MasieroFest @ Planck 2025

G. F. Giudice

Padua, 29 May 2025

Lucentio

William Shakespeare, Taming of the Shrew, Act 1, Scene 1

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To see fair Padua, nursery of arts,

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A course of learning and ingenious studies.

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Pisa, renowned for grave citizens,
[...]
Tell me thy mind, for I have Pisa left
And am to Padua come, as he that leaves
A shallow plash to plunge him in the deep,
And with satiety seeks to quench his thirst.

William Shakespeare, Taming of the Shrew, Act 1, Scene 1


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ANDRE & BELLA MEYER
HALL OF PHYSICS
NEW YORK UNIVERSITY

A NATURAL SOLUTION TO THE μ-PROBLEM IN SUPERGRAVITY THEORIES

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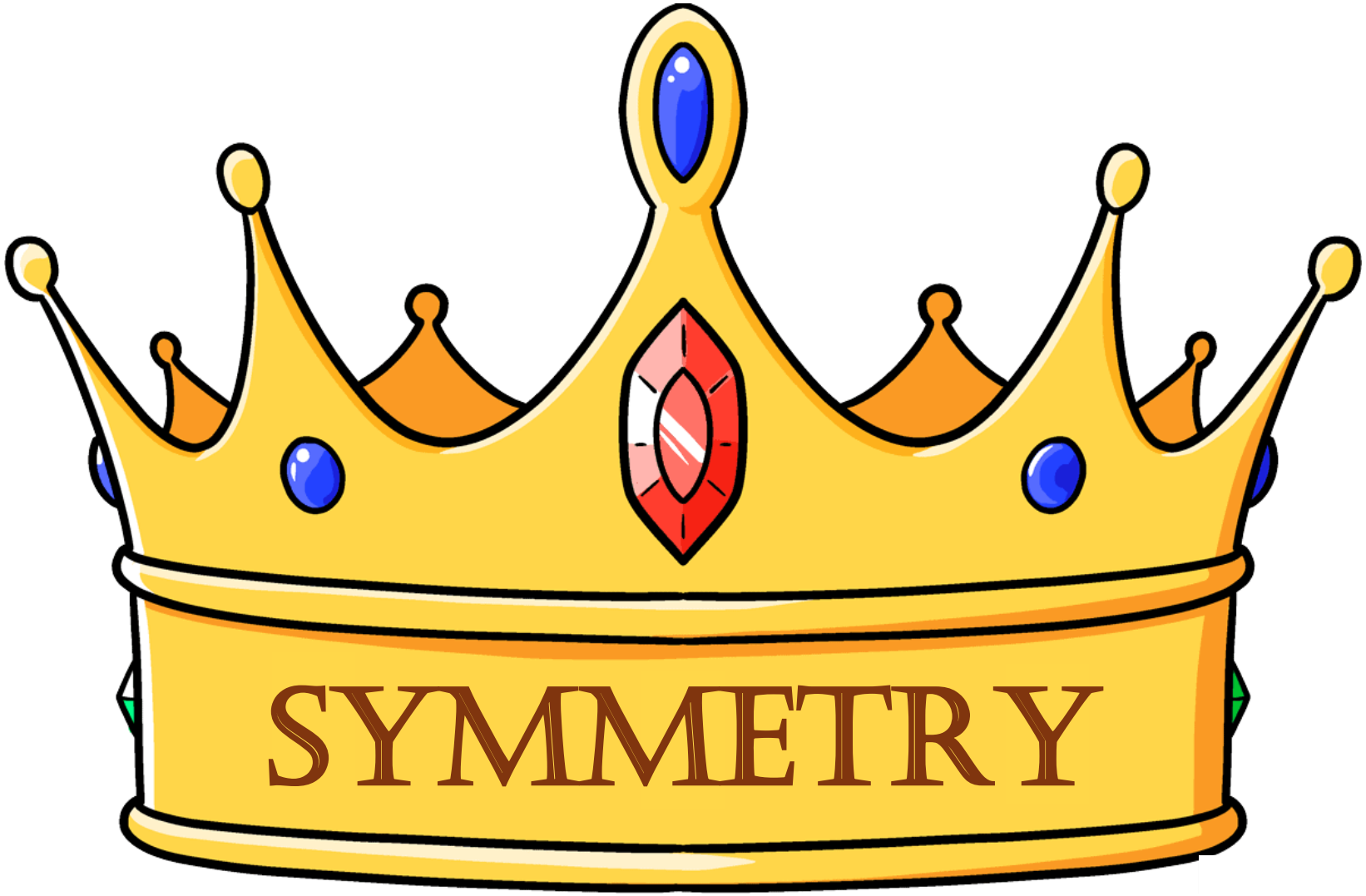
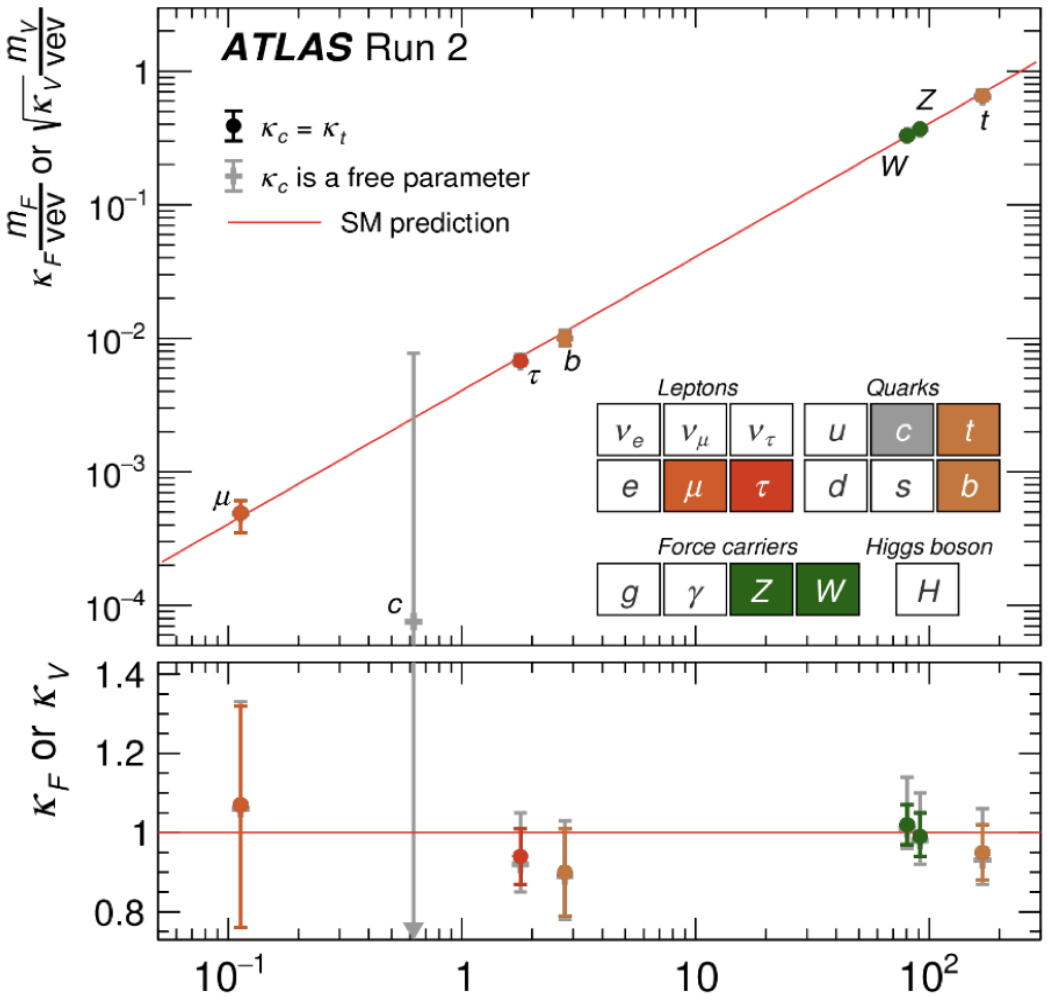
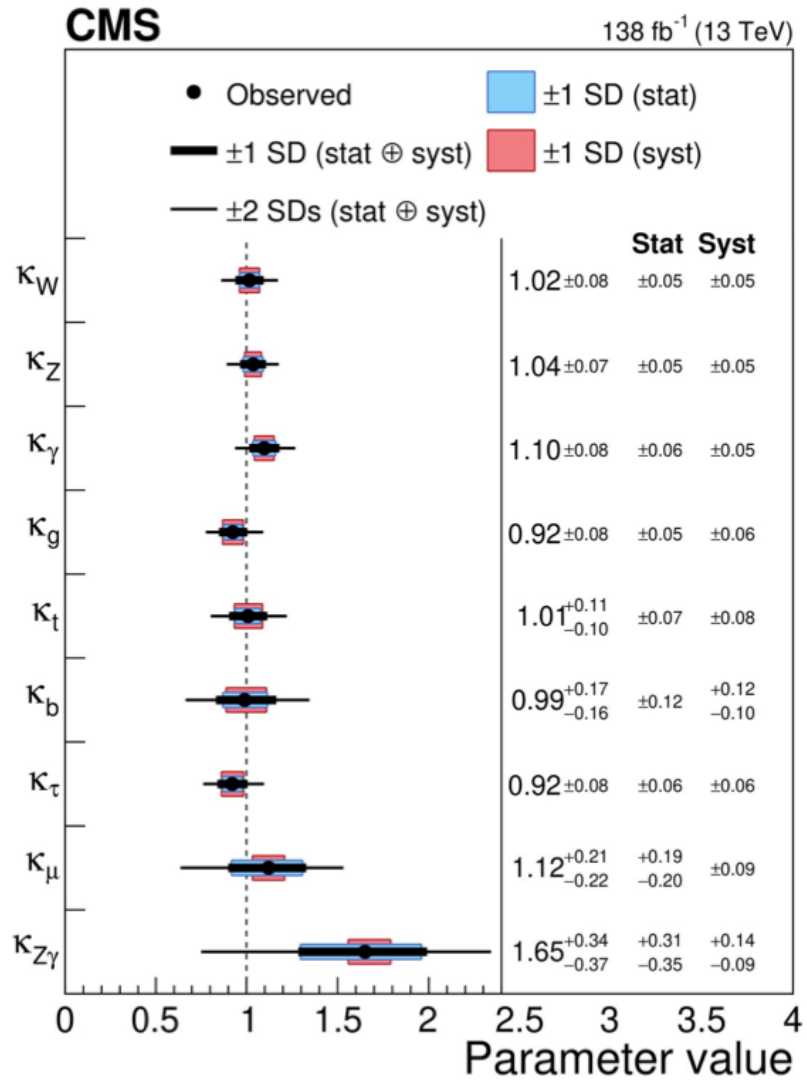
We propose a "natural" way to avoid the introduction by hand of a small mass scale μ in the observable sector of $N=1$ supergravity theories. In our approach, μ automatically arises from the general couplings of broken supergravity. In this way, all low energy mass parameters arise only from supergravity breaking and, in particular, $SU(2)\times U(1)$ is left unbroken in the limit of exact supersymmetry. Our solution of the μ-problem presents interesting connections with the strong *CP* puzzle through the implementation of symmetries à la Peccei and Quinn.


