# Working Group 5

## NuFact 2021 – Regione d'zoom, Cagliari

Richard Ruiz

Institute of Nuclear Physics – Polish Academy of Science (IFJ PAN)

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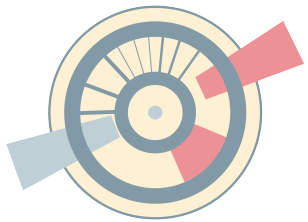
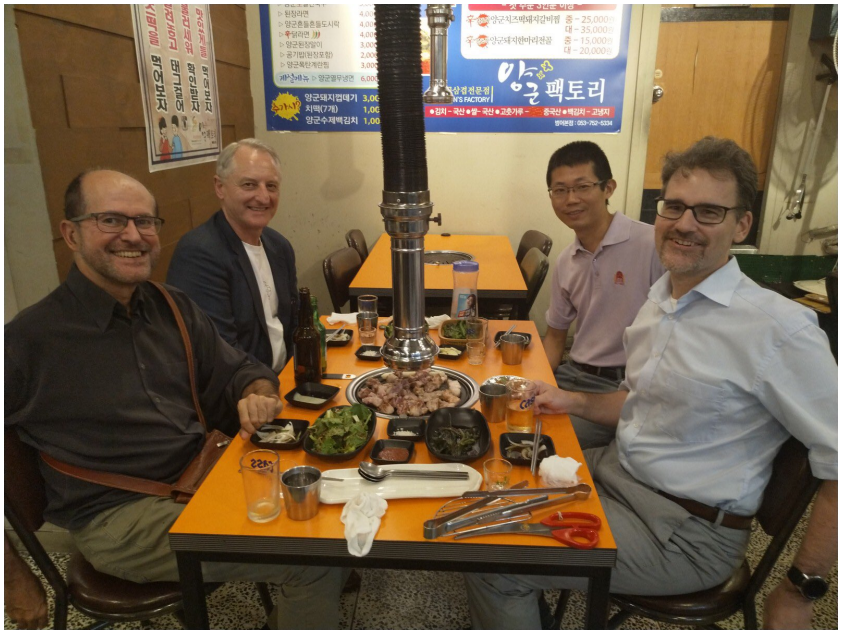


**welcome!**

**Thank you to fellow organizers, administrators, participants, chairs, speakers, and particularly Team WG5**

**Carsten Rott (Utah) and Ian Shoemaker (Virginia Tech.)**




**which one is WG5?**

# Working Group 5: New physics beyond PMNS

- Except for $\nu$ osc. (WG1), $\nu$ scattering (WG2) , and muons (WG4)!

**NuFACT 2021** is the twentysecond in the series of yearly international workshops which started in 1999 and which had previously been called the International Workshop on Neutrino Factories. The change of name to International Workshop on Neutrinos from Accelerators is related to the fact that the workshop program has, over the years, come to include all current and future accelerator and also reactor based neutrino projects, including also muon projects, not only the Neutrino Factory project.

The main goal of the workshop is to review the progress of current and future facilities able to improve on measurements of the properties of neutral and charged lepton flavor violation, as well as searches for new phenomena beyond the capabilities of presently planned experiments. The workshop is both interdisciplinary and inter-regional in that experimenters, theorists and accelerator physicists from Asia, the Americas and Europe share expertise with the common goal of reviewing the results of currently operating experiments and designing the next generation of experiments.

