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Searches for Sterile Neutrino with NOνA

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Merged the following:
Contradictory evidence has been presented on the issue of neutrino mixing between the three known active neutrinos and light sterile neutrino species. Short-baseline neutrino oscillations observed by the LSND and MiniBooNE experiments, the collective evidence of the reactor neutrino anomaly, and the gallium anomaly all point towards sterile neutrinos with mass at the 1 eV level. While these results are tantalizing, they are not conclusive as they are in tension with null results from other short-baseline experiments, and with disappearance searches in long-baseline and atmospheric experiments.

Resolving the issue of the existence of light sterile neutrinos has profound implications for both particle physics and cosmology. The NOvA (NuMI Off-Axis νe Appearance) experiment may help clarify the situation by searching for disappearance of active neutrinos from the NuMI (Neutrinos from the Main Injector) beam over a baseline of 810 km.

In this talk, we will describe a method of how NOvA can look for oscillations into sterile neutrinos, with focus on disappearance of neutral current (NC) neutrino events, will present preliminary results of these searches, and discuss their implications in supporting or constraining the existence of light sterile neutrinos.

Anomalous results observed by short-baseline neutrino oscillation experiments LSND and MiniBooNE, the reactor neutrino and the gallium anomalies all point towards sterile neutrinos with a mass at the 1 eV scale. The evidence remains inconclusive due to tension between null results at short-baseline experiments and disappearance measurements at long-baselines. The NOvA (NuMI Off-Axis nu_e Appearance) long-baseline experiment offers a complementary probe of sterile neutrino mixing. The NOvA detectors have been optimized to detect electrons in order to measure electron-neutrino appearance. Extending the standard 3-neutrino framework to a 3+1 model that includes one sterile flavor and an extra mass state (ν4) allows one to extend the current nu_e appearance measurement to measure NOvA's sensitivity to the extra CP-violating phases. In this talk we present NOvA's first analysis of these additional CP-violating phases and assess future discovery reach in the presence of a light sterile neutrino.

Three-flavor neutrino oscillations have successfully explained a wide range of neutrino oscillation experiment results. However, anomalous results, such as the electron-antineutrino appearance excess seen by LSND and MiniBooNE, do not fit the three-flavor paradigm and can be explained by the addition of a sterile neutrino at a larger mass scale than the existing three flavor mass states.

The NOvA experiment consists of two finely segmented, liquid scintillator detectors operating 14 mrad off-axis from the recently upgraded NuMI muon-neutrino beam. The Near Detector is located on the Fermilab campus, 1 km from the NuMI target, while the Far Detector is located at Ash River, MN, 810 km from the NuMI target. The NOvA experiment is primarily designed to measure electron-neutrino appearance at the Far Detector using the Near Detector to control systematic uncertainties; however, the Near Detector is well suited for searching for anomalous short-baseline oscillations and probing the LSND and MiniBooNE sterile neutrino allowed regions using a variety of final states. This talk will present a novel method for selecting samples with high purity at the Near Detector using convolutional neural networks. Based on this method, the sensitivity to anomalous short-baseline tau-neutrino appearance will be shown, and preliminary results of searches for anomalous electron-neutrino appearance and muon-neutrino disappearance at the NOvA Near Detector will be presented.

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