

BSM/Higgs Group

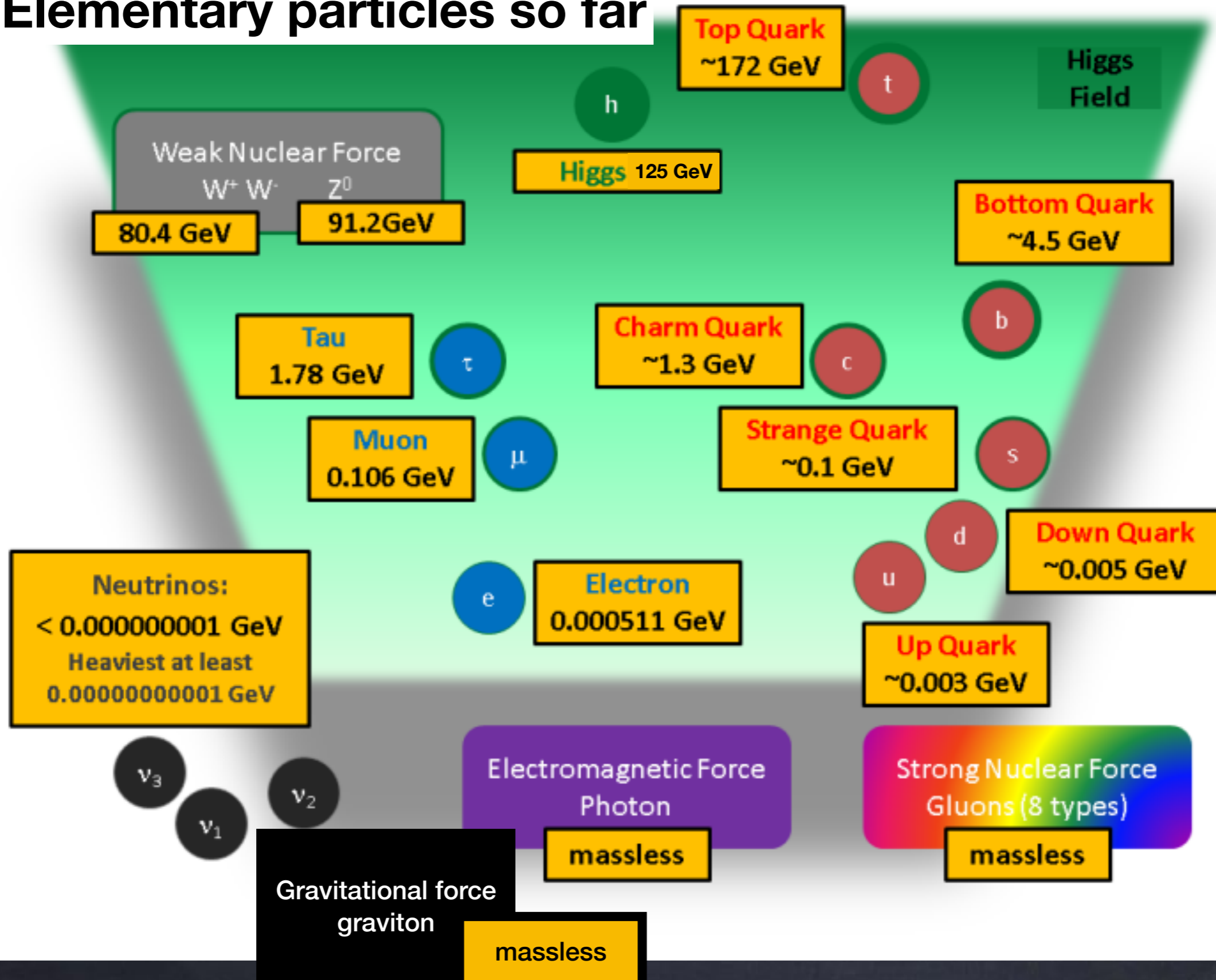
Pôle théorie IJClab
Journée des Nouveaux Entrants
13/05/2026

