Introduction to the NuFact 2024 Working Group 5

Beyond the PMNS matrix

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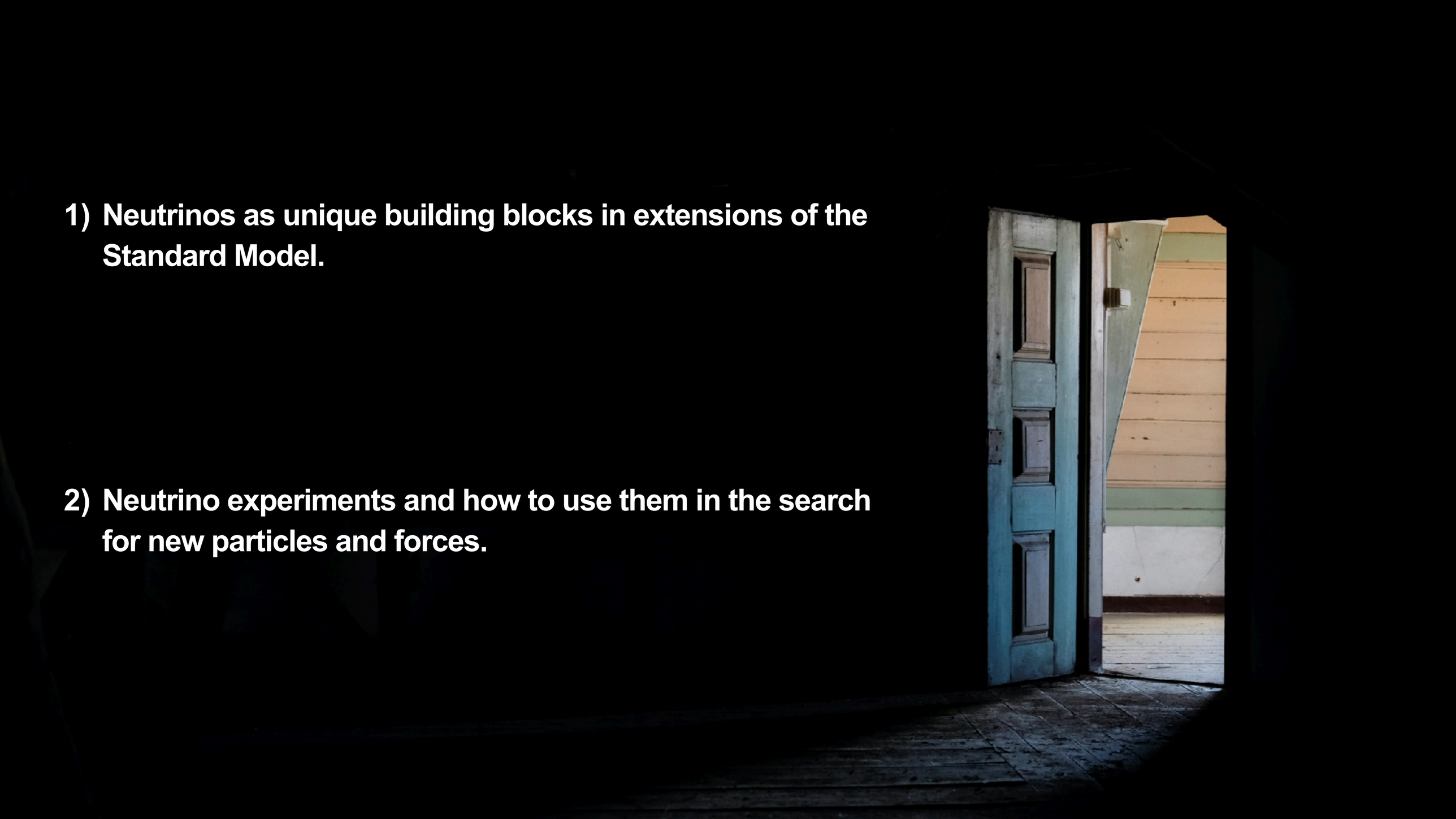
Thanks Koun and Julia for doing a lot of the heavy lifting!

