To be, or not to be

the CP violation is the answer

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Outline

What is past is prologue.

To be, or not to be, this is the question.

The CP violation is the answer, but where is it? Leptonic sector?!

The CP violation is the answer, but where is it? Hadronic sector?!

What is past is prologue.

Bachelor of science in physics

Master of science in particle physics

Postmaster

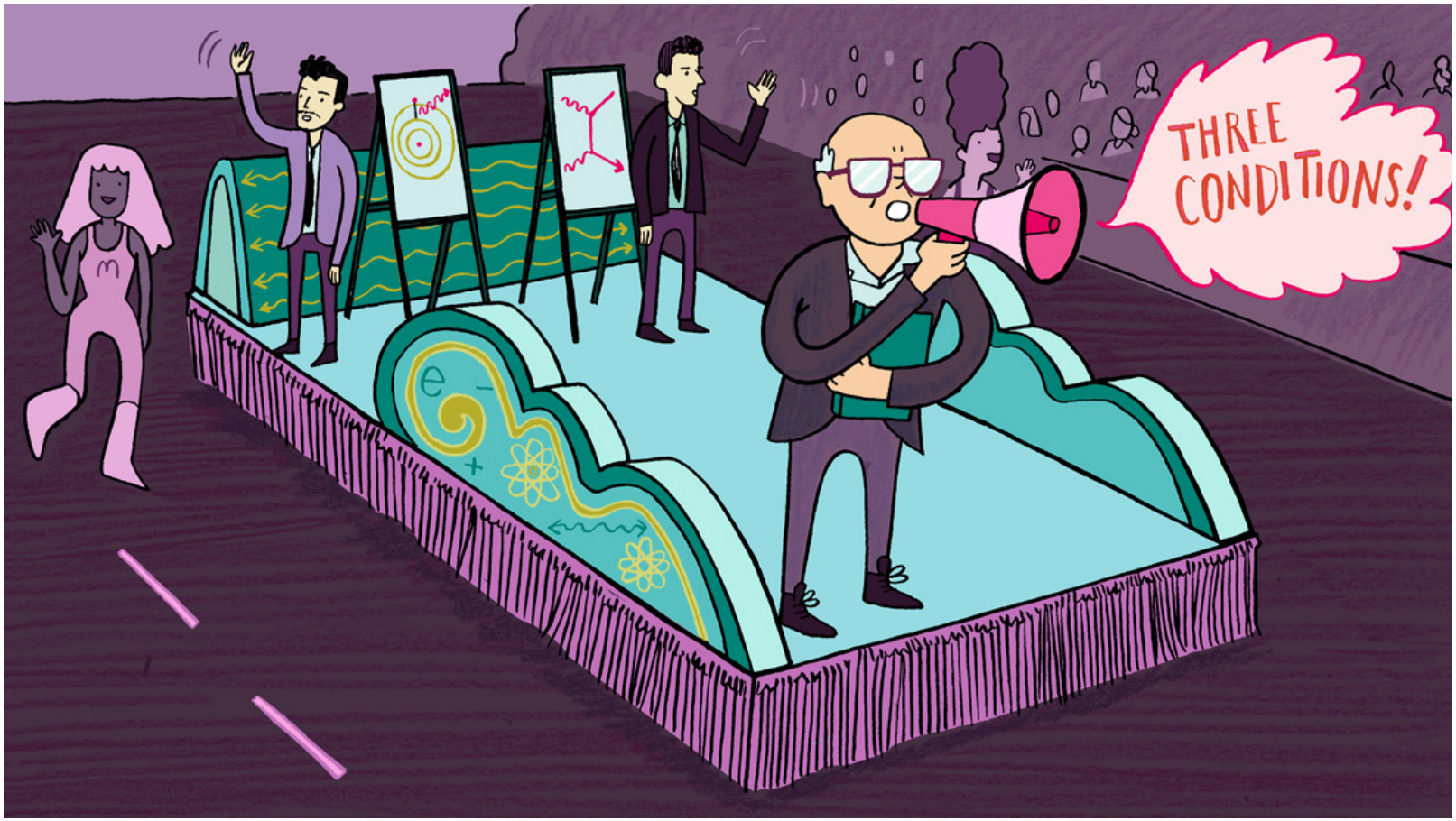
To be, or not to be, this is the question.

Baryon Asymmetry of Universe

$$Y_B^{\rm obs} \equiv \left.\frac{n_B - \overline{n}_B}{s}\right|_0 = (8.73 \pm 0.35) \times 10^{-11}$$

V. Simha et al., JCAP 06 (2008) 016

Sakharov's conditions



1. violation of baryon number conservation,
2. C and CP violation,
3. and the presence of out-of-equilibrium dynamics.