The diagram shows the Standard Model of particle physics as a grid of blocks. The blocks are color-coded: red for quarks, cyan for leptons, purple for forces, and grey for Higgs bosons. The grid is surrounded by cartoon characters with labels like 'Warping', 'ED', 'Susy', 'Anthropic', and 'Higgs boson'.

| Quarks | | | Forces | |
|---------|-----------|------------|-------------|----------|
| u | c | t | Z | γ |
| d | s | b | W | g |
| Leptons | | | Higgs boson | |
| e | μ | τ | 126 | 125 |
| ν_e | ν_μ | ν_τ | | |

P. Cámara, adapted from phdcomics.com

Elementary particles so far



Adapted from Matt Strassler's blog: <http://profmattstrassler.com/>

WHY BSM?

A number of observations cannot be explained within the framework of the Standard Model:

- Neutrino Oscillations
- Dark Matter
- Baryon Asymmetry
- Inflation

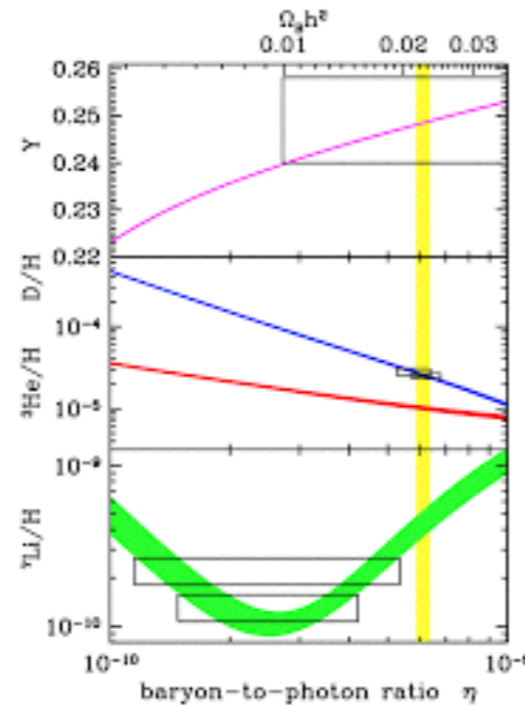
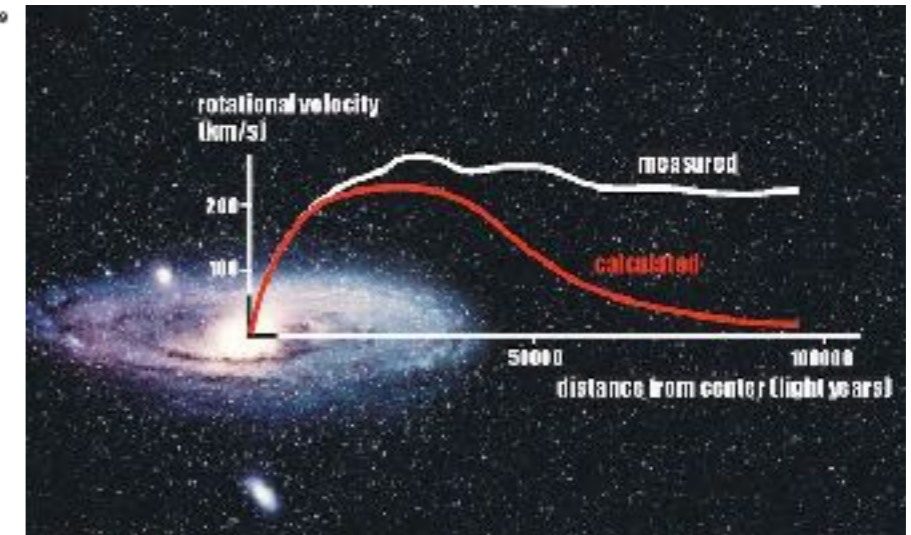
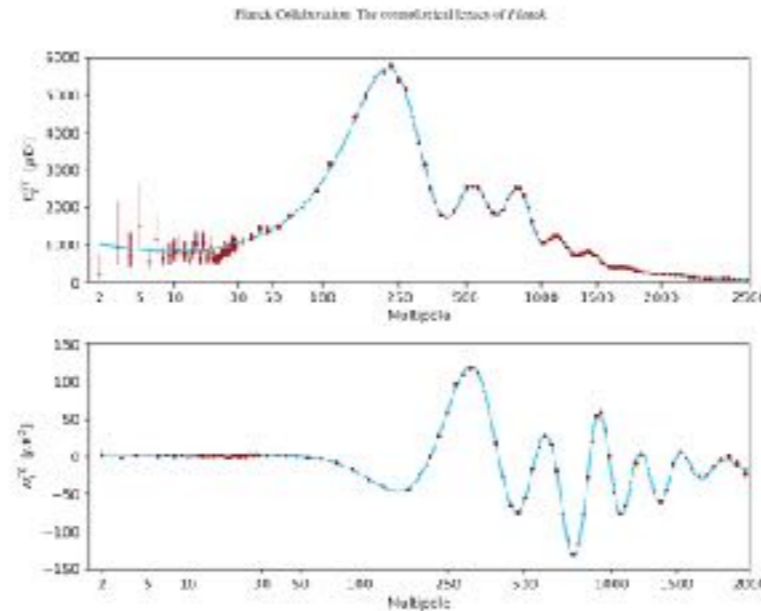
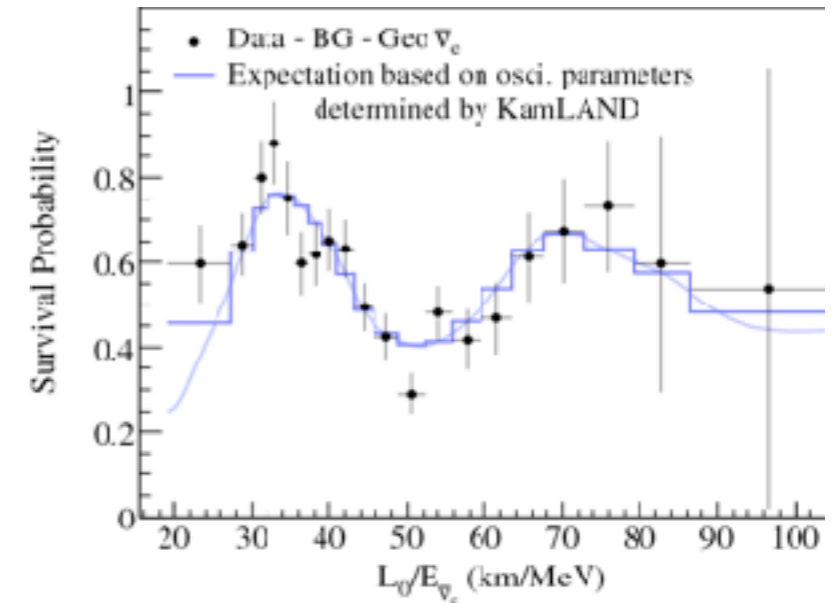


