

NF04: Neutrinos from Natural Sources

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NF04 Topics

This topical group covers neutrino detection from all natural sources, including the Earth and astrophysical sources, as well as modeling of neutrino physics in these sources.

Specific topics include:

- Solar: 26
- Geo: 9
- Supernova: 28
- Atmospheric: 16
- Extragalactic/high energy: 23
- Early universe: 3

https://snowmass21.org/neutrino/natural_sources/start

Solar neutrinos: 26 LOIs received

- CNO flux → metallicity
- 8B neutrino flux and spectrum → NSI
- 7Be neutrino flux
- PP neutrino flux and spectrum → luminosity, magnetic moment
- hep neutrino flux
- Model improvements for heavy element fluxes (CNO, 8B, 7Be)
- Dark matter self-annihilation in the Sun

Geoneutrinos: 9 LOIs received

- Geoneutrino flux with high statistics
- Spectral measurement
- U/Th content
- Geographical spread of measurements to understand crust/mantle ratio
- Possible enhancements via doping, directionality

Supernova neutrinos: 28 LOIs received

- Neutrino Physics/BSM opportunities (neutrino flavor conversions, neutrino properties, dark sector and other BSM physics involving neutrinos)
- Synergy among different detector technologies (flavor-blind and flavor sensitive, neutrino and antineutrino detectors)
- Improved alert system for the detection of SN neutrinos (SNEWS 2.0)
- New technologies (e.g. based on CEvNS)
- Signal interpretation and multi-messenger connections (dependent on improving on theoretical modeling of neutrino-neutrino interactions and related physics)
- DSNB detection (first detection followed by precision measurement)

Solar, geo & SN detection approaches

- LNG (LXe, LAr) TPC, with possibility of low-bkg focus → e-ν scattering, CEνNS
- Gaseous He TPC
- Liquid noble bubble chamber
- Water with possibility of Gd doping (also underwater, ice)
- Liquid scintillator, including water-based, slow scintillators, and doping
- Directionality
- Opaque scintillator with fibre readout (“liquidO”)
- Several additional options for CEνNS detection (CsI, NaI, Ge, Pb)
- A neutrino detector on a spacecraft
- Calibration methods required (n) for nuclear recoil detection

Atmospheric neutrinos: 16 LOIs received

- Several ongoing and the next-generation experiments are proposed.
- Precise measurement of neutrino oscillation parameters and BSM like sterile neutrinos, non-standard neutrino interactions, neutrino decoherence, Lorentz Invariance Violation, neutrino decay, neutral heavy leptons, exotic signatures of black hole evaporation, possibility of the new vector/scalar weak boson.
- Atmospheric neutrino flux prediction via accelerator experiment.
- Other ideas of detection; e.g. nuclear recoil.

Extragalactic: 23 LOIs received

- Push the boundary of the observable neutrino universe to the **ultrahigh energy** regime using air shower imaging or with large radio arrays
- Increase the instrumented volume of optical neutrino telescopes to better study high energy neutrinos
- Increase multi-messenger target of opportunities to find counterparts to HE nus
- Rich particle-physics opportunities including: tests of BSM physics (ex. Lorentz invariance violation and neutrino decay), HE neutrino-nucleon cross-section measurements and inelasticity distribution, flavour ratio, Glashow resonance

Early universe: 3 LOIs received

- Synergy between Stage-4 CMB experiments and terrestrial neutrino experiments for measurement of neutrino absolute mass and mass ordering
- Flavor physics and neutrino physics in dense environments
- Weak decoupling and BBN physics (e.g. precise measurement of N_{eff} with Stage-4 CMB experiments, helium and deuterium abundances)
- Neutrino portal to dark sector and BSM physics (e.g. sterile neutrinos)
- Synergy between upcoming cosmological surveys and advanced numerical simulations
- Upcoming experimental surveys (e.g. PTOLEMY)

NF04 Workshop plans

- Mondays: Nov 9 - Dec 14 (skipping Nov 23), 10 am - 12 pm PST/1-3 pm EST
- 5 (virtual) workshops will further explore some of the topics introduced in the LOIs
- Will focus on 1-2 topics per workshop
- Will request overview talks on areas of common interest, with plenty of time for discussion and community input
- Detailed agenda will be announced soon

NF04 Relevant parallel sessions at CPM

- Neutrinos and astroparticles
- Neutrinos and underground facilities