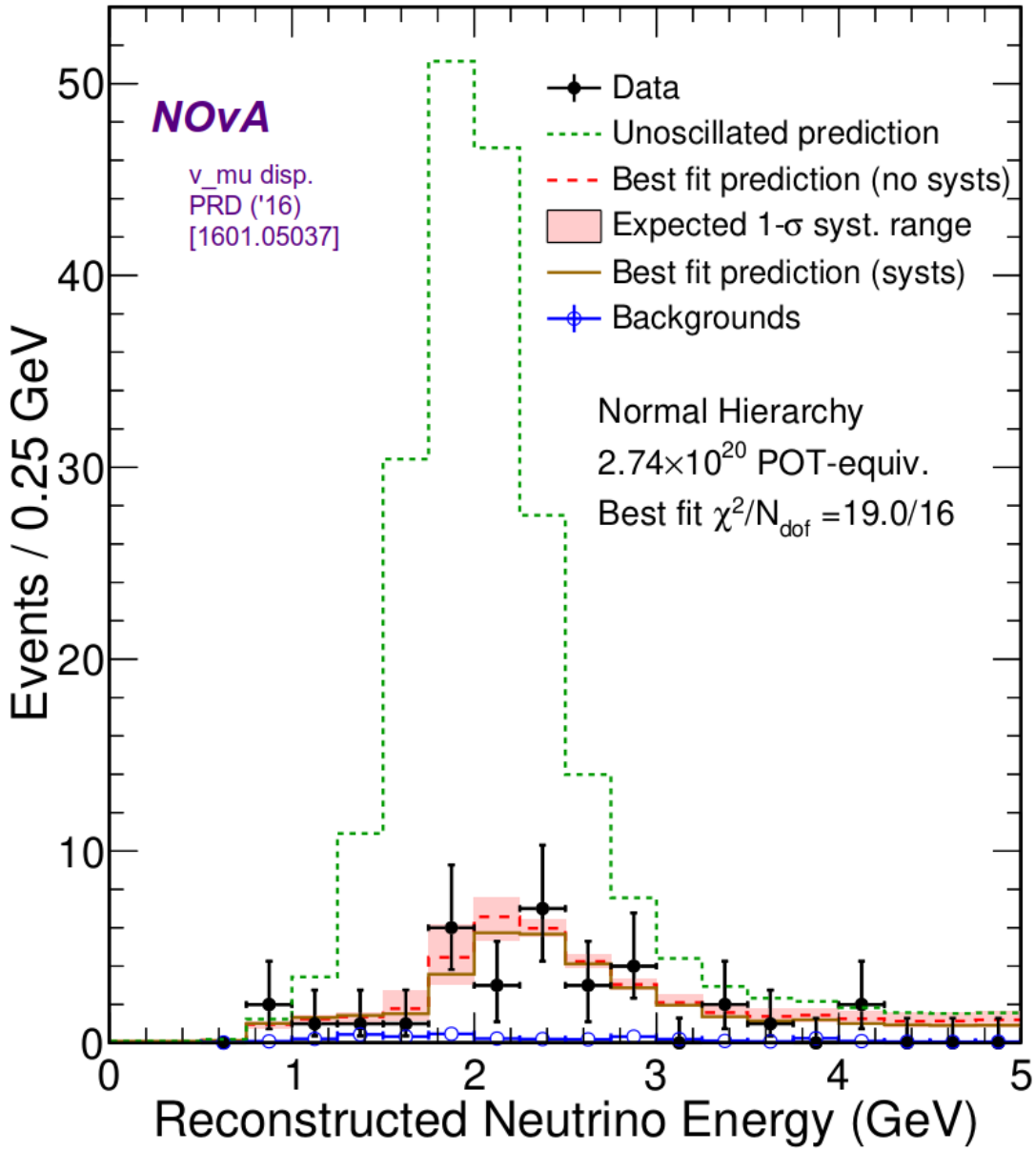
The **NuFACT 2021** workshop is divided into **six Working Groups** covering the following topics:

1. Neutrino Oscillation Physics (Working Group 1),
2. Neutrino Scattering Physics (Working Group 2),
3. Accelerator Physics (Working Group 3),
4. Muon Physics (Working Group 4), and
5. Neutrinos Beyond PMNS (Working Group 5)
6. Detectors (Working Group 6)

Moreover, there will be a special **session on Diversity, Education and Outreach**.