Fig. 1. Primordial abundances versus η , courtesy of R. Cyburt

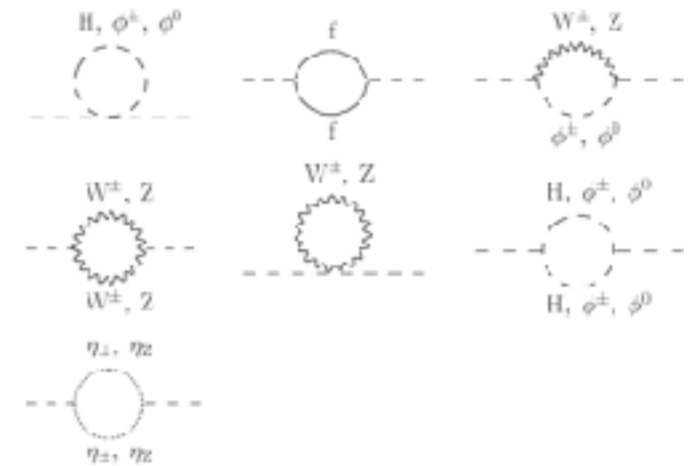
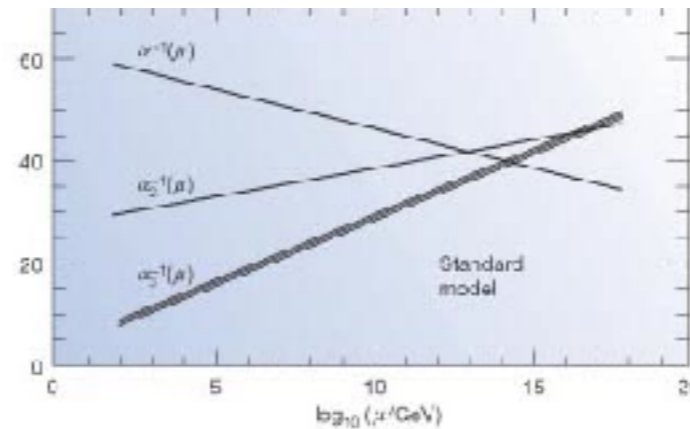
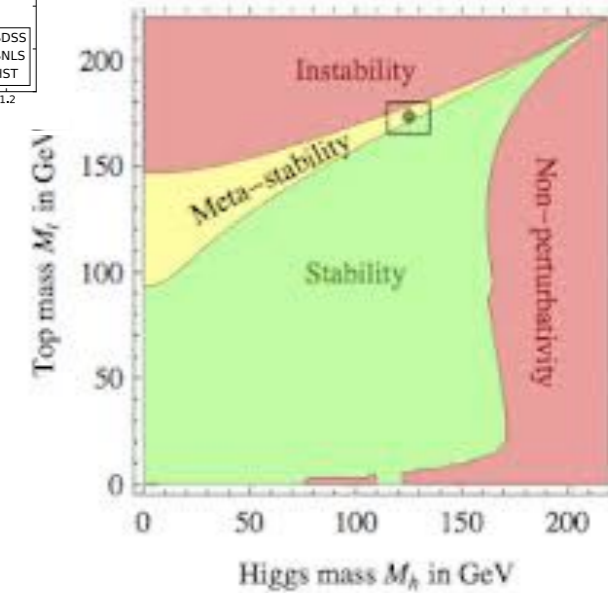
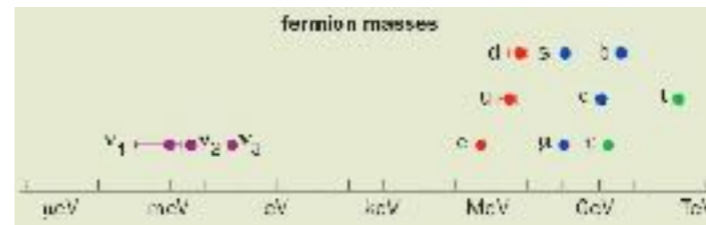
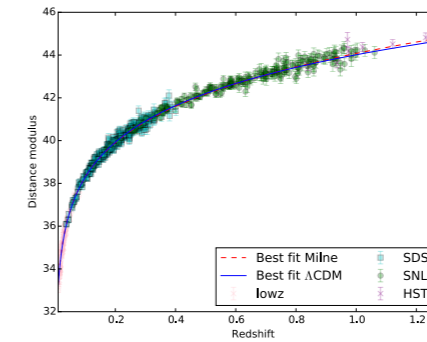


All of them experimental facts!