1) Neutrinos as unique building blocks in extensions of the Standard Model.

2) Neutrino experiments and how to use them in the search for new particles and forces.

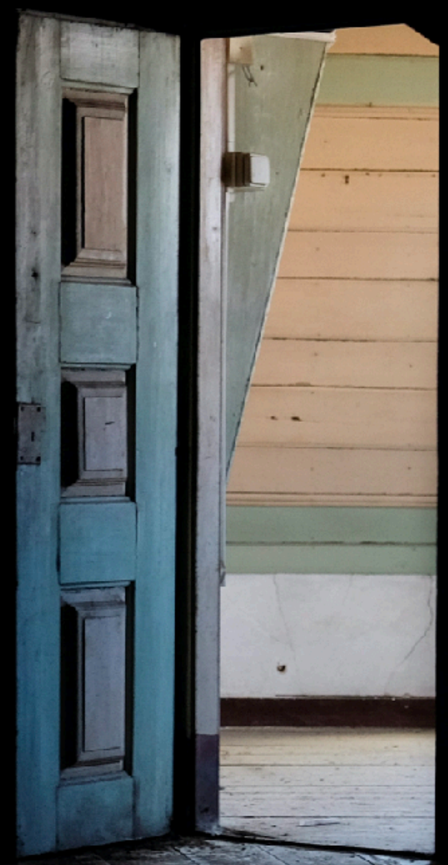


1) **Neutrinos as unique building blocks in extensions of the Standard Model.**

- the only $U(1)_{\mathrm{EM}}$-singlet fermions of the SM,
- mass mechanism unknown,

2) **Neutrino experiments and how to use them in the search for new particles and forces.**

- built for rare phenomena, crucial part of intensity frontier,
- (several) anomalies observed.



Completing the neutrino picture

Why are we excited for prospects of new physics in the neutrino sector?

