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**The search for the elusive  $K_L \rightarrow \pi\nu\bar{\nu}$  with  
the KOTO detector by looking  
for nothing to nothing**



„The KOTO experiment at J-PARC aims to help explain why we live in a matter dominant universe. It is believed that Charge-Parity (CP) violation is critical in this asymmetry, and studying where new CP violation can enter beyond the predictions of the Standard Model (SM) is an exciting frontier for discovering new physics.

The KOTO experiment was designed to observe and study the  $K_L \rightarrow \pi\nu\bar{\nu}$  decay. The Standard Model (SM) prediction for the mode is  $3.0 \times 10^{-11}$  with a small theoretical uncertainty [1]. A previous experimental upper limit of  $2.6 \times 10^{-8}$  was set by the KEK E391a collaboration [2]. The rare “golden” decay is ideal for probing for physics beyond the standard model. A comparison of experimentally obtained results with SM calculations permits a test of the quark flavor region and provides a means to search for new physics.

The signature of the decay is a pair of photons from the  $\pi^0$  decay and no other detected particles. For the measurement of the energies and positions of the photons, KOTO uses a Cesium Iodide (CSI) electromagnetic calorimeter as the main detector, and hermetic veto counters to guarantee that there are no other detected particles.

KOTO’s initial data was collected in 2013 and achieved a similar sensitivity as E391a result [3]. Since then, we completed hardware upgrades and had additional physics runs in 2015, 2016-2018, and earlier this year. This presentation will present the motivation for this study, new results from KOTO [4], and discuss the status of the ongoing search in detecting  $K_L \rightarrow \pi\nu\bar{\nu}$ .”