Standard Model

The Standard Model has all the basic ingredients.

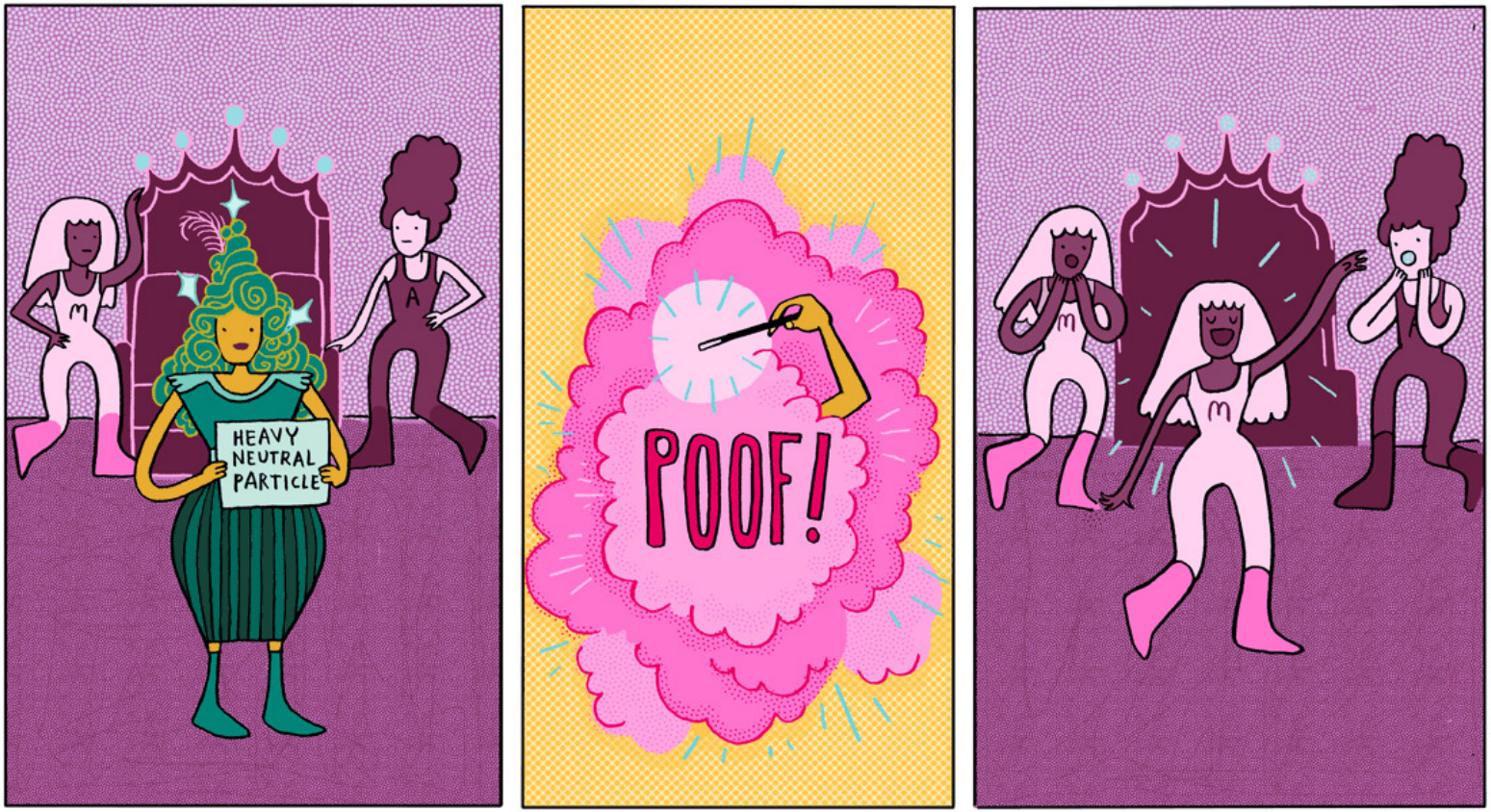
M.B. Gavela et al., Nucl.Phys.B 430 (1994) 345-381, 345-426

So far, while the CP violation was observed in neutral kaon decays, beauty decays at BaBar and Belle experiments and charm decays at LHCb, the amount of CP violation is far from satisfying the BAU.

