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Probing the Nature of Neutrinos with the Deep Underground Neutrino Experiment (DUNE)

Wednesday, October 1, 2025 2:00 PM (25 minutes)

The Deep Underground Neutrino Experiment (DUNE) is an ambitious research program in neutrino physics under construction at Fermilab and the Sanford Underground Research Facility (SURF). Neutrino oscillations have led to the discovery that neutrinos have nonzero masses. The current model describes the oscillation phenomenon in terms of three mixing angles and one CP-violating phase. Within the three-flavor paradigm, the other two major unknowns are the neutrino mass ordering and whether charge-parity is violated in the leptonic sector.

Unlike past neutrino experiments, DUNE is uniquely designed to measure many oscillation parameters and eventually test the validity of the oscillation model. Additionally, its design will offer the opportunity for non-beam-related neutrino physics, including the detection of supernova and solar neutrinos. Such a broad physics program is made possible by measuring neutrinos and antineutrinos as function of energy over a wide-band beam, using large underground Liquid Argon Time Projection Chambers (LArTPC) able to provide exquisite imaging capabilities. DUNE is a dual-site experiment with a detector close to the neutrino beam source at Fermilab (Near Detector) and a detector 1300 km away in South Dakota (Far Detector). The Near Detector measures the unoscillated neutrino flux and constrains systematic uncertainties to predict the neutrino flux at the Far Detector, where the oscillated (anti-)neutrino beam is measured. In its first phase, the Far Detector will comprise two 10,000 ton (fiducial) LArTPC a mile underground; the Near Detector will consist of a LArTPC module and two additional trackers to obtain a robust characterization of the neutrino flux.

In this talk, I will present the rich DUNE neutrino physics program, including opportunities for Beyond Standard Model physics. I will highlight how its sophisticated design makes DUNE a robust and comprehensive experiment. I will also outline the current status of its operating prototypes and ongoing construction.

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