INSS 2026 project : Supernova

Haowei Zheng, Justin Mitchell, Lea Schlickmann, Maël Martin

July 10th 2026

SNEWPY: from flux simulation to event rate

SNEWPY is a Python package for working with supernova neutrinos.

It gives us the ability to:

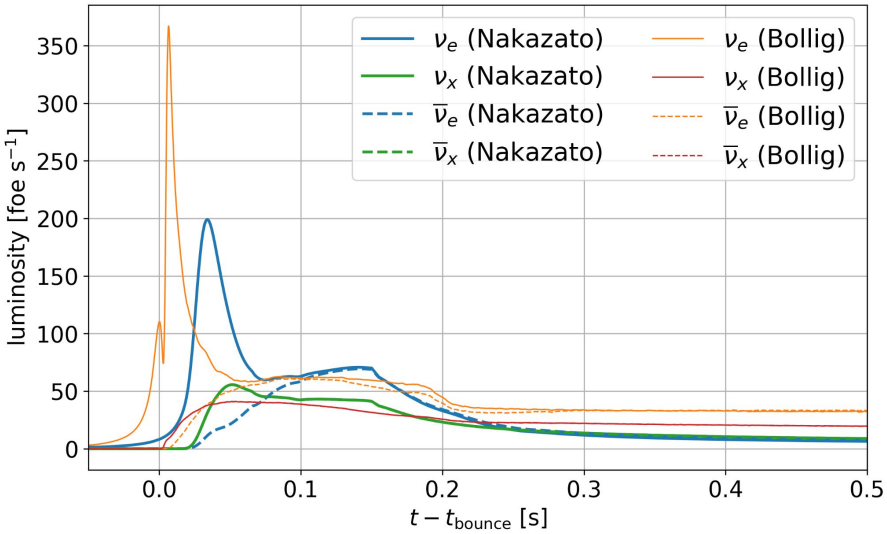
- Compare the flux predictions from different supernova flux models (Energy/time from bounce)
- Oscillate the neutrino flavors with a set of PMNS parameters
- Predict event rate with different detector setups using SNOwGLoBES

Official boring logo

Our very cool new logo

Comparing supernova models with SNEWPY

Tutorial example : comparison between Nakazato and Bollig models



Free input parameters :

Nakazato :

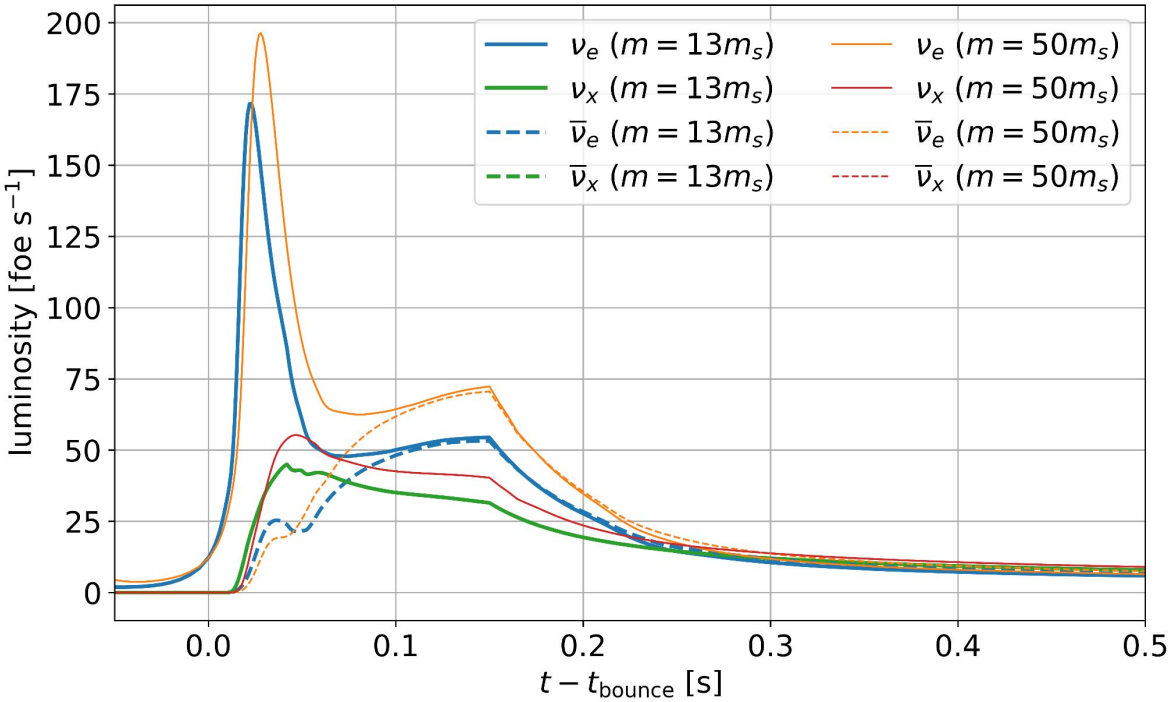
→Progenitor mass
→Revival time
→metallicity
→equation of state

