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An event generator for supernova neutrinos in argon

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The next galactic core-collapse supernova will be an exciting opportunity for the neutrino physics and astrophysics communities. The successful detection of many neutrinos from this event would allow us to test models of supernova dynamics, perform neutrino oscillation measurements over astronomical distances, and search for a variety of exotic physics beyond the Standard Model. While many of the existing neutrino detectors that would be sensitive to a nearby supernova use water or liquid scintillator as the target material, a liquid argon time projection chamber (LArTPC) such as the DUNE experiment would be uniquely sensitive to charged-current interactions of electron neutrinos. This sensitivity would allow DUNE to provide complementary information about a supernova event, such as a measurement of the neutronization burst. However, unlike the relatively simple antineutrino captures on protons that dominate in oil- and water-based neutrino detectors, supernova neutrino reactions on argon are strongly affected by nuclear structure and can lead to numerous final states. Future analyses of LArTPC data will need to account for these subtleties in order to do supernova neutrino physics. To help understand the response of a LArTPC to tens-of-MeV neutrinos, we have created an event generator called MARLEY (Model of Argon Reaction Low Energy Yields) that simulates charged-current electron neutrino scattering on argon. In this talk, we present the algorithms used in MARLEY and some calculations of expected supernova signals in DUNE.

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