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First Search for Majorana Neutrino at the Inverted Mass Ordering Region with KamLAND-Zen

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The discovery of neutrinoless double beta decay (0νββ) would shed light on the persistent puzzle surrounding the origin of neutrino mass and help explain the matter-dominated universe. As one of the leading experiments searching for 0νββ, the KamLAND-Zen experiment has provided a stringent constraint on the neutrinoless double-beta(0νββ) decay half-life in 136Xe using a xenon-loaded liquid scintillator. We report an improved search using an upgraded detector with almost double the amount of xenon and an ultra-low radioactivity container, corresponding to an exposure of 979kg·yr of 136Xe. We have not observed 0νββ yet, but this search makes use of novel algorithms to perform beta-gamma separation using machine learning and tag spallation products on order day time scales. As a result, we obtain a lower limit for the 0νββ decay half-life of T > 2.29×10ˆ26 yr at 90% C.L., corresponding to upper limits on the effective Majorana neutrino mass of 36 –156 meV using commonly adopted nuclear matrix element calculations. Our improved sensitivity provides a limit that reaches below 50 meV for the first time and is the first search for 0νββ in the inverted mass ordering region.

Primary author: LI, Aobo (UNC Chapel Hill)

Presenter: LI, Aobo (UNC Chapel Hill)

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