Bollig :

→Progenitor mass

Different models imply several free and fixed parameters resulting in different time flux

Same model different progenitor mass



- used Nakazato model
- varied progenitor mass while keeping other parameters constant (revival_time=100ms, metallicity=0.02, eos='shen')

Comparing supernova models with SNEWPY

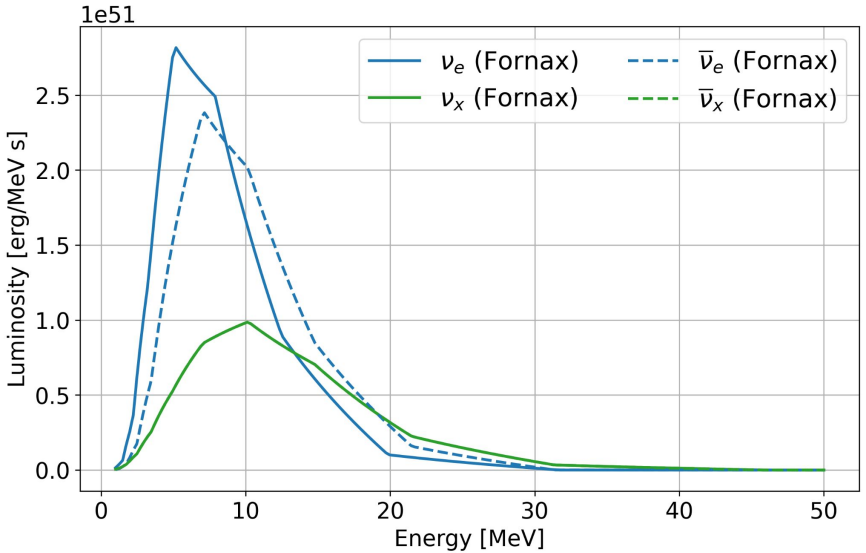
Looking at the initial energy spectrum for different models : Fornax, Fisher and Warren

How the **Fornax** model is build :

→3D modeling trying to faithfully reproduce the explosion mechanism

→ Fixed metallicity and the covered progenitor mass range from 12 to 26 M_{solar}

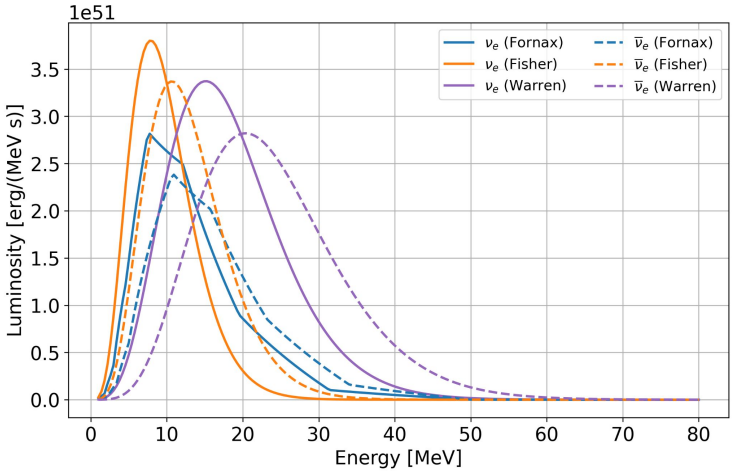
→High calculation cost



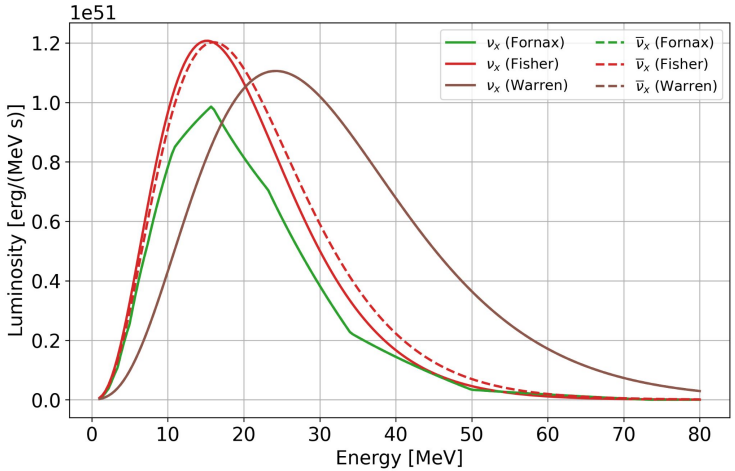
Comparing supernova models with SNEWPY

Looking at the initial energy spectrum for different models : Fornax, Fisher and Warren

Fisher : 1D modeling, “artificial” explosion, fixed progenitor mass



Warren : 1D modeling, turbomixing parameter, wide range of progenitor mass, low calculation cost

