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DUNE Science and Status

Neutrino oscillations are firmly established experimentally, but two major unknowns remain: the ordering of the three masses and whether charge-parity symmetry is violated. The Deep Underground Neutrino Experiment (DUNE) is a next-generation long-baseline neutrino oscillation experiment that aims to address these and other fundamental questions in particle physics and astrophysics. DUNE is the first experiment to measure neutrinos and antineutrinos as a function of energy over a broad spectrum spanning the first two oscillations. DUNE's very long 1300 km baseline breaks the degeneracy between the asymmetry caused by the matter effect and that potentially caused by CP violation, yielding a clean determination of the mass ordering. DUNE's liquid-argon technology provides exquisite imaging, enabling excellent flavor and energy determination. All of this combines to make DUNE a unique neutrino oscillation experiment.
Unique features of DUNE include the powerful high-intensity neutrino beam from the PIP-II accelerator upgrade at Fermilab, a complex near-detector system, and four massive liquid-argon time-projection chambers (LArTPCs) at the far site. In addition to beam-based physics, DUNE will carry out a rich non-beam program, including the detection of neutrinos from supernovae, the Sun, and cosmic-ray interactions in the atmosphere. As of 2025, excavation at the far site is complete, and infrastructure work is ongoing in preparation for detector installation. ProtoDUNE modules at CERN and Fermilab have demonstrated the DUNE detector technologies. The physics program is expected to begin in phases, with non-beam physics starting as early as 2029 and full beam-based operations with the near detector commencing around 2031. This presentation provides an overview of the experimental design, status, and anticipated physics reach of DUNE.

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