# $\nu$ evidence for new physics

**Problem:** according to the SM, $m_\nu = 0$. (The data disagree, obviously.)



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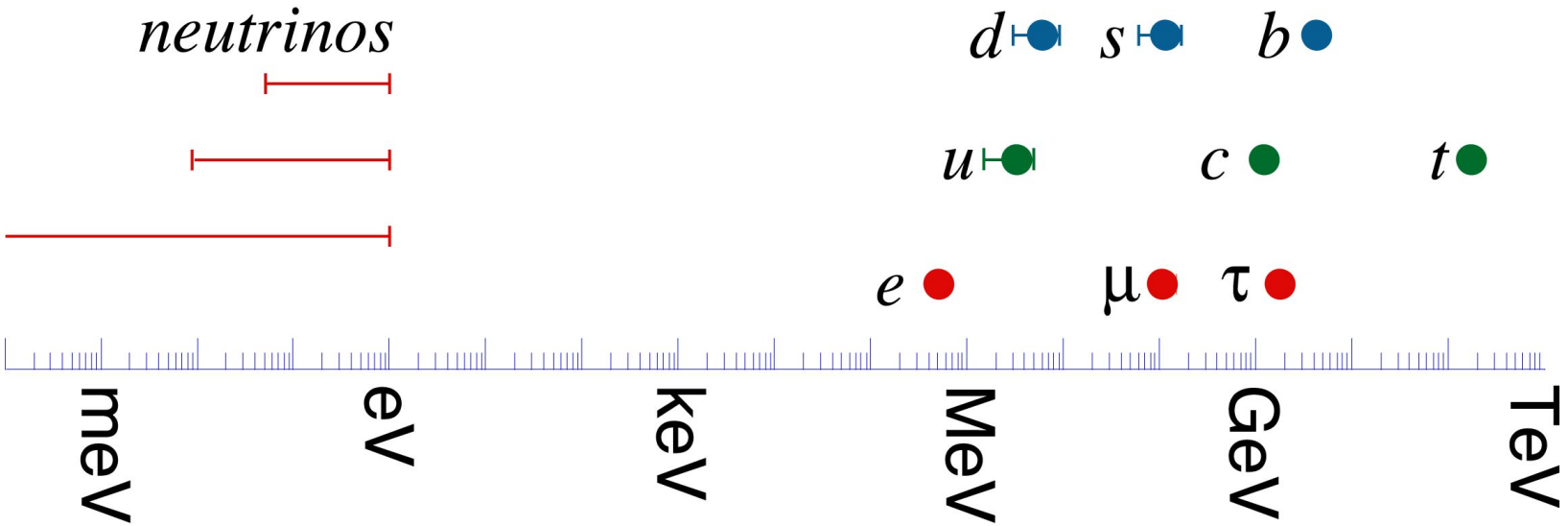



**Neutrino masses**  ('15) $\Longrightarrow$ **many open questions:**

- $\nu$ have mass. What is generating $m_\nu$?
- $\nu$ masses are *tiny*. What sets the scale of $m_\nu$?
- $m_\nu$ are nearly degenerate. What sets the pattern of $m_\nu$?
- $\nu$ carry no QCD/QED charge. Are $\nu, \overline{\nu}$ the same (Majorana)?

