

Antineutrinos from the Sun and Sterile Neutrino Decays



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from $p^2 = m^2$ to $p^2 \neq m^2$

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[See this talk on YouTube](#)



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in collaboration w/ Maxim Pospelov
to appear

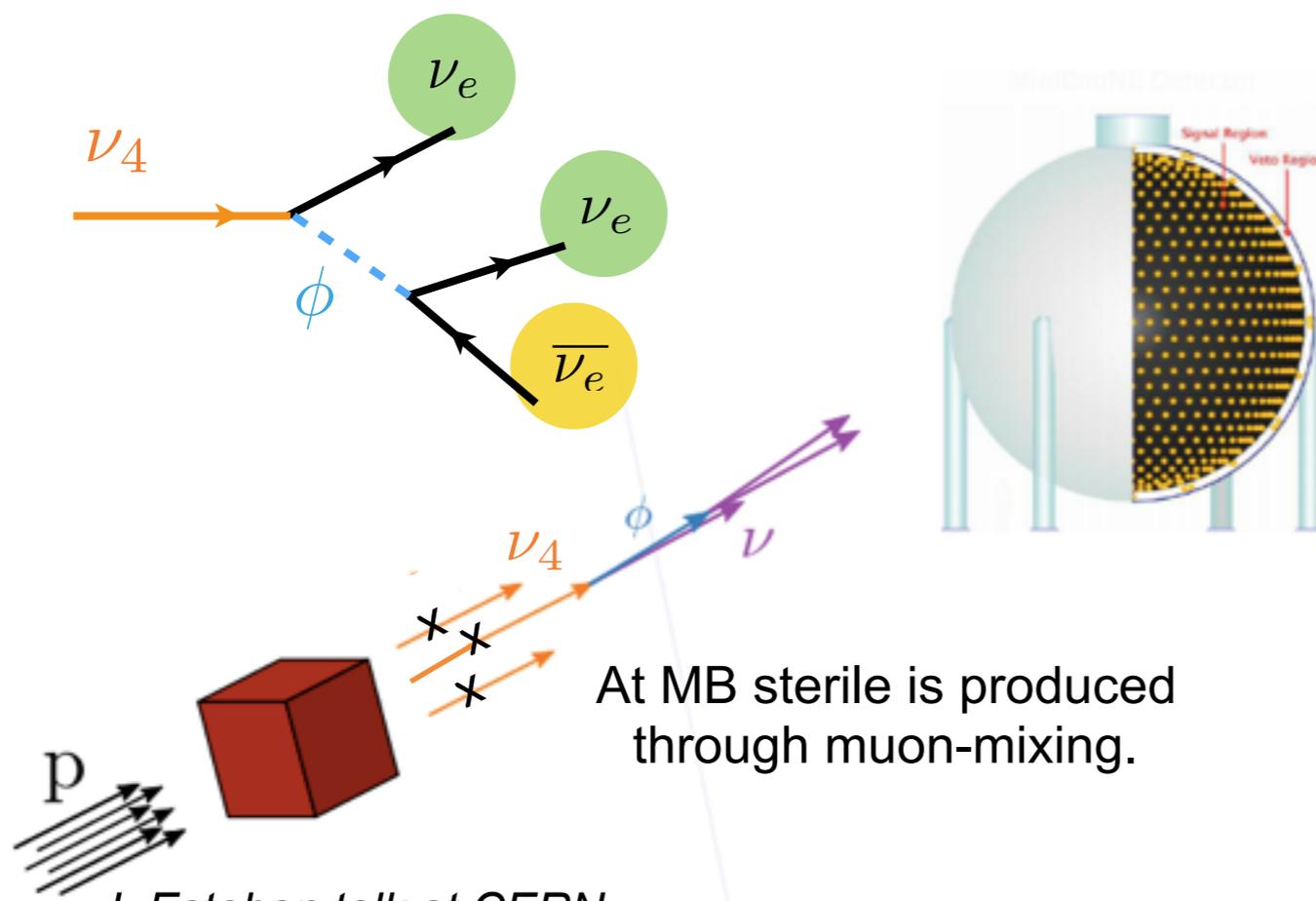


A shift from eV sterile neutrinos to explain SBL anomalies

Sterile neutrino visible decays:

M. Dentler *et al*, *PRD101(2020) 115013*.

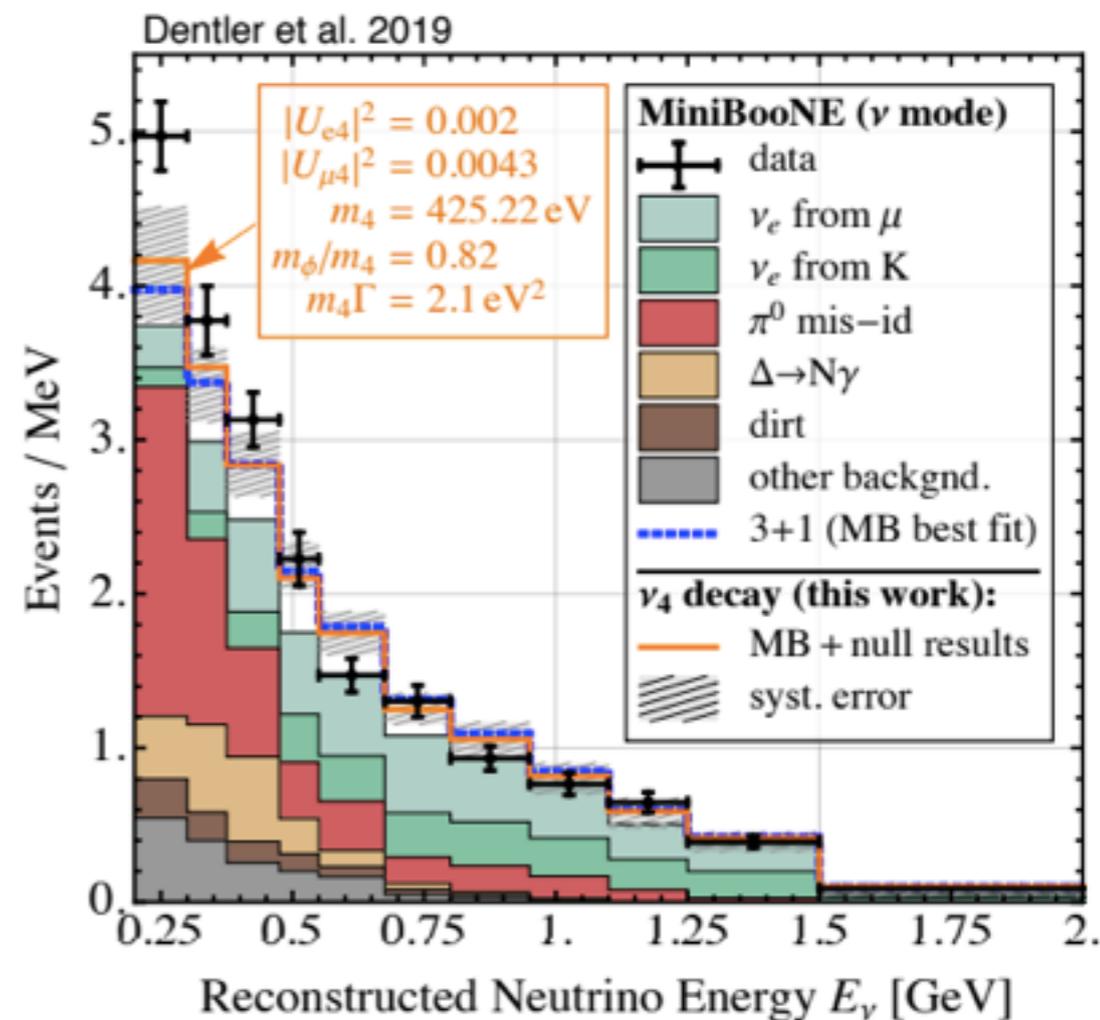
$$-\mathcal{L} \supset g_s \bar{\nu}_s \nu_s \phi + m_{ab} \bar{\nu}_a \nu_b.$$



