INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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Thesis Title:
First Sterile Neutrino Search at NOvA Experiment Using both Neutrino and Anti-Neutrino Data

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Thesis Submitted to the Academic Division	:	Physics
Date of completion of Thesis Viva-Voce Exam	:	07/07/2026
Key words for description of Thesis Work	:	World Leading Limits in Sterile Neutrino Searches

SHORT ABSTRACT

Neutrinos are among the most abundant fundamental particles in the universe, and yet they are so elusive that they pass through almost everything without leaving a trace. For decades, researchers have measured neutrino oscillations in great detail, refining our understanding of the theories. Yet, once again, neutrino shows their incredibly surprising nature through some recent experimental results, suggesting that our current understanding might be incomplete. Several experiments have observed an unexpected difference in the observed neutrino behaviour from what the Standard Model predicts, showing an excess in some cases (e.g. LSND, MiniBooNE) and a deficit of neutrino events in others (e.g. SAGE, GALLEX). These anomalies challenge our conventional theories of standard three neutrino flavors and phenomenologically motivate the sterile neutrino hypothesis, which does not interact through the usual weak force. While some results appear consistent with this idea, others have found no supporting evidence (e.g. MicroBooNE), leaving the question unanswered. NOvA is one such long-baseline neutrino experiment with its Near Detector (ND) at Fermilab and a Far Detector (FD) at 810 km in Minnesota. It uses the NuMI beam as its primary source of neutrinos for oscillation studies. Its two-detector setup, extended baseline, and ability to conduct combined ν-$\bar\nu$ analyses position it to explore these phenomena in new ways.

We use the joint ν_{μ} and neutral current (NC) disappearance channels to probe active-sterile mixing in the 3+1 model. This analysis utilizes a data sample of 27$\times$10^{20} protons on target (POT) in neutrino mode and 12.5$\times$10^{20} protons on target (POT) in antineutrino mode. We found no evidence of sterile neutrino at 90$\ %$ C.L. We present the limits in $\sin^{2}\theta_{24}$ vs Δm^{2}_{41}, $\sin^{2}\theta_{34}$ vs Δm^{2}_{41}, and $\sin^{2}2\theta_{\mu\tau}$ vs Δm^{2}_{41} parameter spaces. The limits provided by this analysis are world leading in most of the parameter spaces.