Completing the neutrino picture

Early 1990s

NEUTRINO MOMENTS, MASSES AND CUSTODIAL SU(2) SYMMETRY *

Howard GEORGI and Michael LUKE

Lyman Laboratory of Physics, Harvard University, Cambridge, MA 02138, USA

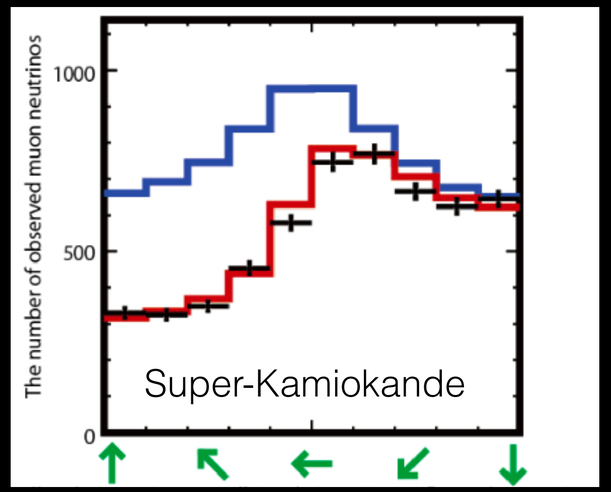
1. The problem

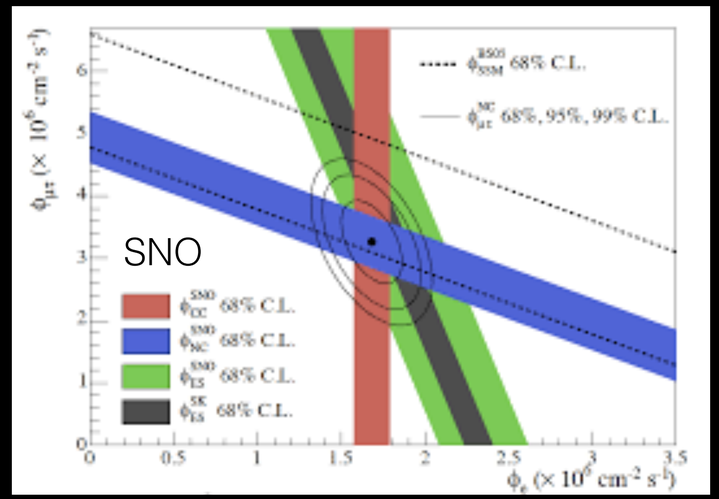
Most likely, the solar neutrino problem [1] has nothing whatever to do with particle physics. It is a great triumph that astrophysicists are able to predict the number of B^8 neutrinos coming from the sun as well as they do, to within a factor of 2 or 3 [2]. However, one aspect of the solar neutrino data, the apparent

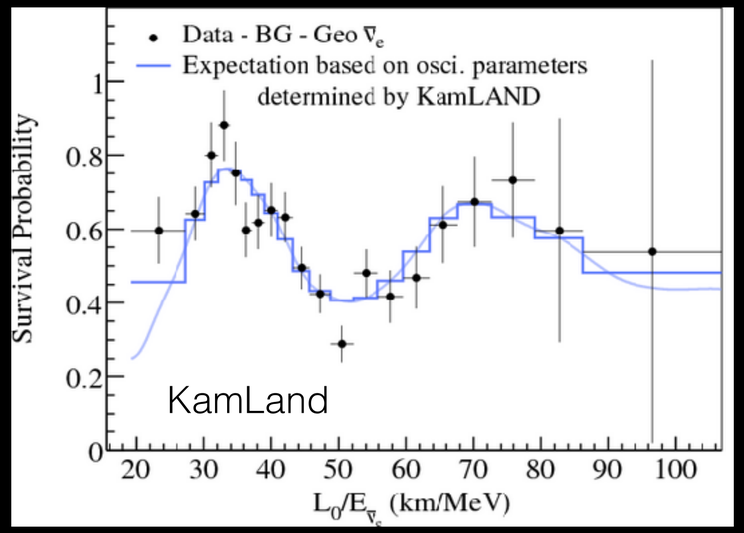
Completing the neutrino picture

Theory expectation	Experiment
Massless neutrinos.	No.
Mixing is small.	No.
Third angle θ_{13} is zero.	No.