I. Esteban talk at CERN
10.5281/zenodo.3509890.

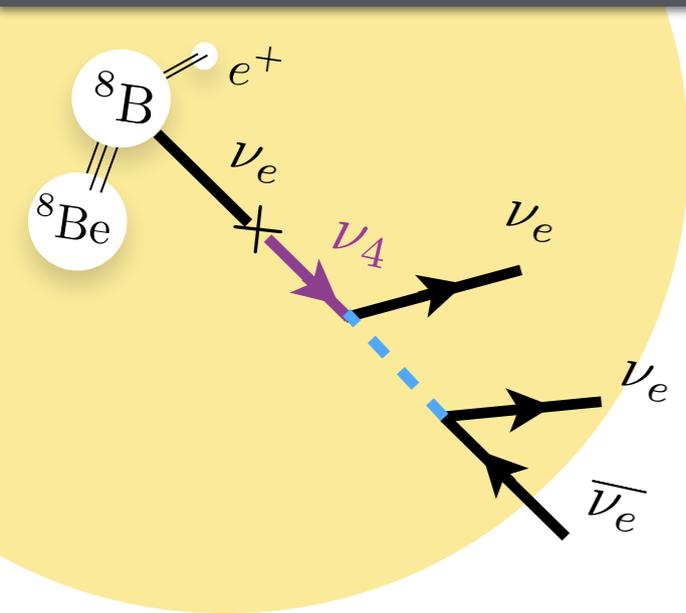
An effective $\nu \rightarrow \bar{\nu}$ transition

MiniBooNE energy distribution

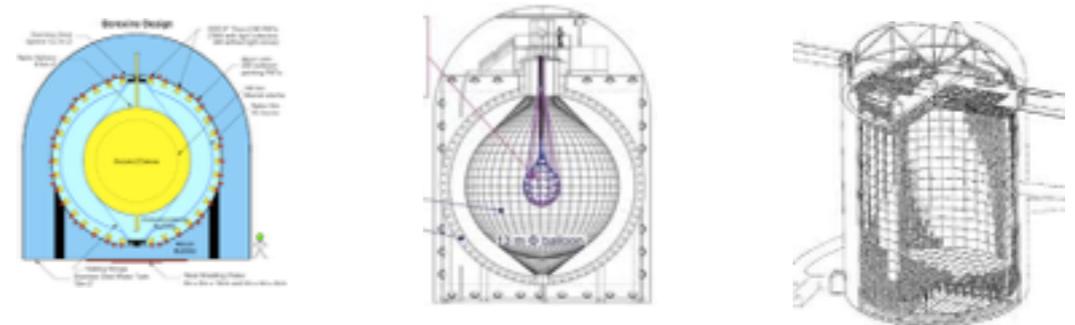


Avoids tension with disappearance exps,
and may be extended to satisfy cosmology.

Existing constraints on Solar antineutrinos



The Sun does not emit antineutrinos:

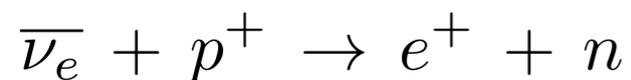


$$P_{\nu_e \rightarrow \bar{\nu}_e}^{\text{Borexino}} (E_\nu \geq 1.8 \text{ MeV}) < 7.2 \times 10^{-5}$$

$$P_{\nu_e \rightarrow \bar{\nu}_e}^{\text{KamLAND}} (E_\nu \geq 8.3 \text{ MeV}) < 5.3 \times 10^{-5}$$

$$* P_{\nu_e \rightarrow \bar{\nu}_e}^{\text{SK-IV}} (E_\nu \geq 9.3 \text{ MeV}) \lesssim 1.0 \times 10^{-4}$$

$\bar{\nu}_e$ detection through
Inverse Beta Decay



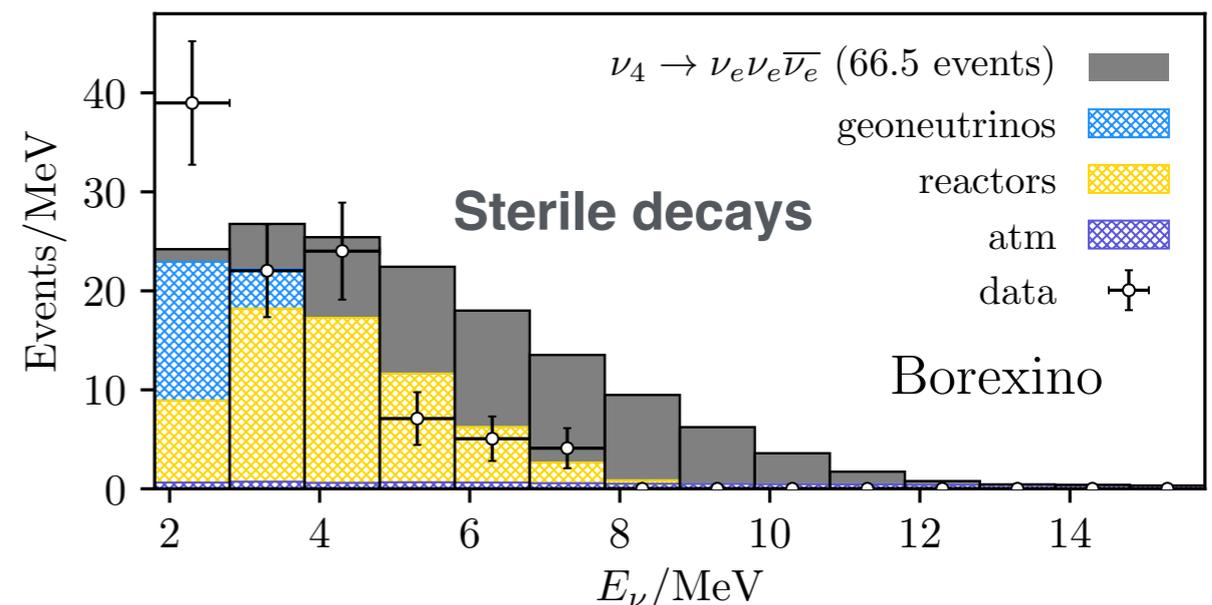
IBD has **small backgrounds** and much **larger cross section** than nu-e elastic!