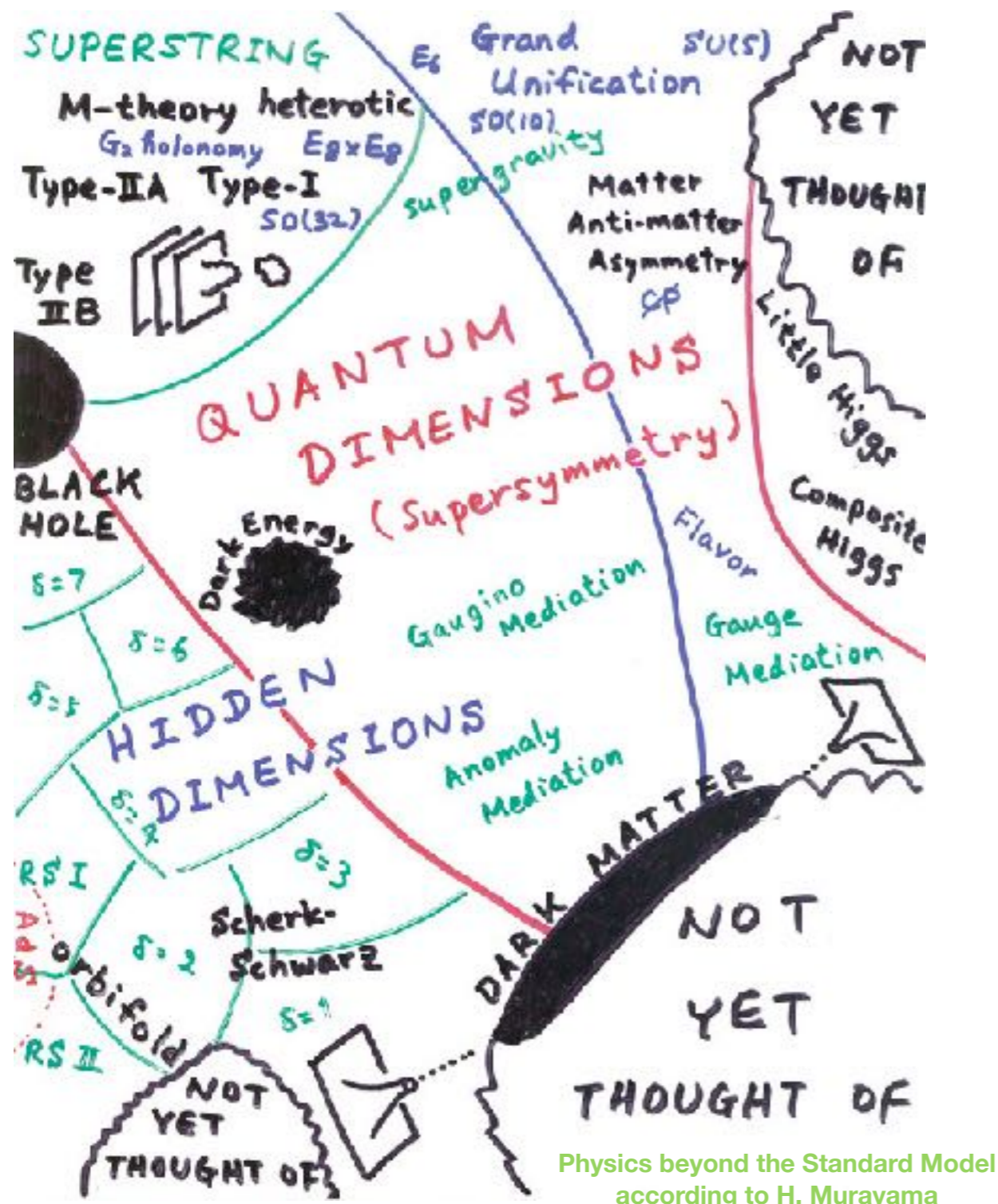
WHY BSM?

Certain features of the Standard Model appear ad-hoc or fine-tuned:

- Small cosmological constant
- Fermion generation structure and mass/mixing hierarchies
- Vacuum metastability
- Gauge coupling unification
- Strong CP problem
- Higgs naturalness problem



WHICH BSM?



Physics beyond the Standard Model according to H. Murayama

There isn't one model or a class of models that is currently preferred by theory or experiment

We need to study many different forms that new physics models take, and many different experimental signatures, that these models predict

Typical roads to BSM

Models addressing problems of the SM

e.g supersymmetry to address naturalness, or axions to address theta-problem of QCD