The 2000 — 2020



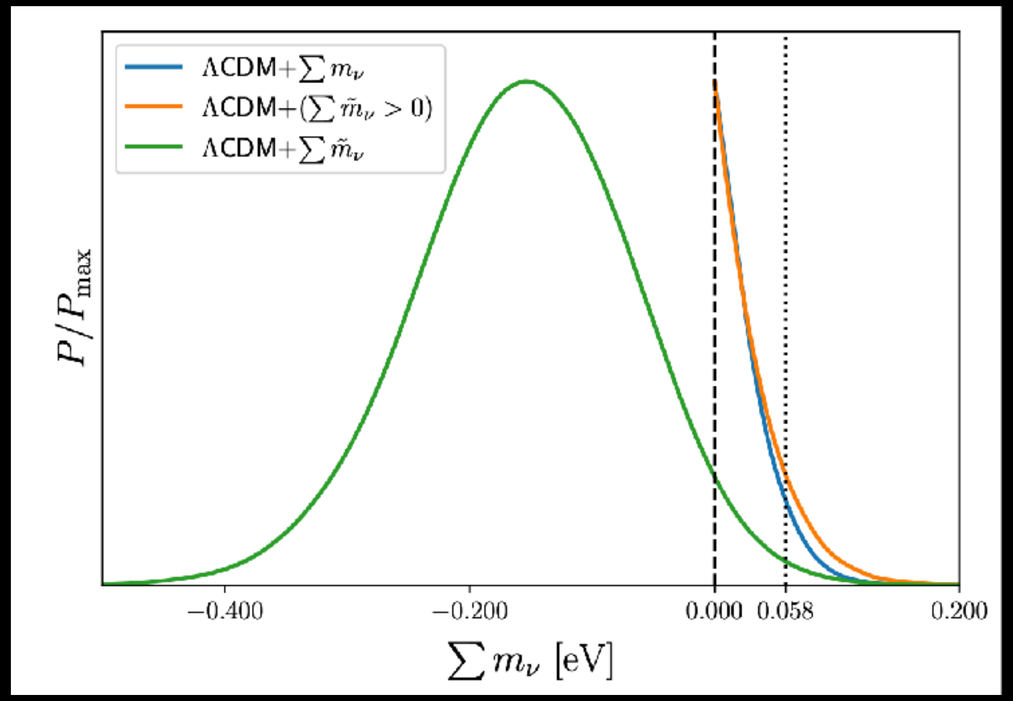




Completing the neutrino picture

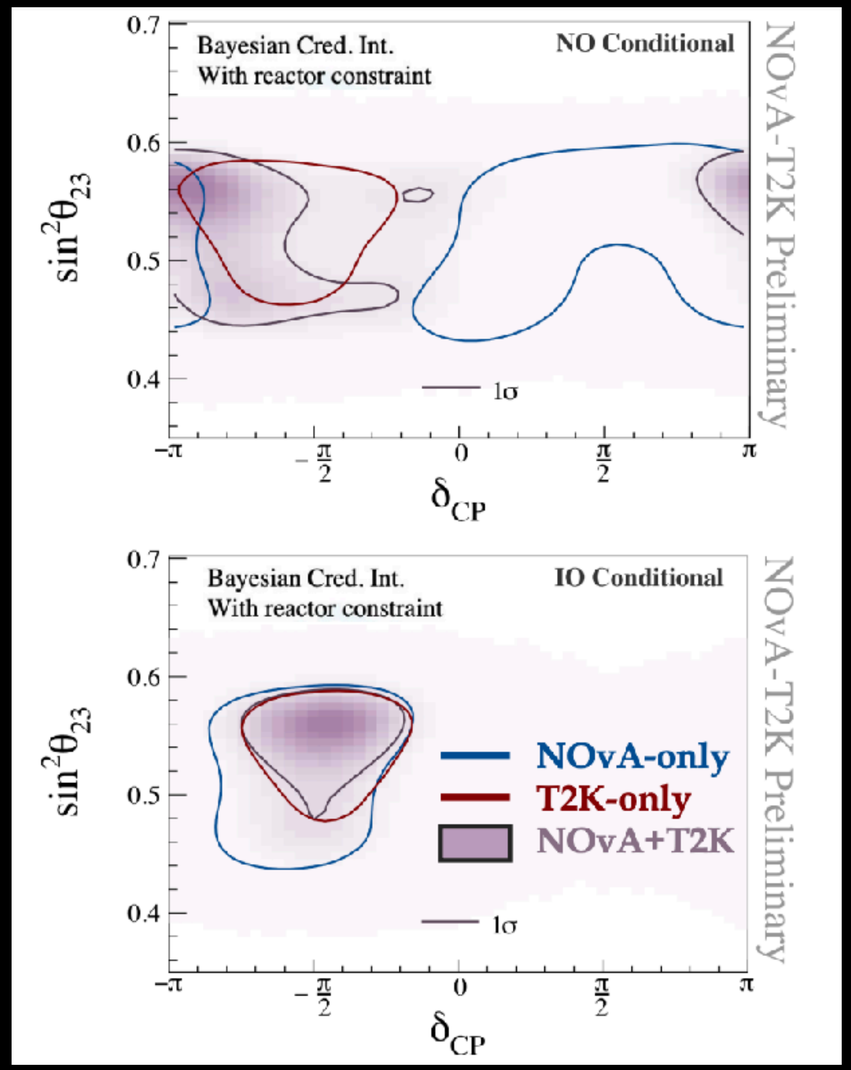
DESI on sum of neutrino masses

N. Craig, D. Green,J. Meyers, S. Rajendran



Now

Nova T2K joint fit



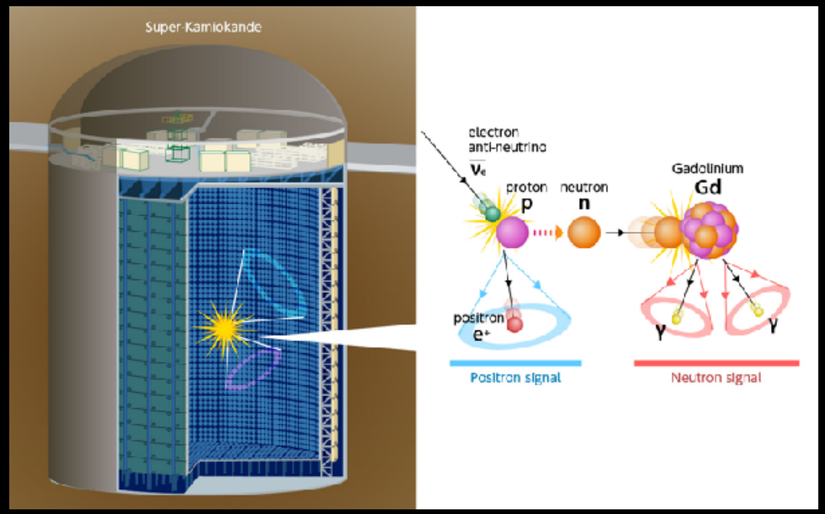
