

IRN Neutrino contribution to the European Strategy for Particle Physics Update (ESPPU)

THEORY

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Theory is a crucial part of the general effort of the neutrino community to understand the fundamental properties of neutrinos and to identify the new physics at the origin of their masses

It is therefore important to maintain a sustained activity in neutrino theory in order to be able to fully exploit and interpret experimental results – and sometimes to guide experimental searches

Theoretical activities in neutrino physics

- models and theoretical methods to compute neutrino cross sections
- flavour models predicting neutrino masses and lepton mixing angles / δ_{CP} ; potential correlations with the matter-antimatter asymmetry of the Universe
- signatures of new physics in neutrino experiments (non-standard neutrino interactions (NSIs), non-unitarity of the PMNS matrix, light sterile neutrinos...)
- constraining the neutrino mass generation mechanism (e.g., heavy neutral leptons searches at the LHC / SHiP / FCC-ee)
- also relevant for LBL physics program : predictions of Grand Unified models for proton lifetime and decay modes; theoretical predictions for supernovae neutrinos and the diffuse supernovae neutrino background
- nuclear matrix element calculations for neutrinoless double beta decay

Recommendations

CERN has always been a privileged place for exchanges between theorists from various countries, especially from Europe. It is important to reinforce this role by encouraging and supporting initiatives such as the annual CERN Neutrino Platform Pheno Week.

CERN could also play a major role in fostering further collaboration between experimentalists and theorists and between different LBL (and non-LBL) experiments in the neutrino domain. In support to this activity, CERN could provide crucial help to develop common frameworks and software platforms to host programs of Monte Carlo simulation, and provide computing power for comparison and combination of their results