Searching Beyond Standard Model

The CP violation is the answer, but where is it?
Leptonic sector?!

Thermal leptogenesis

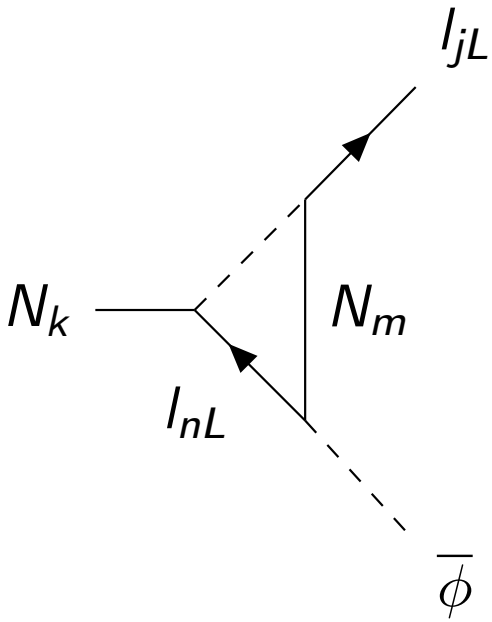


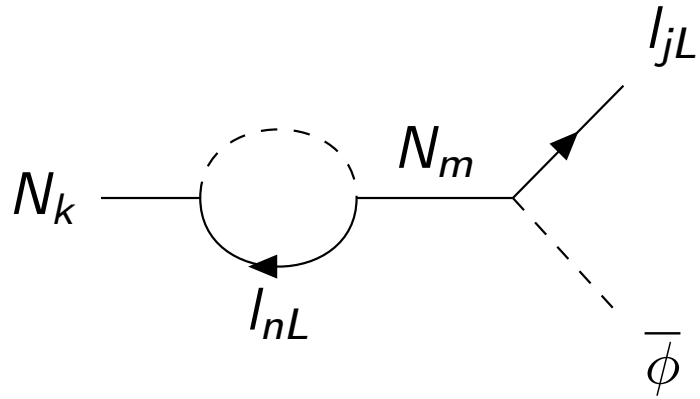
Through extension of the standard model by adding at least two right-handed neutrinos.

M.A. Luty, Phys.Rev.D 45 (1992) 455-465

CP violation

$$\epsilon_1 \equiv \frac{\Gamma_1 - \overline{\Gamma}_1}{\Gamma_1 + \overline{\Gamma}_1}$$





$$\epsilon_1 = \sum_{k\neq 1} \frac{1}{8\pi} \frac{\Im\left(yy^\dagger\right)^2_{1k}}{\left(yy^\dagger\right)_{11}} \left[f\left(\frac{M_k^2}{M_1^2}\right) + \frac{M_1 M_k}{M_1^2 - M_k^2} \right]$$

Davidson-Ibarra bound

$$M_1 > 10^9 \text{ GeV}$$

S. Davidson et al., Phys.Lett.B 535 (2002) 25-32

Low-scale leptogenesis

Taking into account hypermanetic field effects in the early universe

S. Safari, MD, S. Abbaslu, S. S. Gousheh, arXiv:2401.01105

Concentrate on the effects of Tsallis nonextensive statistical mechanics in the early universe

MD, Eur.Phys.J.C 84 (2024) 3, 340

Forsake the isotropic cosmological principle for a Bianchi type-I metric in the early universe