Neutrinos never seem to like the status quo!

We are looking in places we never looked before:

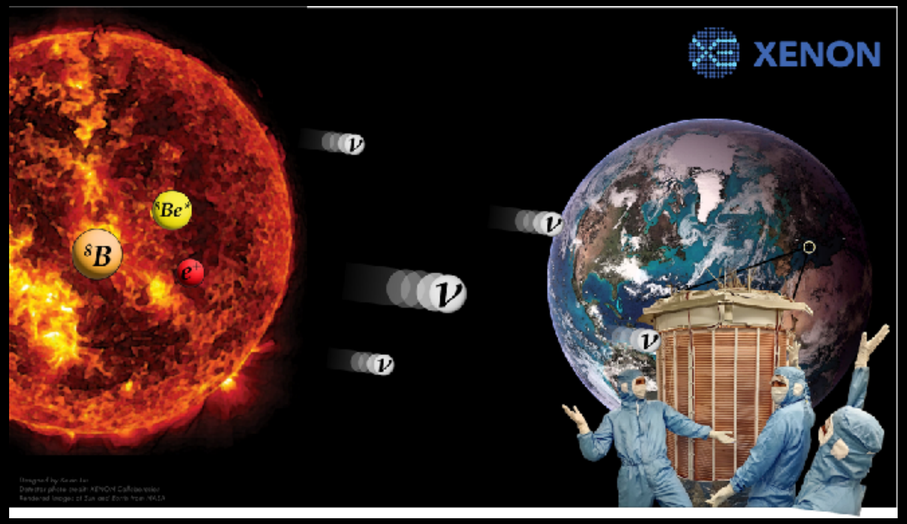
For example:

- Highest-energy neutrinos with neutrino telescopes
- Diffuse Supernova Neutrino Background at SK.
- Solar neutrinos with coherent scattering (CEvNS).