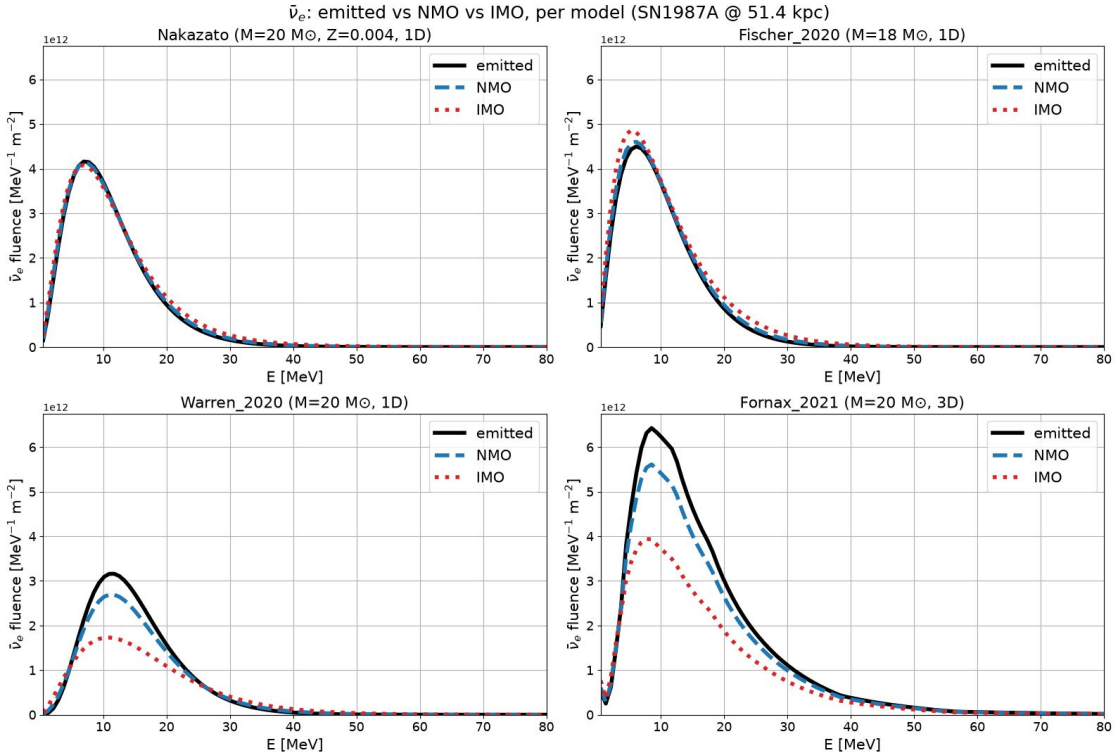


The energy spectra show different results according to the model. Only a new supernova detection should be able to confirm or reject these different models.

Oscillated Flux

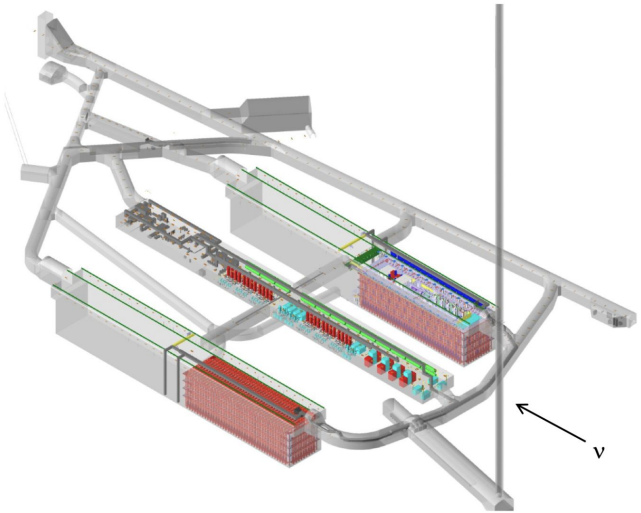
Neutrino oscillation controls the flux leaving the supernova through MSW effect

- Oscillation stops after a while through decoherence
- Mass ordering affects the oscillated spectrum
- Currently, very model dependent…



Next-generation detector for supernova neutrino observation

DUNE →40kTons of LArTPCs



Channel	Liver-more	GKVM	Garching
$\nu_e + {}^{40}\mathrm{Ar} \rightarrow e^- + {}^{40}\mathrm{K}^*$	2648	3295	882
$\overline{\nu}_e + {}^{40}\mathrm{Ar} \rightarrow e^+ + {}^{40}\mathrm{Cl}^*$	224	155	23
$\nu_X + e^- \rightarrow \nu_X + e^-$	341	206	142
Total	3213	3656	1047

→More than a thousand of events should be detected for a 10 kpc supernova

→DUNE can provide unique information about the neutronisation burst through its sensitivity of the ν_e

→DUNE can also reconstruct the supernova position thanks to the elastic scattering channel