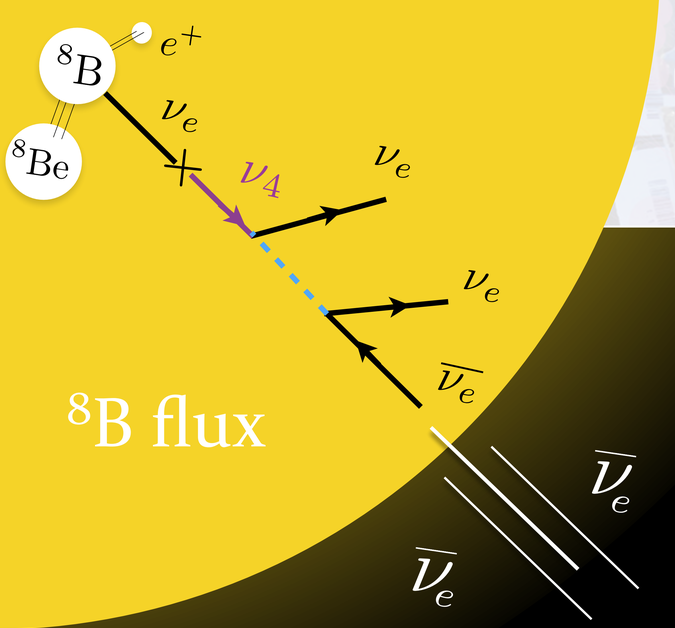
Antineutrinos from the Sun and Sterile Neutrino Decays

MATHEUS HOSTERT in collaboration w/ Maxim Pospelov
University of Minnesota & Perimeter Institute
To appear arXiv:2008.xxxx m.hostert@umn.edu

ICHEP 2020



IDEA

Recent proposals to explain LSND, MiniBooNE and reactor anomalies via a decaying-sterile neutrino can lead to large antineutrino fluxes from the Sun.

In the minimal model of [1], where one adds only a sterile neutrino and a very light scalar:

$$-\mathcal{L} = g_\phi \overline{\nu_s} \nu_s \phi + \sum_{\alpha,\beta} m_{\alpha\beta} \overline{\nu_\alpha} \nu_\beta$$

Here, neutrinos are *Dirac* and the new interaction is assumed to be *parity conserving.*

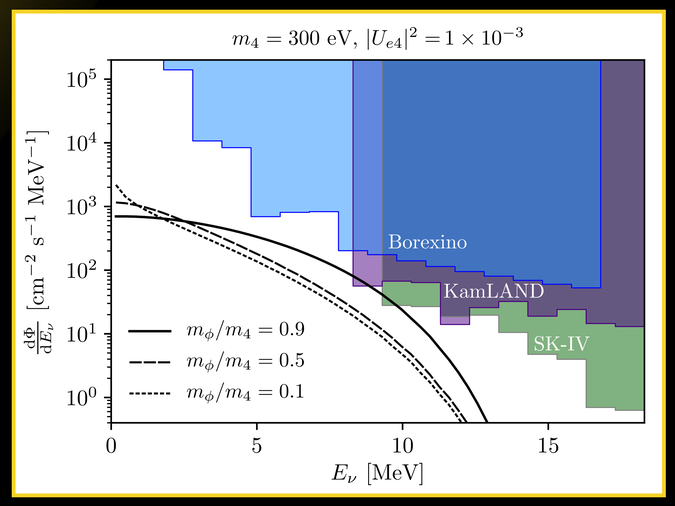


Fig 1. New physics prediction for *nuebar* fluxes and limits quoted by Borexino, KamLAND, and SuperK-IV.

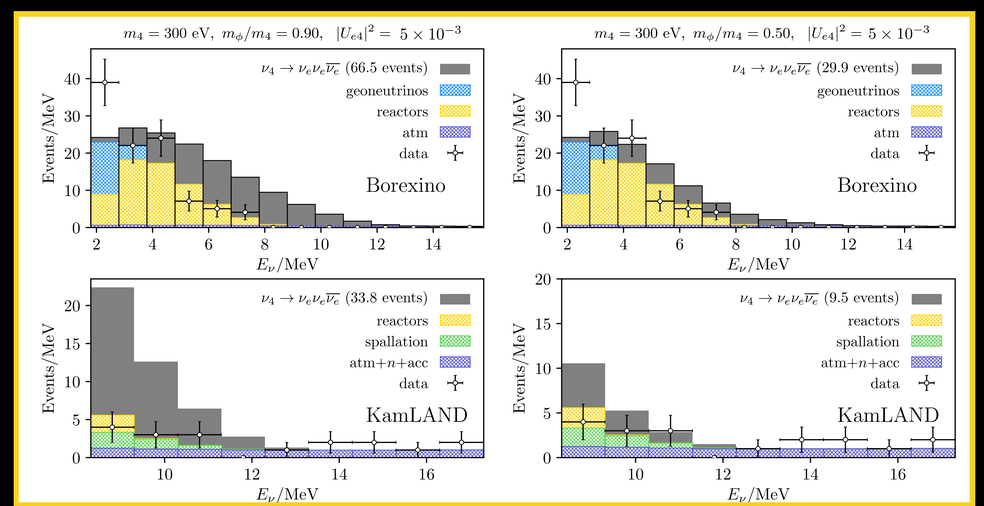


Fig 2. IBD events at Borexino (top) and KamLAND (bottom). New physics prediction from our simulation is in gray for two benchmark points.

Sterile neutrinos w/ O(100 eV) to O(100 keV) are produced in the Sun via *electron-mixing,* and decay to scalars, which in turn decay to $\nu\overline{\nu}$ pairs:

$$\nu_4 \to \nu\phi \to \nu\nu\overline{\nu}$$

If neutrinos are *Majorana*, antineutrinos are produced already in the primary decay. In that case, stronger bounds from 0nuBB would apply in minimal models. If the scalar is massless, light neutrinos would also decay.

Antineutrinos undergo non-resonant flavour conversion in the Sun, and scatter via IBD inside liquid-scintillator detectors, such as Borexino, Kamland, or inside the water tank of Super-Kamiokande (SK).

$$\overline{\nu}_e\, p^+ \to e^+\, n$$

Several other constraints also apply, e.g., from neutrino free streaming, appearance searches at KARMEN and OPERA, as well as beta decay kink searches. Our constraints are often the strongest, especially for large m_ϕ/m_4. Additional new physics may reconcile the model with cosmological observables.

RESULTS & TAKEAWAY

Inverse beta decay and the large B8 Solar flux are ideal probes of $\nu \to \overline{\nu}$ transitions in the Sun.
This provides a strong constraints on decaying-sterile neutrino explanations of LSND+MiniBooNE. A simultaneous explanation of the two anomalies is in tension with our limits. In the remaining MiniBooNE region, one would expect signatures at SK-Gd and JUNO.

[1] M. Dentler *et al*, PRD101(2020) 115013.
[2] A. deGouvea *et al*, JHEP07(2020)141.
[3] S. Palomares-Ruiz *et al,* JHEP09(2005)048.
[4] S.J. Li *et al,* Nucl.Phys.B 944(2019)114661.