Low-energy astrophysics with KamLAND

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on behalf of the KamLAND collaboration

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We present two results of a search for MeV-scale neutrino and anti-neutrino events correlated with gravitational wave events/candidates and large solar flares with KamLAND.

The KamLAND detector is a large-volume neutrino detector using liquid scintillator, which is located at 1 km underground under the top of Mt. Ikenoyama in Kamioka, Japan. KamLAND has multiple reaction channels to detect neutrinos. Electron antineutrino can be detected via inverse-beta decay with 1.8 MeV neutrino energy threshold. All flavors of neutrinos can be detected via neutrino-electron scattering without neutrino energy threshold. KamLAND has continued the neutrino observation since 2002 March.

We use the data set of 60 gravitational waves provided by the LIGO/Virgo collaboration during their second and third observing runs and search for coincident electron antineutrino events in KamLAND. We find no significant coincident signals within a ±500 s timing window from each gravitational wave and present 90% C.L. upper limits on the electron antineutrino fluence between 10^{8}–10^{13} cm^{-2} for neutrino energies of 1.8–111 MeV (Figure 1).

For a solar-flare neutrino search at KamLAND, we determine the timing window using the solar X-ray data set provided by the *GOES* satellite series from 2002 to 2019 and search for the excess of coincident event rate on the all-flavor neutrinos. We find no significant event rate excess in the flare time windows and get 90% C.L. upper limits on the fluence of neutrinos of all flavors (electron anti-neutrinos) between 10^{10}–10^{13} cm^{-2} (10^{8}–10^{13} cm^{-2}) for neutrino energies in the energy range of 0.4–35 MeV (Figure 2).

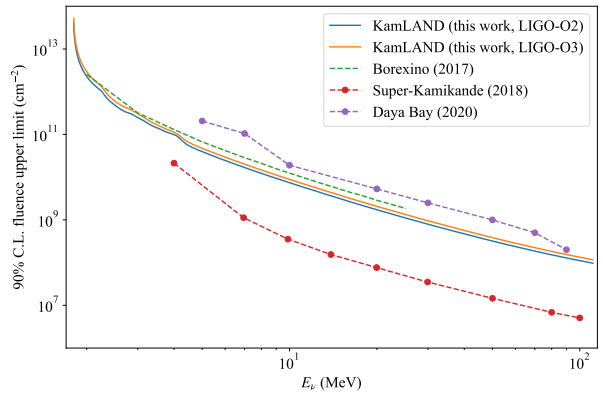

Figure 1: Upper limits on the $\bar{\nu}_e$ fluence with 90% C.L. Figure is reproduced from S.Abe *et al.*, 2021 *ApJ* **909** 116.

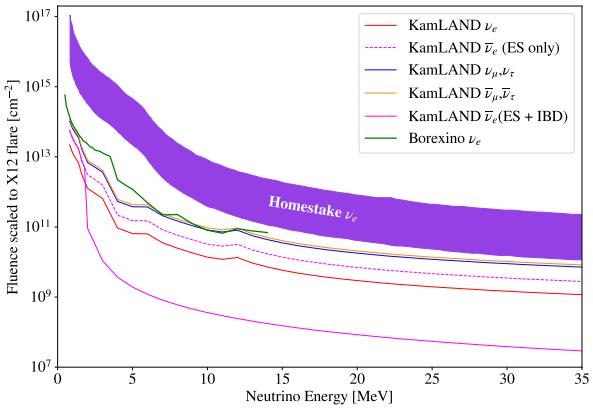

Figure 2: Fluence upper limits with 90% C.L. scaled to the Homestake flare intensity. Figure is reproduced from arXiv:2105.02458[astro-ph.SR]