MD, Int.J.Mod.Phys.A 38 (2023) 35n36, 2350181

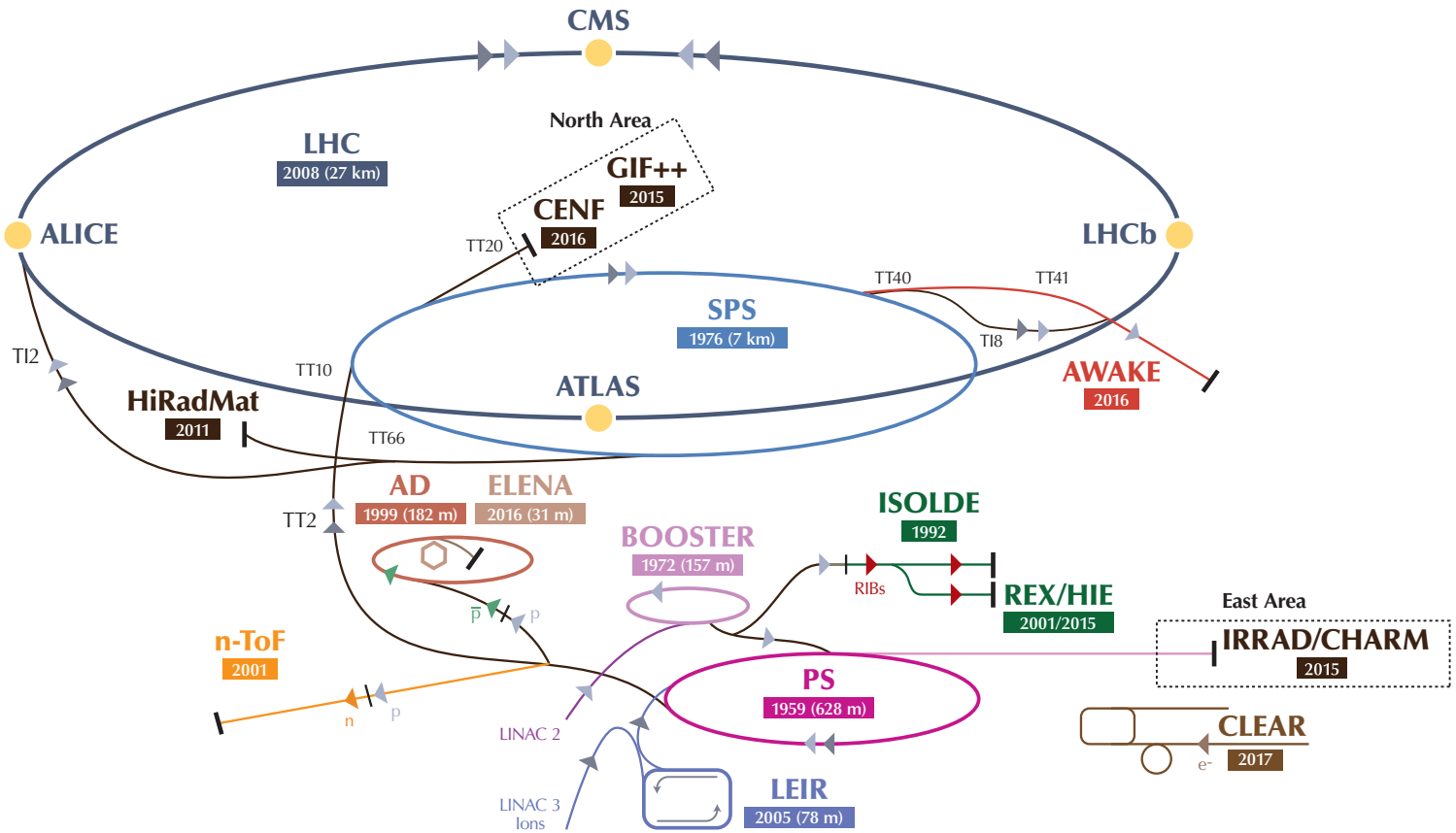
Non-Standard Interaction of neutrinos

The seesaw mechanism may lead the NSI! Search for axial NC DIS of neutrino-nucleus in the presence of NSI in DUNE-like experiments

S. Abbaslu, MD, S. Safari, Y. Farzan, JHEP 04 (2024) 038

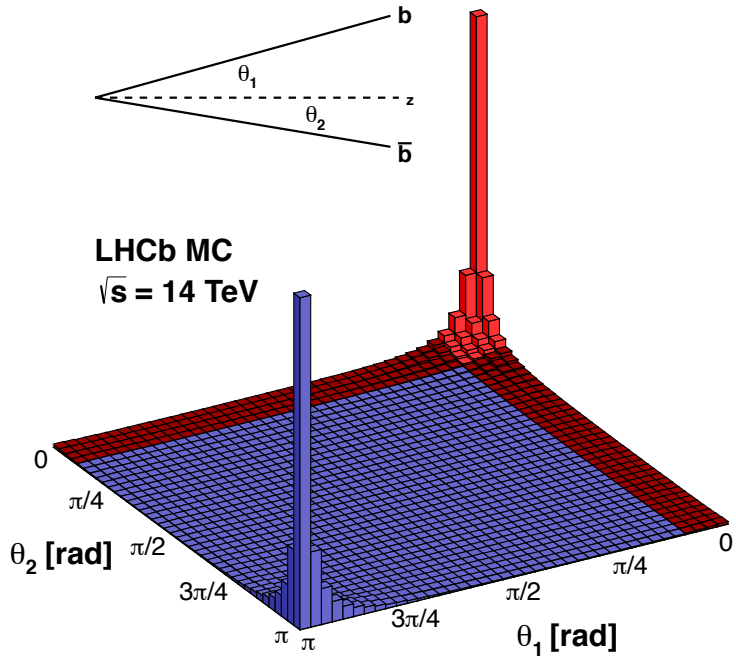
The CP violation is the answer, but where is it?
Hadronic sector?!