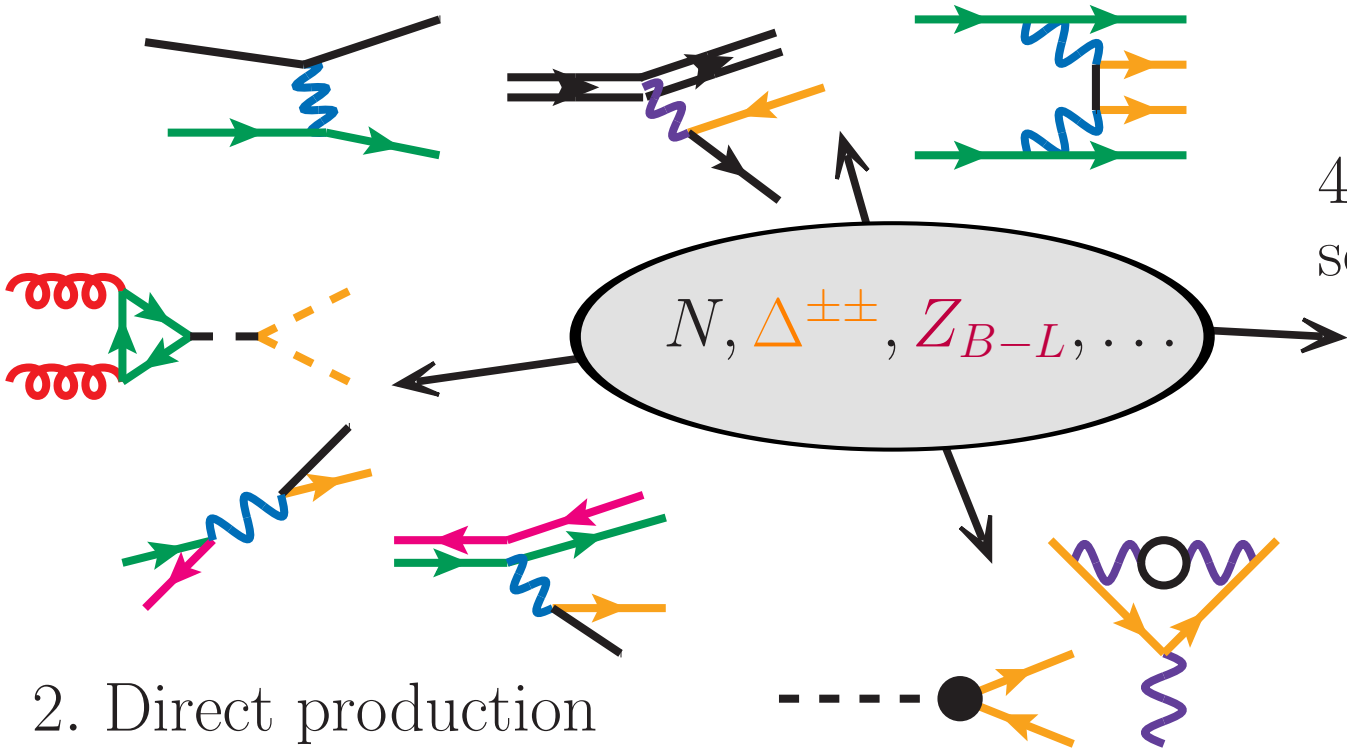
$m_\nu \neq 0$ + **renormalizability + SM gauge inv.** $\Longrightarrow$ **new particles!**

[Ma ('98)]

Incredibly powerful but also incredibly vague since new particles:

- ... can be light ☺ or heavy ☹
- ... can be short-lived ☺ or long-lived ☺
- ... can have SM gauge interactions, e.g., $H^{\pm\pm}$ in Type II Seesaw
- ... can have new gauge interactions, e.g. $\nu_R$ and $Z_{B-L}$ in $U(1)_{\mathrm{B-L}}$
- ... must couple to $\Phi_{SM}$ and $L$, often inducing collider processes that do not conserve **lepton number (LNV)** and/or **lepton flavor (LFV)**

# Many ways to explore neutrino mass models




For reviews on neutrino mass models and their tests, see, e.g.,
Y. Cai, J. Herrero-García, M. Schmidt, A. Vicente, R. Volkas [1706.08524];

