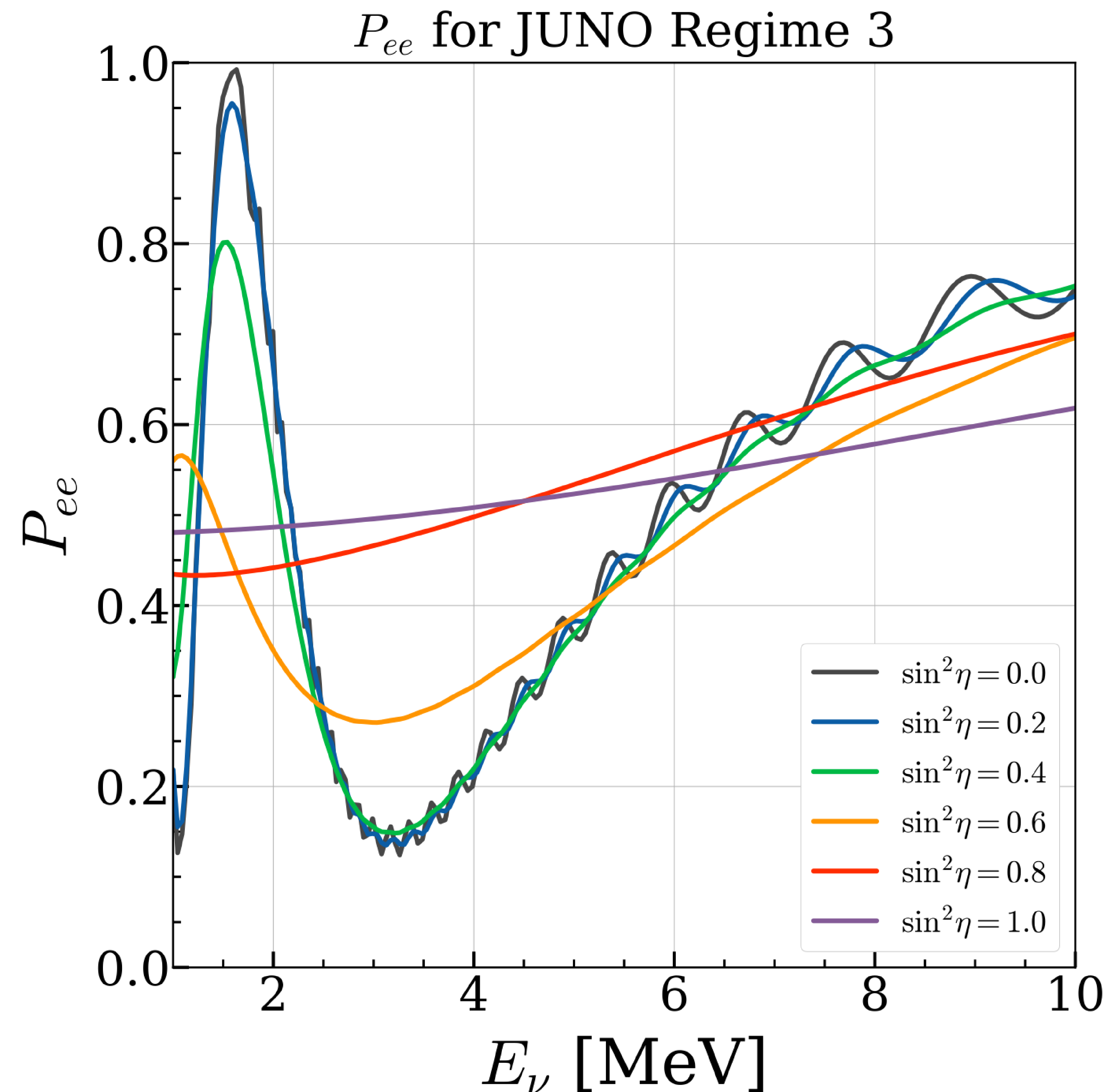
- $\mathcal{L}_\phi = \frac{1}{2} \sum_{i=1}^3 g_i \phi \overline{\nu_{iL}^c} \nu_{iL} + \text{h.c.}$
- Diagonal in vacuum neutrino mass basis



