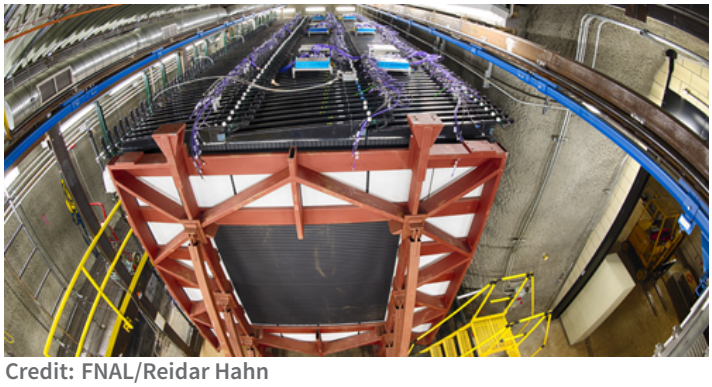
Sterile Neutrinos Remain Elusive

A comparison of neutrinos measured 1 km and 810 km from their source finds no evidence of a putative fourth neutrino flavor.

By **Charles Day**

Although the electroweak interaction appears to require exactly three neutrino flavors, a fourth and additional flavors are admissible provided they are "sterile"—that is, they interact only via gravity. Like the other flavors, sterile neutrinos are expected to participate in neutrino oscillation, the morphing of one flavor into another. Hints of sterile neutrinos have been spotted in experiments, and they remain in play as a dark matter contender. Now the NOvA Collaboration has reported the results of its latest search for evidence that muon neutrinos morph not just into electron neutrinos, as the standard model expects, but also into a fourth, sterile neutrino flavor [**1**]. The search came up empty, but it did tighten existing constraints and impose new ones.

Based at the Fermi National Accelerator Laboratory (Fermilab), Illinois, the NOvA experiment creates a stream of muon neutrinos by firing protons at a carbon target. Some of the muon neutrinos reach a detector housed at Fermilab; others reach a detector 810 km away in northern Minnesota. Inferring the possible presence of sterile neutrinos entailed incorporating them into the mathematical description of neutrino oscillation. This description predicts how the oscillations might change the flux of muon neutrinos, which can disappear from the beam through neutrino oscillation or other processes.



Credit: FNAL/Reidar Hahn

The NOvA team found no evidence that introducing a fourth, sterile neutrino provided better agreement with their data than the standard model of three "active" flavors: electron, muon, and tau. What's more, the researchers could exclude sterile neutrino parameter ranges that were previously admitted by IceCube (see **Synopsis: No Sterile Neutrinos from Eight Years of IceCube**). Two previous experiments, LSND and MiniBooNE, found strong hints of sterile neutrinos. Although NOvA did not probe the same parameter space, the results conflict.

Charles Day is a Senior Editor for *Physics Magazine*.

REFERENCES

1. M. A. Acero *et al.* (NOvA Collaboration), "Dual-baseline search for active-to-sterile neutrino oscillations in NOvA," **Phys. Rev. Lett. 134, 081804 (2025).**