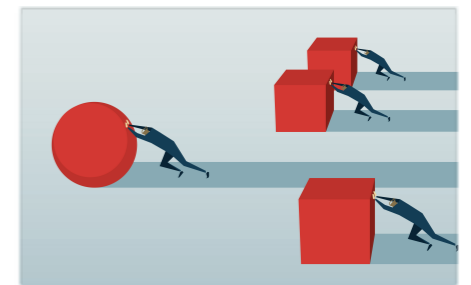
Ad-hoc models to explain experimental anomalies

e.g leptoquarks to address B-meson anomalies or milli-charged dark matter to address 21cm absorption signal

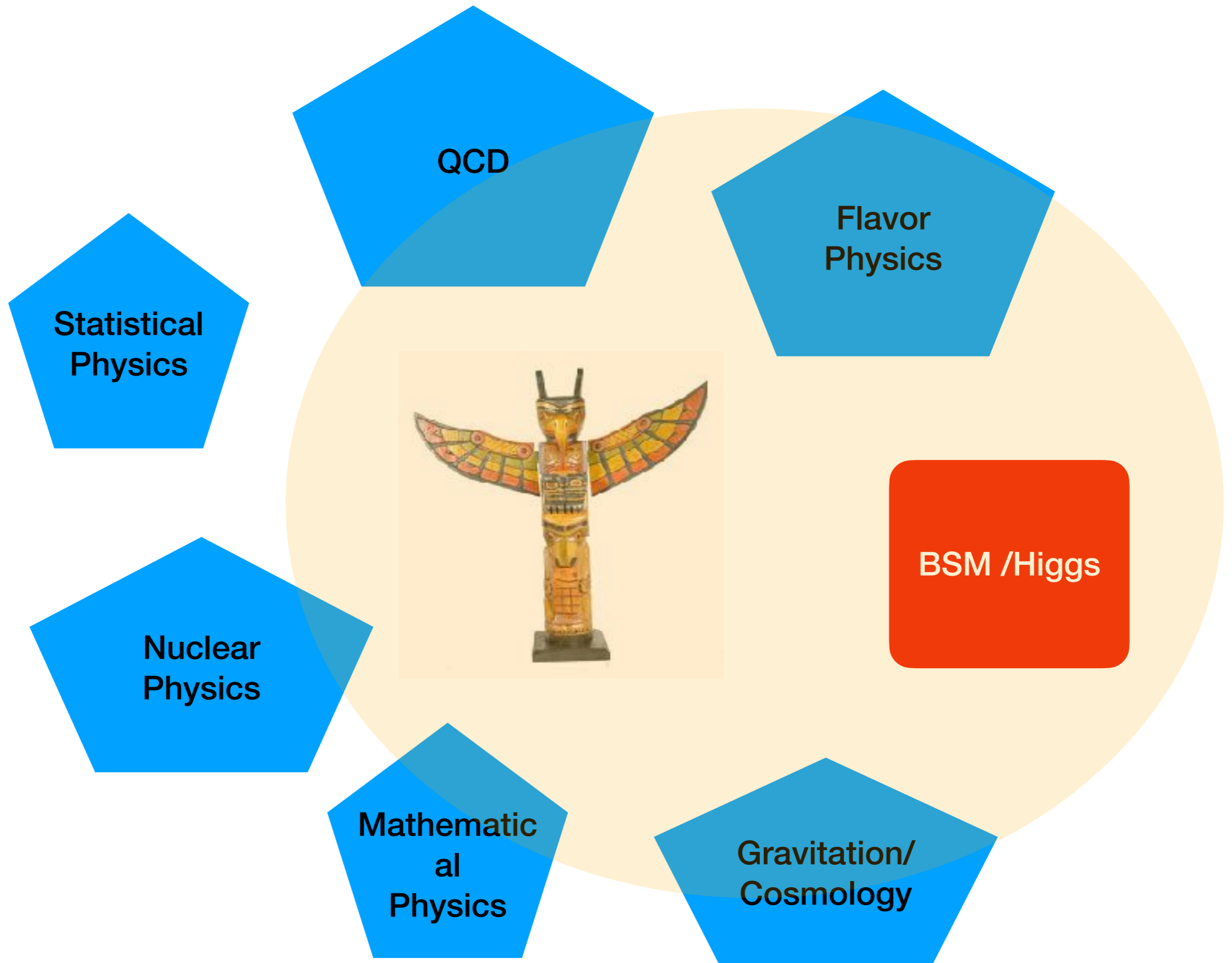


Model-independent effective theory

explore all possible higher-dimensional effective interactions added to the SM

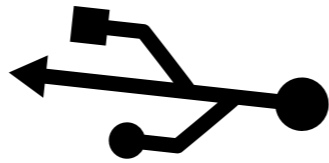


Position within Theory Pole



BSM/Higgs

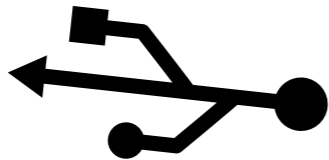
Asmaa ABADA (Pr)



Salvador URREA-GONZALEZ

Claire Chevalier

Yann MAMBRINI (DR)

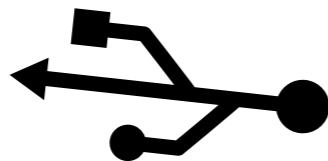


Mathieu GROSS

Gregory MOREAU (MdC)



Adam FALKOWSKI (DR)



Niccolo FECI

Edoardo ALVIANI



BSM/Higgs



BSM/Higgs group asks a lot of question

- Are there new particles beyond those of the Standard Model
- Is nature natural
- How is electroweak symmetry broken
- How do neutrinos get their mass
- What was happening in the first seconds of the universe
- What is the nature of dark matter
- What caused matter-antimatter asymmetry
- Are there extra dimensions of spacetime
- ...