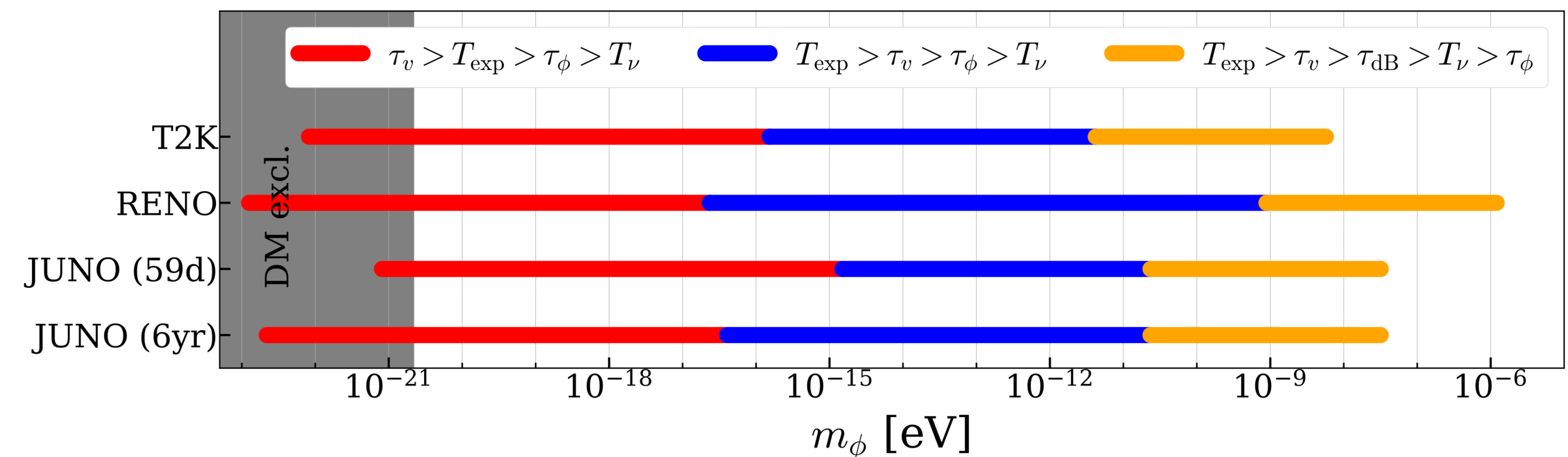
- **Neutrino mass:**

- Time-varying Majorana mass term $m_i^{\text{dark}} = g_i \phi$
- Continuous parameterization $\mu_i(\vec{x}, t) = m_i^{\text{vac}} + m_i^{\text{dark}}(\vec{x}, t) = m_i^0 [\cos^2 \eta + \sin^2 \eta A(\vec{x}, t)]$