accelerator complex



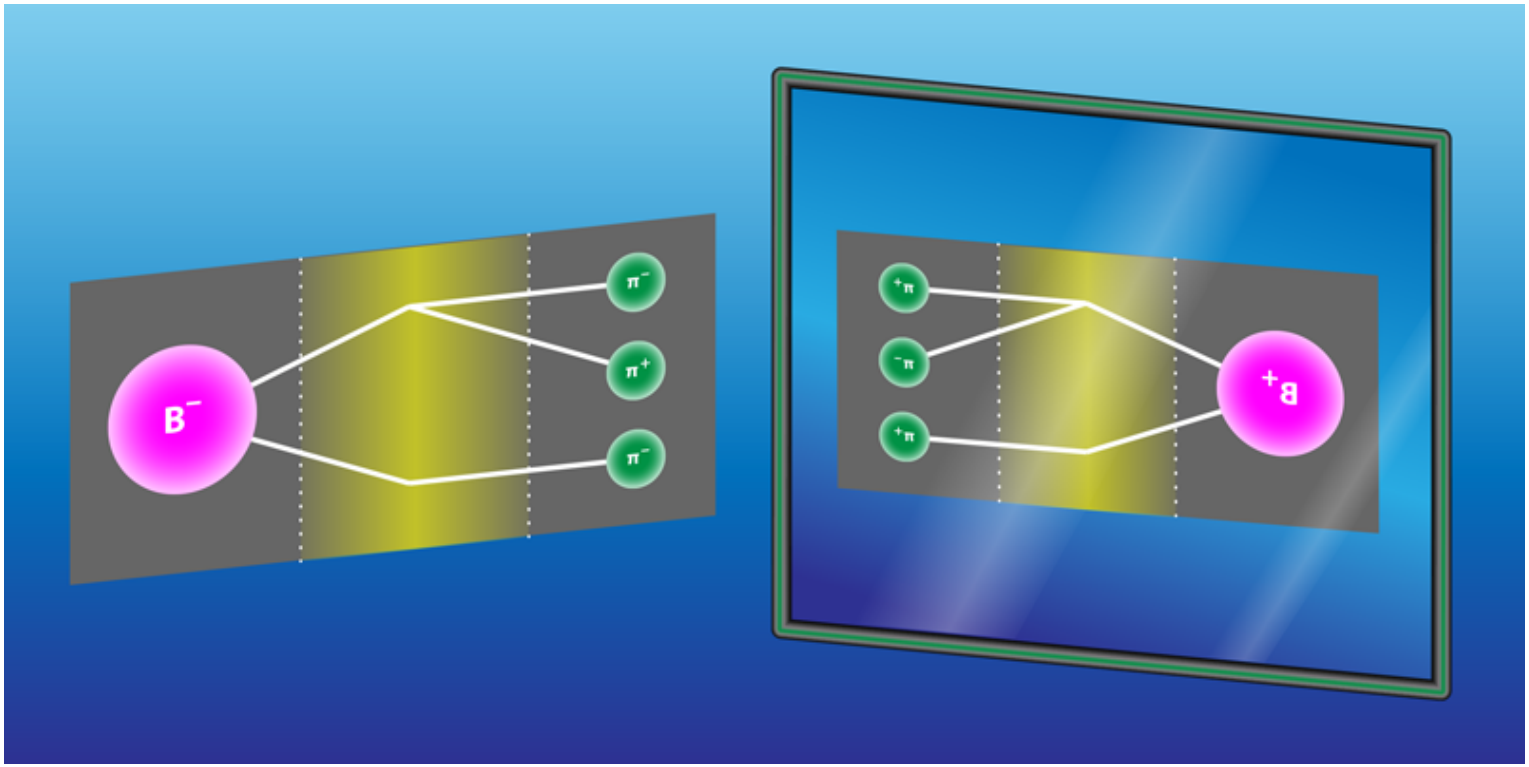
When the two beams arrives the maximum energy which they can, they collide at one of the four experiments located at the LHC.

(eauty) detector



The (eauty) detector exploit the maximum production of $b\bar{b}$ and $c\bar{c}$ pairs in the forward (backward) direction at higher energies.

CP violations in Bbeauty meson decays



Thanks for your attention!