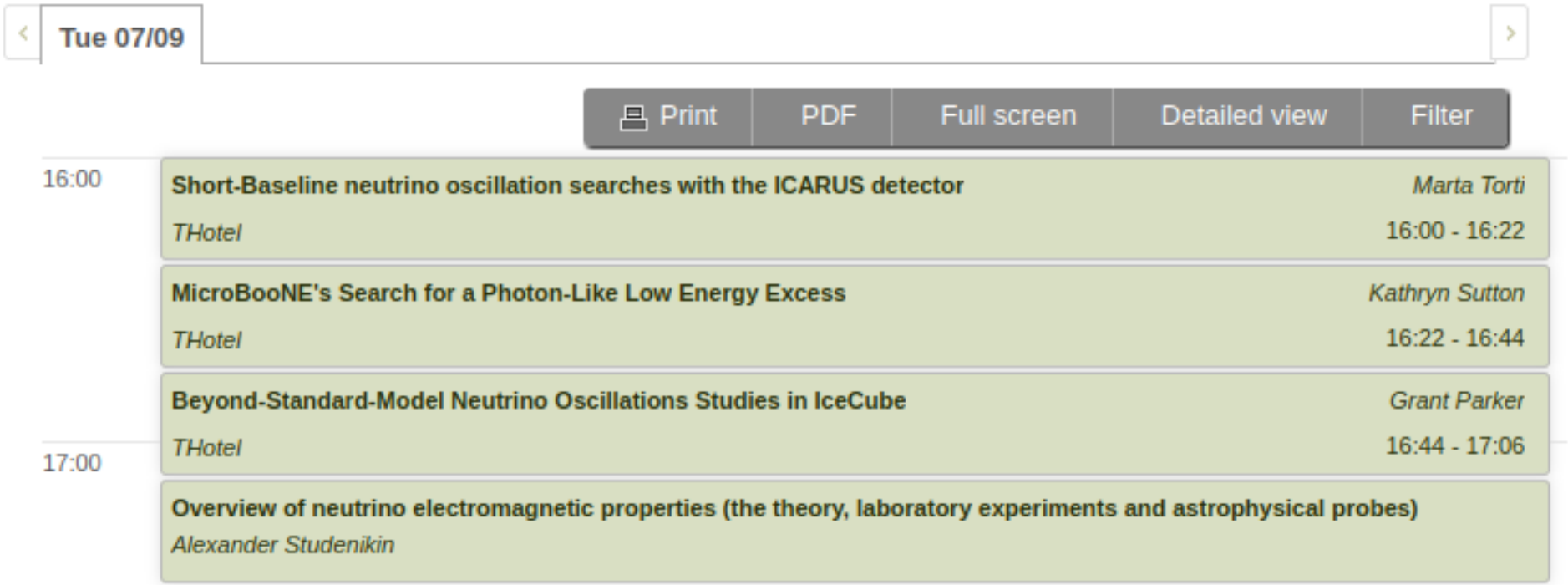
Y. Cai, T. Li, T. Han, RR [1711.02180]; S. Pascoli, RR, C. Weiland [1812.08750]

# Working Group 5 Agenda

# Day 2 (Tuesday)

# WG 1 + WG 5 Joint Session

- **Chair:** Neil McCauley



# Day 3 (Wednesday)

# WG 5 Sessions (three!)

- **Chairs:** Serguey Petcov, Vedran Brdar, and Zahra Tabrizi

| | | |
|---|---|---|
| 13:00 | Reactor antineutrino anomaly in light of recent flux model refinements<br>*Parallel 5* | *Zhao Xin*<br>12:40 - 13:02 |
| | Neutrino oscillations in presence of large extra dimensions at JUNO and TAO<br>*Parallel 5* | *Christoph Andreas Ternes*<br>13:02 - 13:24 |
| | Recent results of the DANSS experiment<br>*Parallel 5* | *Igor Alekseev*<br>13:24 - 13:46 |
| 14:00 | Recent results of the SoLid experiment<br>*Parallel 5* | *d Galbinski*<br>13:46 - 14:08 |
| | A New Approach to Probe Non-Standard Interactions in Atmospheric Neutrino Experiments<br>*Parallel 5* | *Mr Anil Kumar*<br>14:20 - 14:40 |
| | EFT at FASERnu: an experiment to probe them all<br>*Parallel 5* | *Zahra Tabrizi*<br>14:40 - 15:00 |
| 15:00 | Belle II experiment: status and prospects<br>*Parallel 5* | *Antonio Passeri*<br>15:00 - 15:20 |
| | Beyond the Standard Model Physics Prospects at Deep Underground Neutrino Experiment<br>*Parallel 5* | *Justo Martin-Albo et al.*<br>15:20 - 15:40 |
| 16:00 | Searches for New Physics with a Stopped-pion Source at the Fermilab Accelerator Complex<br>*Parallel 5* | *Jacob Zettlemoyer et al.*<br>16:00 - 16:20 |
| | New sources of leptonic CP violation at the long baseline experiments<br>*Parallel 5* | *Alessio Giarnetti*<br>16:20 - 16:40 |
| | Probing the effects of scalar Non Standard Interactions at Long Baseline Experiments<br>*Parallel 5* | *Mr Abinash Medhi*<br>16:40 - 17:00 |
| 17:00 | Recent searches for sterile neutrinos at NOvA<br>*Parallel 5* | *Jeremy Edmund Hewes*<br>17:00 - 17:20 |

