

# Nustec board meeting

7 December 2021  
Saori Pastore

- Status report on WG Long term community planning
- Status report on the Snowmass White Paper  
“Theoretical Tools for Neutrino Scattering”

# Long-term community planning WG

## Members

Luis Alvaro-Ruso  
Saori Pastore  
Yoshinari Hayato

# WG's description

Mission:

- 1) **Advertise activities happening around the world to both the Board and NuSTEC-News**
- 2) **Organize meetings to discuss NuSTEC's activities and roles in international long-term planning programs**

# WG's Status report

The WG met once to collect info on planned and ongoing workshop relevant to NuSTEC

[NF06 Low Energy Neutrino and Electron Scattering Workshop](#) November 12, 2021

[Neutrino–Nucleus Interactions in the Standard Model and Beyond](#) @ CERN January 17-21, 2022

[Neutrino Program at KITP](#) February 14-April 1, 2022

[Theory Frontier Workshop](#) at [KITP \(workshop page\)](#) February 23-25 2022

[Neutrino Frontier Workshop](#) @ ORNL March 16-18, 2022

[Neutrino 2022 @Seoul](#) May 30 to June 4, 2022 (most likely in a hybrid format)

NuFact 2022 @ Utah (Dates have not been announced)

[NuSTEC WS: Expanding Our Palette: A Workshop on Improving the Art of Neutrino-Nuclei Modelling with Charged Lepton Scattering Data](#) March 2022

[Neutrino-Nucleus Interactions in the Standard Model and Beyond](#) January 2022

Plus

[IUPAP Neutrino Panel report](#)

# Snowmass

WPs are informed from the **LOIs** submitted to Snowmass (usually US based institutions since LOIs inform US agencies)

The full list of WPs can be found [here](#)

LOIs can be found [here](#)

# Snowmass Topical Group: Neutrino Theory

Co-Conveners: André de Gouvêa (Northwestern U.), Irina Mocioiu (Penn State U.), Saori Pastore (Washington U.), Louis Strigari (TAMU)

Wiki-page: [TF11/NF08](#)

# Neutrino Theory: List of topics

## Theory of Neutrino Physics

1. What is the **origin of nonzero neutrino** masses. Open questions, models, and how can we learn more? How does this connect with other open questions in particle physics and cosmology (dark matter puzzle, baryogenesis, stability of the Higgs boson mass)?
2. Is there a **theory of flavor**? What is it? How do we learn more? How well do we need to know the elements of the mixing matrix (including CP), and why? How are leptons and quarks connected?
3. Solving current (and future!) **neutrino puzzles**, including the short-baseline anomalies.

These include connections to experiments that will help piece the neutrino mass puzzle, including searches for kinematical effects of nonzero neutrino masses and understanding the neutrino mass ordering, searches for new neutrino states and new neutrino properties and interactions, searches for charged-lepton flavor-violation, searches for lepton number violation (e.g. neutrinoless double-beta decay), searches for baryon number violation (proton decay, neutron-antineutron oscillations), high energy collider experiments, low-energy observables, including searches for permanent EDMs, other experiments that will help shine light on the flavor puzzle (e.g., rare meson decays and other flavor observables in the quark sector).

## Theory for Neutrino Physics

1. **Simulating astrophysics sources** of neutrinos and computing neutrino transport in these environments (supernova neutrinos sources of ultra-high energy neutrinos and cosmic rays);
2. **BSM neutrino physics in early universe cosmology** (neutrino properties from cosmology and solve “puzzles” in cosmological data);
3. Computing **neutrino-nucleon and neutrino-nucleus scattering**, from low-energy scattering — including CEvNS — solar and supernova neutrinos up to DIS, including implementation (and validation against electromagnetic data);
4. **Neutrino phenomenology** for neutrino experiments. Understanding how well different neutrino properties including BSM effects can be measured and constrained by future neutrino experiments of all stripes (oscillations, both long- and short-baselines, CEvNS, solar, atmospheric, SN, and UHE neutrinos, direct detection experiments);
5. **Non-neutrino phenomenology** for neutrino experiments (e.g., searches for DM in neutrino experiments, searches for hidden sectors, etc);
6. Computing **matrix elements for neutrinoless double-beta decays**.



## White papers:

1. [Theoretical tools for neutrino scattering: interplay between lattice QCD, EFTs, nuclear physics, phenomenology, and neutrino event generators](#) (commissioned by TF11/NF08, NF06, TF05, RF04)
2. [Theory of neutrinoless double beta decay](#) (commissioned by TF11/NF08, TF05, RF04)
3. [Muon colliders for neutrinos](#) (new topic with TF, EF, under debate)

## Workshops:

1. [Mini-workshop](#) on Neutrino Theory. [21-23 September, 2020](#) (more general, with abstract submission)
2. Snowmass [mini-workshop](#) in preparation for the white paper “Theoretical tools for neutrino scattering: the interplay between lattice QCD, EFTs, nuclear physics, phenomenology, and neutrino event generators.” [August 23-25, 2021](#)
3. Theory of neutrinoless double beta decay WP [Oct 22nd @ 9 am ET](#)

# WP Theoretical tools for neutrino scattering

Across-frontiers effort

WP commissioned by [TF11](#)-[NF06](#)-[TF05](#)-[CompF02](#)-[RF04](#)

WP based on several [LOIs](#)

**Mini workshop in preparation for the whitepaper**  
“Theoretical tools for neutrino scattering:  
interplay between lattice QCD, EFTs, nuclear physics, phenomenology, and neutrino event generators”  
<https://indico.fnal.gov/e/miniwhitepaper>

- [The needs of the neutrino experimental program](#) (Coordinator: **Kendall Mahn**)
- [LQCD calculations for neutrino-nucleus scattering](#) (Coordinator: **Mike Wagman**)
- [\(Ab initio\) nuclear many-body studies for neutrino-nucleus scattering](#) (Coordinator: **Joe Carlson, Natalie Jachowicz**)
- [Coherent elastic neutrino-nucleus scattering](#) (Coordinator: **Louis Strigari**)
- [Neutrino-induced shallow and deep inelastic scattering](#) (Coordinator: **Natalie Jachowicz**)
- [Neutrino event generators](#) (Coordinator: **Steven Gardiner**)

We welcome your participation in the discussion, which will be reflected in the white paper. If you cannot attend, please fill out [this google form](#) with any comments or additions. The form will remain open after the workshop.

[Short session](#) (5-10 pages) because a WP on the topic is being written

[Long session](#) (10-15 pages) because no WP on the topic is being written

Main challenge and goal: provide a **unified and coherent** picture of the theory required to progress

# WP STATUS

Co-conveners invited colleagues to help them write their designated session

The writing process has been initiated

A first draft is expected in January 2022

# WPs of interest to NuSTEC

Co-conveners were made aware of the existence of NuSTEC related WPs

- H/D WP (R. Hill)
  - SIS/DIS WP (T. Katori)
  - NuSTORM WP (K. D. Long)
  - Electron Scattering WP (V. Pandey)
  - Event Generators (S. Gardiner CompF02, ...)
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- Theory of Neutrinoless Double Beta Decay WP (E. Mereghetti et al.)
  - FPF (V. Pandey)

# Important Deadlines

**15 March 2022:** Due date for contributed papers (“white papers”)

All info related to Snowmass can be found here

<https://snowmass21.org/theory/neutrino>