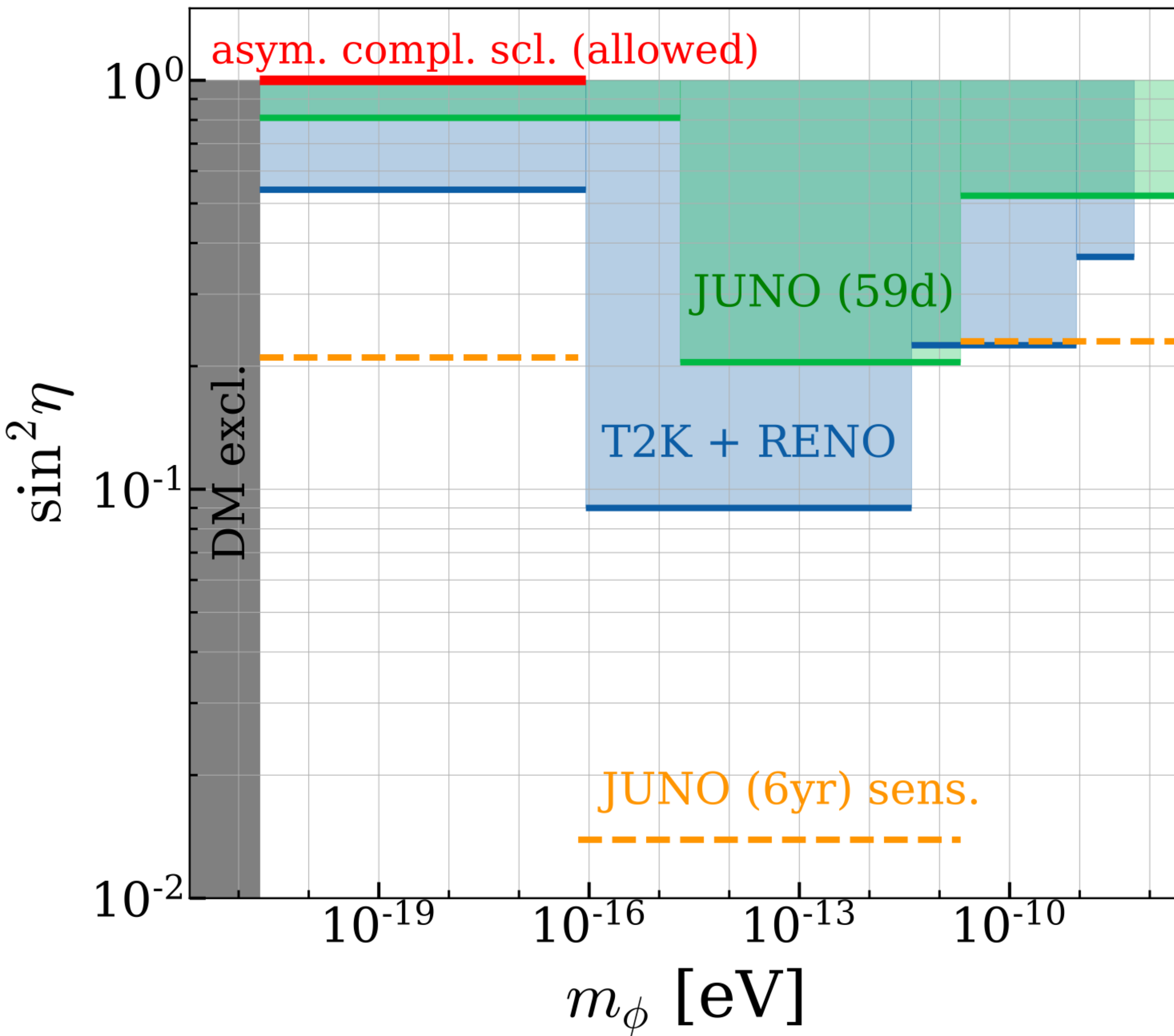
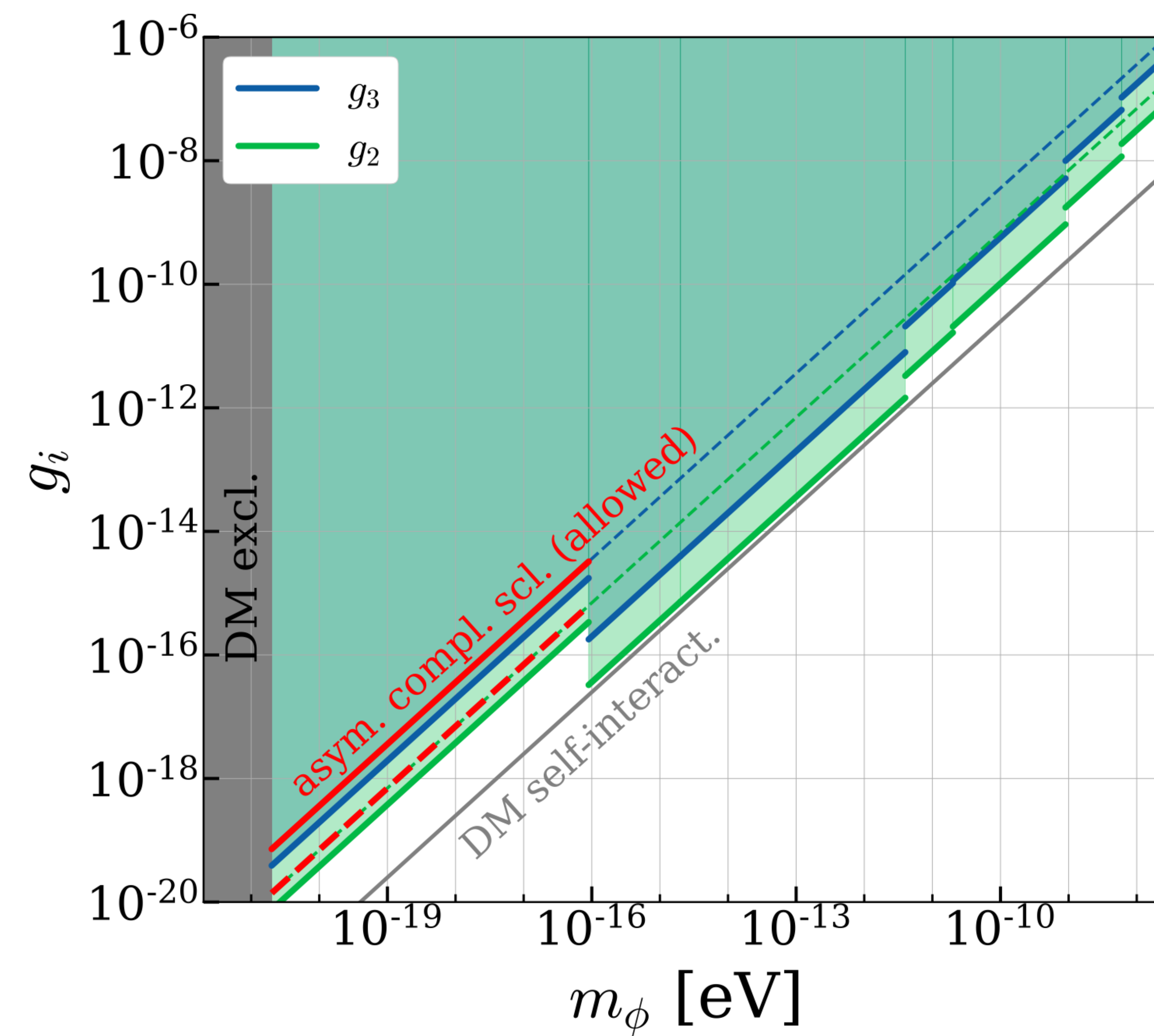
Modified Neutrino Oscillations as a Probe



- Effect on vacuum neutrino oscillation probabilities
- Scalar field and experimental timescales
- 3 regimes depending on scalar mass
- Variations are either very slow ($\sim$ constant) or very fast ($\sim$ fully averaged)



Constraining Dark Neutrino Mass and Scalar-Neutrino Coupling



- T2K, RENO, JUNO (sensitivity)
- Pure scalar-induced neutrino mass excluded
- Limits on coupling