# Day 4 (Thursday)

# WG 5 Sessions (three!)

- **Chairs:** Valentina De Romeri, Carsten Rott, Sacha Davidson

| | | |
|---|---|---|
| | Tests of neutrino mass models at LHCb<br>*Parallel 5* | *Martino Borsato*<br>12:40 - 13:00 |
| 13:00 | Tests of neutrino mass models at ATLAS<br>*Parallel 5* | *Tadej Novak*<br>13:00 - 13:20 |
| | Tests of neutrino mass models at CMS<br>*Parallel 5* | *Sungbin Oh*<br>13:20 - 13:40 |
| | FCC: a (heavy) neutrino factory<br>*Parallel 5* | *Alain Blondel*<br>13:40 - 14:00 |
| 14:00 | | |
| | Detecting and studying high-energy neutrinos with FASER$\nu$ at the LHC<br>*Parallel 5* | *Xin Chen*<br>14:20 - 14:42 |
| | Search for K+ decays to a lepton and invisible particles<br>*Parallel 5* | *Nicolas Lurkin*<br>14:42 - 15:04 |
| 15:00 | Status of the SND@LHC experiment<br>*Parallel 5* | *Eric Van Herwijnen*<br>15:04 - 15:26 |
| | Latest Results from JSNS2<br>*Parallel 5* | *Takasumi Maruyama*<br>15:26 - 15:48 |
| 16:00 | Beyond Tree Level at Neutrino Experiments<br>*Parallel 5* | *Vedran Brdar*<br>16:00 - 16:20 |
| | Status of the HOLMES experiment: commissioning of the ion implanter<br>*Parallel 5* | *Dr Giovanni Gallucci*<br>16:20 - 16:40 |
| | Latest results from the CUORE experiment<br>*Parallel 5* | *Alberto Ressa*<br>16:40 - 17:00 |
| 17:00 | Neutrinolss Double Beta Decay search with CUPID<br>*Parallel 5* | *Fabio Bellini*<br>17:00 - 17:20 |

# Day 5 (Friday)

# BSM-related Plenaries

- **Chairs:** Frederik Wauters, Carsten Rott

| | | |
|---|---|---|
| | **Coffee Break** *THotel* | 14:10 - 14:20 |
| | **Results from the g-2 experiment** *Plenary* — *Simon Corrodi* | 14:20 - 14:50 |
| 15:00 | **Lepton flavour physics in the neutrino and muon sector** *Plenary* — *Sacha Davidson* | 14:50 - 15:20 |
| | **muon experiments searching for CLFV** *Plenary* — *Gavin Hesketh* | 15:20 - 15:50 |
| | **Coffee Break** *THotel* | 15:50 - 16:00 |
| 16:00 | **Sterile neutrino searches** — *Carlos A. Argüelles-Delgado* | 16:00 - 16:30 |
| | **Theory overview of mass models** — *Goran Senjanovic* | 16:30 - 17:00 |
| 17:00 | **Exploring BSM Physics at Neutrino Oscillation Experiments** — *Sanjib Kumar Agarwalla* | 17:00 - 17:30 |
| | **Scientific Committee Meeting** — *Walter Marcello Bonivento et al.* | |
| 18:00 | *THotel* | 17:30 - 18:30 |

**The discovery of nonzero neutrino masses inspires many, many questions!**

**We hope WG5 talks will shed some light on these exciting mysteries!**

**Thank you!**

# Nu Masses and New Particles

Nonzero neutrino masses  $\Longrightarrow$ new degrees of freedom exist: [Ma'98]

$$m_\nu \neq 0 + \text{left} - \text{handed (LH) Weak currents}$$

$(renormalizability)$

LH Majorana Mass : $m_\nu^L \overline{\nu_L} \nu_L^c$ — Dirac Mass : $m_\nu^D \overline{\nu_L} \nu_R$

$(gauge\ invariance)$

$m_\nu^L = y\langle\Delta\rangle$ or new dynamics — $m_\nu^D = y\langle\Phi_{\rm SM}\rangle$

$m_\nu \neq 0$ + **renormalizability + gauge inv.** $\Longrightarrow$ **new particles!**