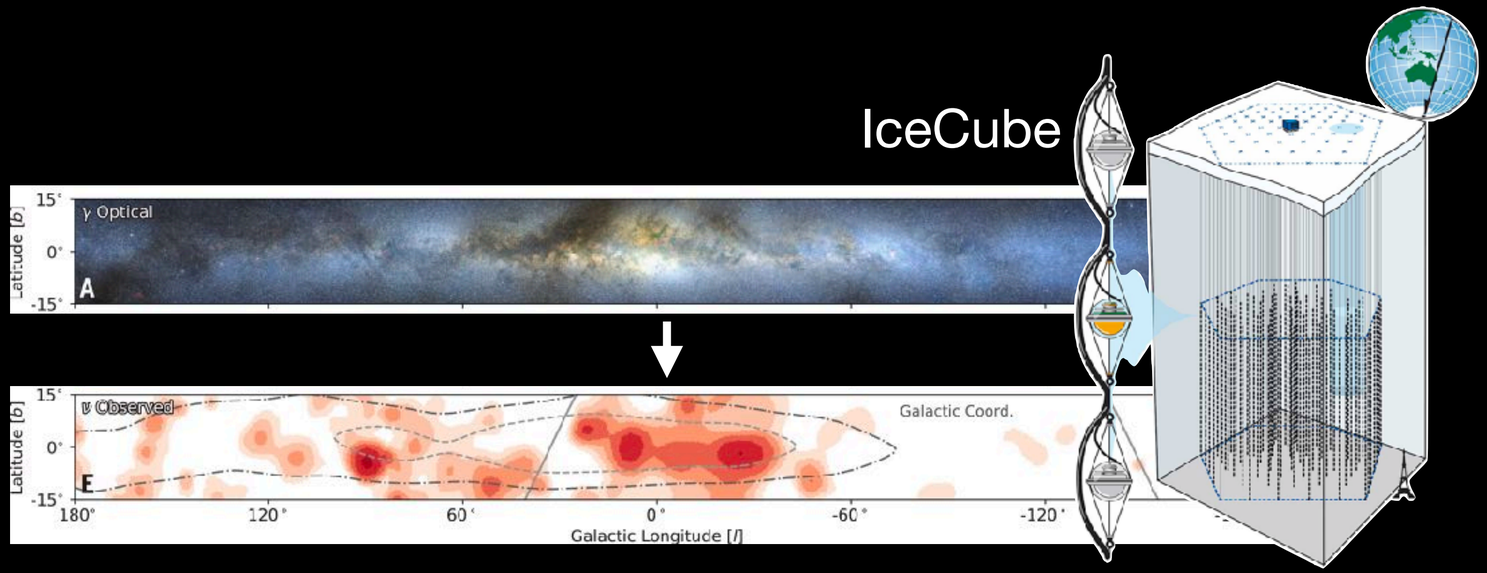
Super-Kamiokande



XENONnT



IceCube



This NuFact edition, WG5 will explore these questions:

1) Where do we look for the most valuable hints of **the origin of neutrino masses**?

2) How to identify connections between **neutrinos and dark matter** (theory & experiment)?

3) Have we already stumbled on new physics, e.g., at **short baselines**?

4) How do we exploit the dawn of new probes of **astrophysical neutrinos** to learn about new physics?

5) Oscillations can be modified by many new effects. How to best leverage the worldwide neutrino program to **disentangle "*new*" new physics in oscillations**?

We will come back to these questions on Saturday!

WG5 parallel sessions
Monday (1 session)

Leveraging high statistics of neutrino interactions and high-resolution detectors.

New physics at short-baseline neutrino experiments.

New physics
in neutrino interactions

Chair: Julia Gehrlein (Colorado State University)

MicroBooNE's Beyond Standard Model Physics Program	*Keng Lin*
E1100, #402	13:45 - 14:05
Constraints on new physics with (anti)neutrino-nucleon scattering data	*Richard Hill*
E1100, #402	14:05 - 14:25
Searching for anomalous photon and dark-sector e+e- pairs in the MicroBooNE detector	*Erin Yandel*
E1100, #402	14:25 - 14:45
Search for a Long-Lived $\mu\mu$ Resonance at ICARUS in SBN	*Nathaniel Rowe*
E1100, #402	14:45 - 15:05
Model-independent new-physics simulation with GENIE	*Komninos-John Plows*
E1100, #402	15:05 - 15:25

WG5 parallel sessions
Tuesday (1/2 sessions)

Looking up at the sky for messengers of new physics.

New ideas to study the highest energy neutrinos and the cosmic neutrino background

and how they can reveal new forces.