$$\sigma_{\text{IBD}} \gg \sigma_{\nu-e}$$

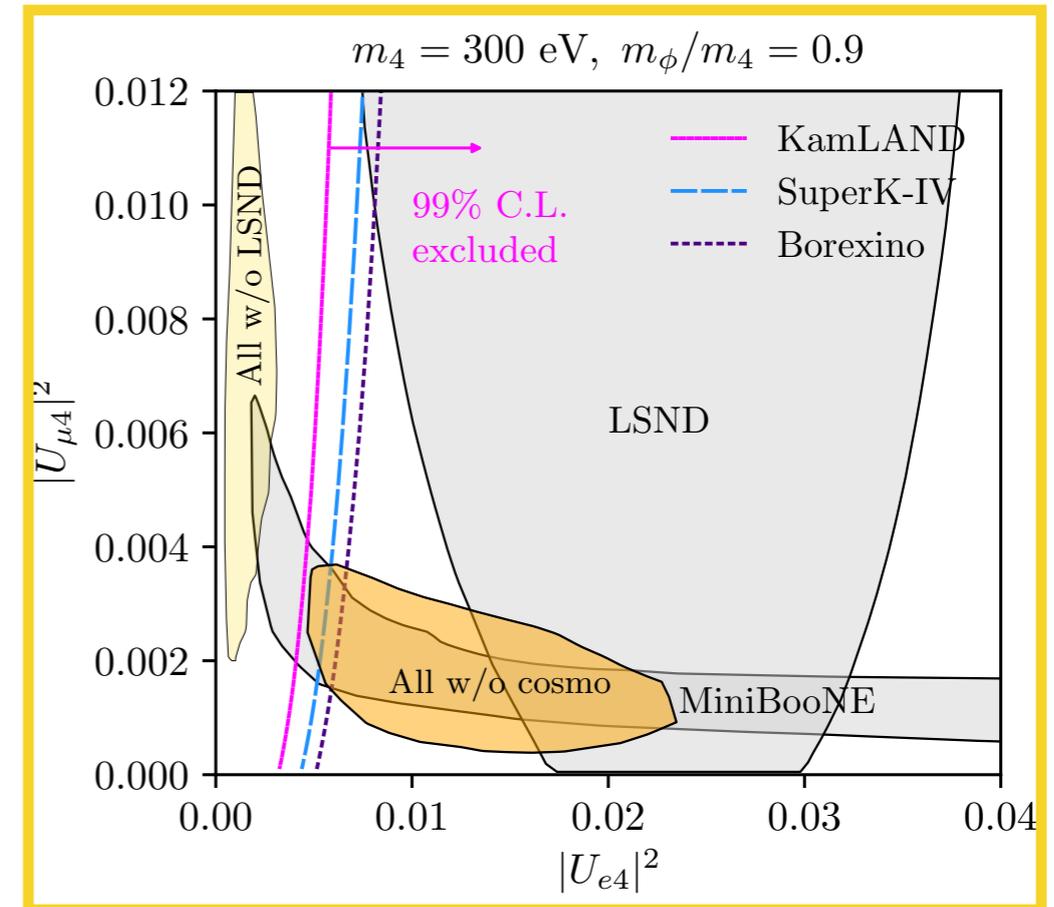
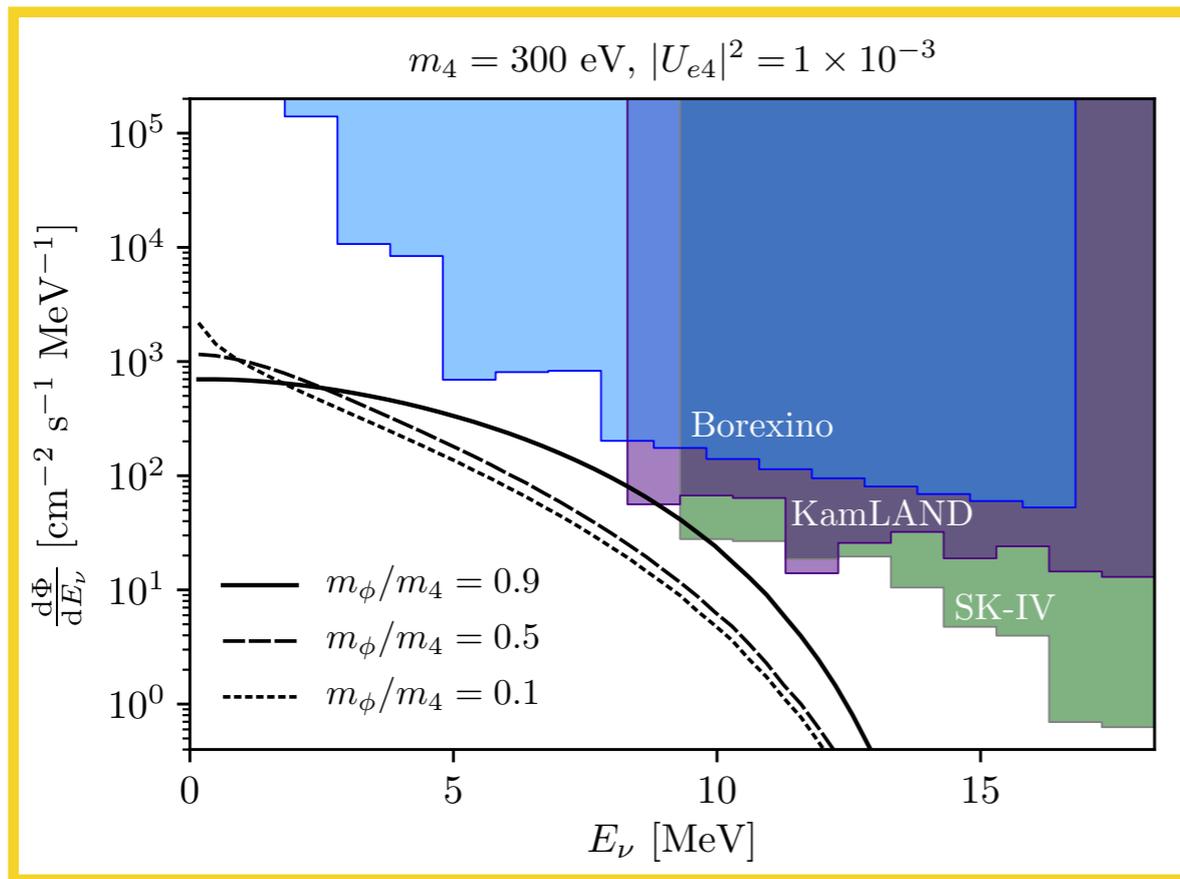
When produced, $\bar{\nu}_e$ undergoes **matter-suppressed** flavour transitions.

From a dedicated simulation of the NP signature:

$$m_4 = 300 \text{ eV}, m_\phi/m_4 = 0.90, |U_{e4}|^2 = 5 \times 10^{-3}$$



Predictions of decaying-sterile hypothesis



A simultaneous explanation of LSND and MiniBooNE is in tension with Solar antineutrino searches.

Significant improvement expected at JUNO and SK-Gd

S.J. Li *et al*, *Nucl.Phys.B* 944(2019)114661

Bounds becomes stronger for Majorana neutrinos, but may be weakened if:

- Only MiniBooNE is explained and taking small m_ϕ/m_4
- Complicate the model and decouple decay from

electron-heavy mixing: S. Palomares-Ruiz *et al*, *JHEP09(2005)048* A. deGouvea *et al*, *JHEP07(2020)141*