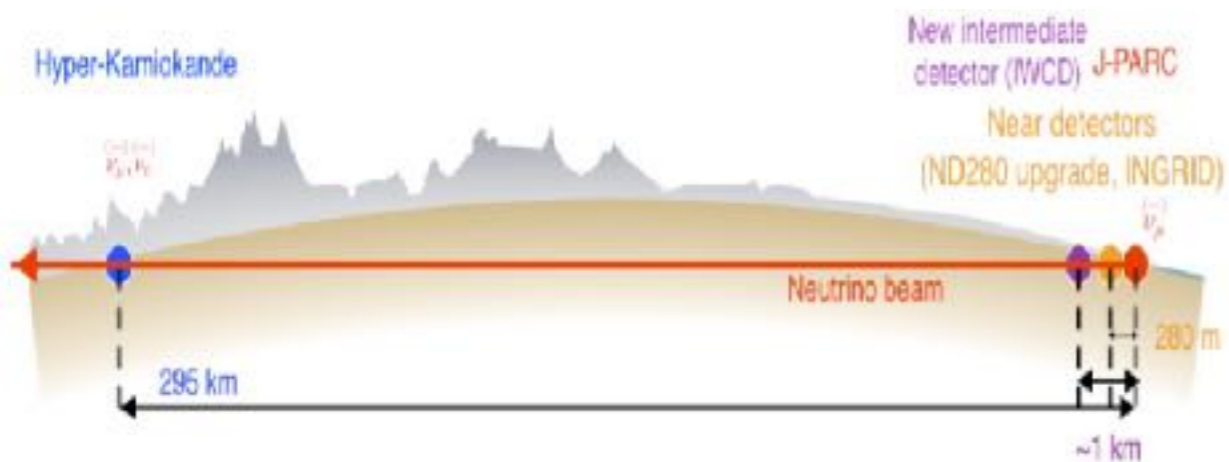
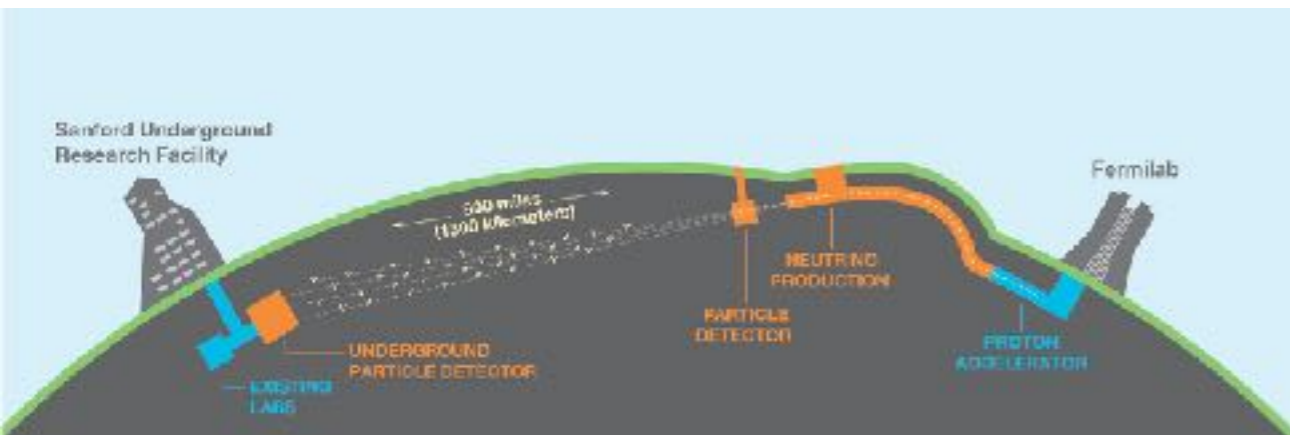
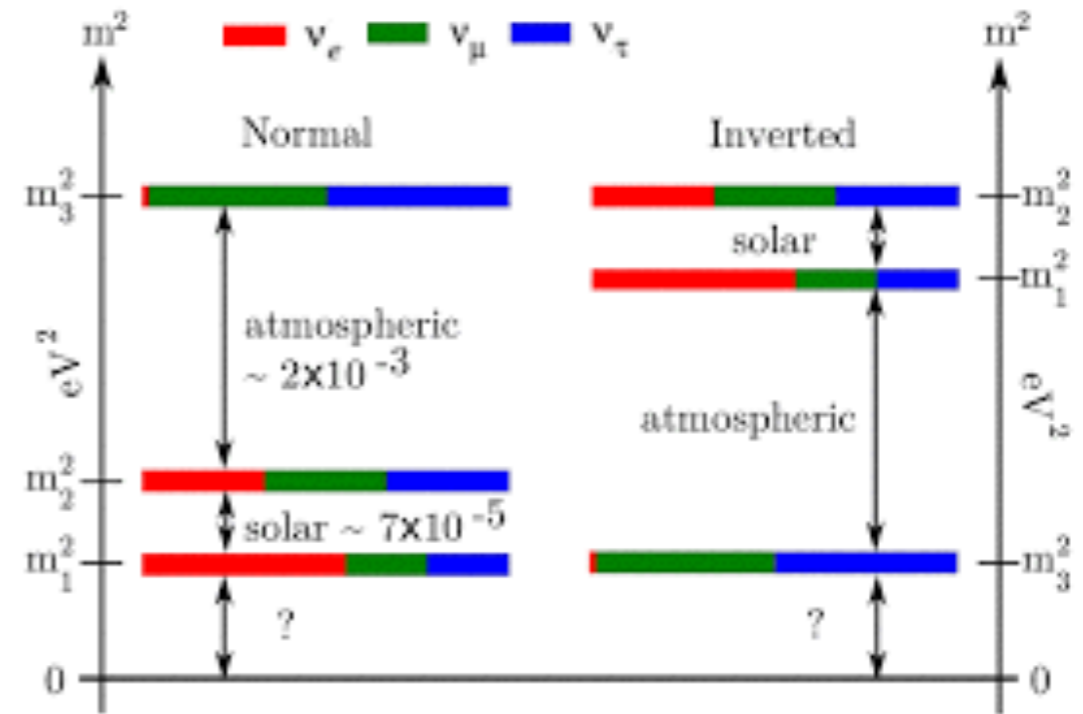
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Answers

BSM/Higgs

A couple of answers expected very soon



$$U_{PMNS} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{-i\delta_{CP}} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta_{CP}} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$P(\nu_\mu \rightarrow \nu_e) \stackrel{?}{=} P(\bar{\nu}_\mu \rightarrow \bar{\nu}_e)$$

Thank you



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