New physics
in astrophysical neutrinos

Chair: Shiqi Yu (Utah University)

Unlocking high energy tau-neutrino astronomy with the TAMBO deep-valley detector array	*Robert-Mihai Amarinei*	
E1100, #402		13:45 - 14:05
Probing self-interacting sterile neutrino dark matter with the diffuse supernova neutrino background	*Ann Suliga*	
E1100, #402		14:05 - 14:25
Constraining long-range interaction using the flavor composition estimates from astrophysical neutrino experiments	*Sudipta Das*	
Neutron Stars as a Probe of Cosmic Neutrino Background	*Garv Chauhan*	
E1100, #402		14:45 - 15:05

WG5 parallel sessions
Tuesday (2/2 sessions)

More with astrophysical neutrinos, now at low energies with coherent elastic neutrino-nucleus scattering.

Even newer experimental ideas: paleo detectors.

Neutrino x dark matter complementarity

Chair: Peter Denton (Brookhaven National Laboratory)

Probing new physics from neutrinos at dark matter direct detection experiments	*Gonzalo Herrera*	
E1100, #402	16:15 - 16:35	
Looking at the flavor composition of solar neutrinos	*Nityasa Mishra*	
E1100, #402	16:35 - 16:55	
Investigating the future of proton decay searches using paleo detectors	*Cassandra Little*	
E1100, #402	16:55 - 17:15	
Physics opportunities with kaon decay-at-rest neutrinos: search for sterile neutrino and non-standard interactions		
Mr Aman Gupta		
A comprehensive analysis of supernova neutrino-dark matter interactions	*Deepak Sathyan*	
E1100, #402	17:35 - 17:55	

WG5 parallel sessions
Thursday (1/2 sessions)

Constraining short-baseline neutrino oscillations and testing longstanding anomalies:

Testing MiniBooNE and LSND with the SBN program, JSNS^2, and reactor neutrinos.

Looking for sterile neutrino oscillations

Chair: Minerba Betancourt (Fermilab)

Status of the Short-Baseline Near Detector at Fermilab	*Tereza Kroupova et al.*
E1100, #402	13:45 - 14:05
First Results of the ICARUS Experiment at Fermilab	*Jacob Zettlemoyer*
E1100, #402	14:05 - 14:25
New results in the JSNS2 experiment	*DongHa Lee*
E1100, #402	14:25 - 14:45
Latest results from MicroBooNE's electron neutrino Low Energy Excess Search	*Fan Gao et al.*
E1100, #402	14:45 - 15:05
The STEREO neutrino experiment: Overview & latest results.	*Dr Ilham El Atmani*
E1100, #402	15:05 - 15:25

Joint WG1 + WG5 parallel session
Thursday (2/2 sessions)

Leveraging precision measurements of oscillation to test tiny deviations from PMNS.

Non-standard interactions and the role of new fundamental symmetries.

Exotic flavor evolution in oscillations

Chair: Vishvas Pandey (विश्वास पाण्डेय) (Fermilab)

Neutrino mass ordering sensitivities at DUNE, HK and KNO in presence of scalar NSI	*Dr Moon Moon Devi*	
A1100, #401	16:15 - 16:35	
T violation at a future neutrino factory	*Sho Sugama*	
A1100, #401	16:35 - 16:55	
A plethora of long-range neutrino interactions probed by DUNE and T2HK	*Pragyanprasu Swain*	
A1100, #401	16:55 - 17:15	
Flavor-Dependent Long-Range $\mathbf{\nu}$ Interactions in DUNE and T2HK: Synergy Breeds Power	*Masoom Singh*	
A1100, #401	17:15 - 17:35	
Neutrino NSI from Ultralight Scalars	*Adrian Thompson et al.*	
A1100, #401	17:35 - 17:55	

Please keep in mind:

Our schedule is a small fraction of the beyond-the-PMNS world.
We will leave the rest to you!
Let us interact, exchange, and explore new ideas together.

Looking forward to many discussions this week!

Have fun!