

# “HEP Theorists’ Whitepaper”

---

Andreas Kronfeld

Sam Zeller

Joe Carlson

Richard Hill

Gabe Perdue

Rocco Schiavilla

# Audience $\Rightarrow$ Motivation

---

- High-energy physicists.
  - Because they have adopted neutrino physics as a major thrust, and the major US-based thrust.
- Main interest is in neutrino oscillation parameters, including CP violation,
  - as well as (other) windows to physics beyond the standard model, e.g., non-Standard interactions (such as a  $Z'$  boson).
- What are the theoretical uncertainties in the neutrino oscillation parameters? Are they robust? How can they be reduced?

# Features of a Document

---

- Executive summary.
- Detailed, hierarchical list of all the sources of uncertainty in neutrino-nucleus interactions, including (but not limited too):
  - initial- and final-state nuclear wave function;
  - nucleon-level matrix elements;
  - post-collision transport (when pions and hadronic resonances arise).
- Current estimates and future prospects for improving each entry in the list. (“Improve” can mean “reduce” or “make quantifiable”.)

# Theory Framework

---

- HEP theorists (all of us) should be able to gain an understanding, because the nuclear theory is organized around effective field theories—
  - of nucleons and other hadrons (rather than “elementary” fields).
- HEP theorists (some of us) are familiar enough with QCD, hadronic physics, chiral perturbation theory to enter in a meaningful dialogue with nuclear theorists. It goes without saying that the nuclear work is key.
- Building the list will require the expertise of nuclear theorists.
- Fermilab is a suitable place to hold a conversation among nuclear theorists, QCD-oriented HEP theorists, and BSM-oriented theorists.