SYMMETRY

What is the dynamics responsible for EW breaking?



Nature 607, 52-59 (2022)



$$\kappa = \frac{g}{g_{SM}}$$

~7-8%

~10%

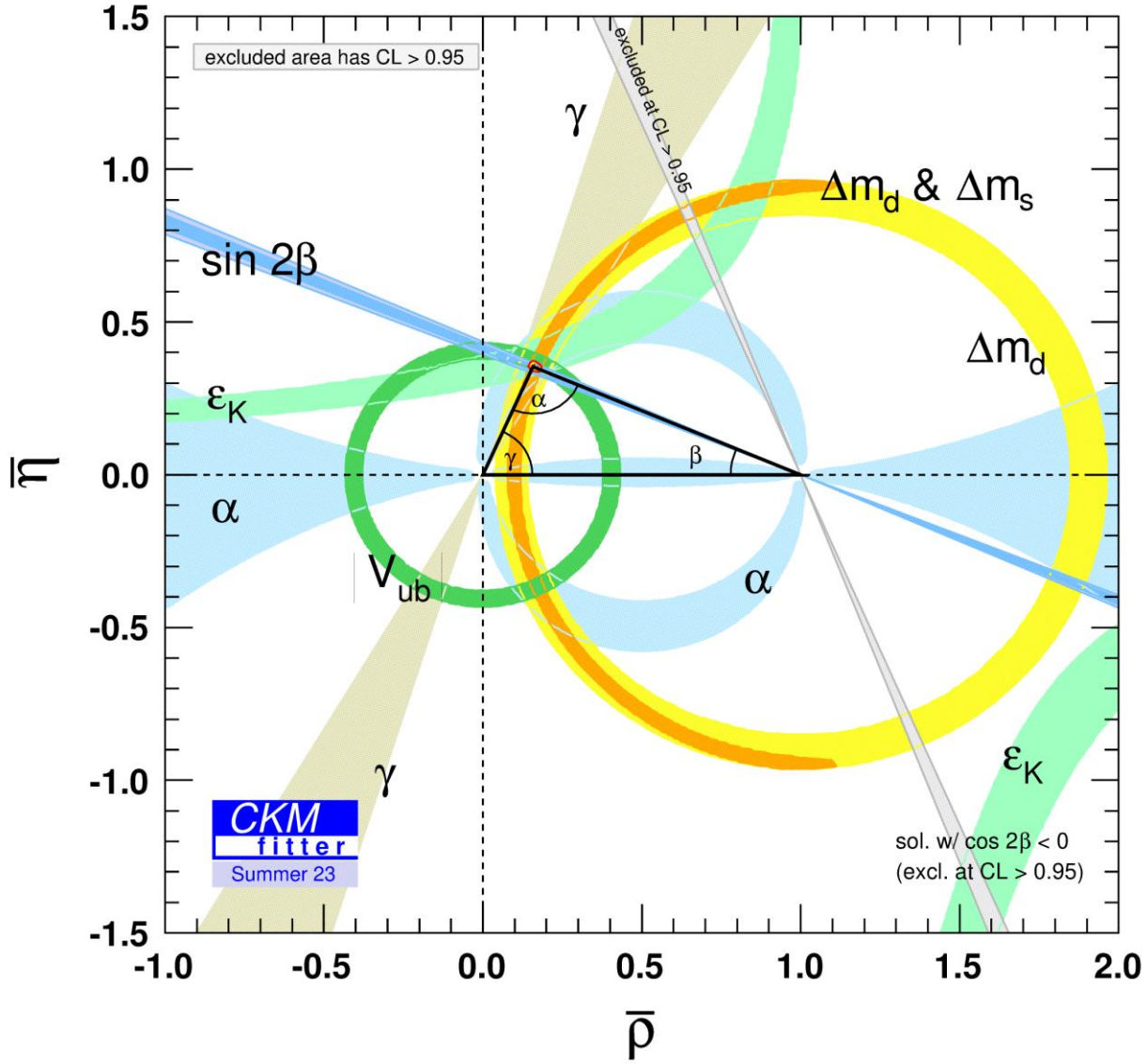
~15%

~ 8%

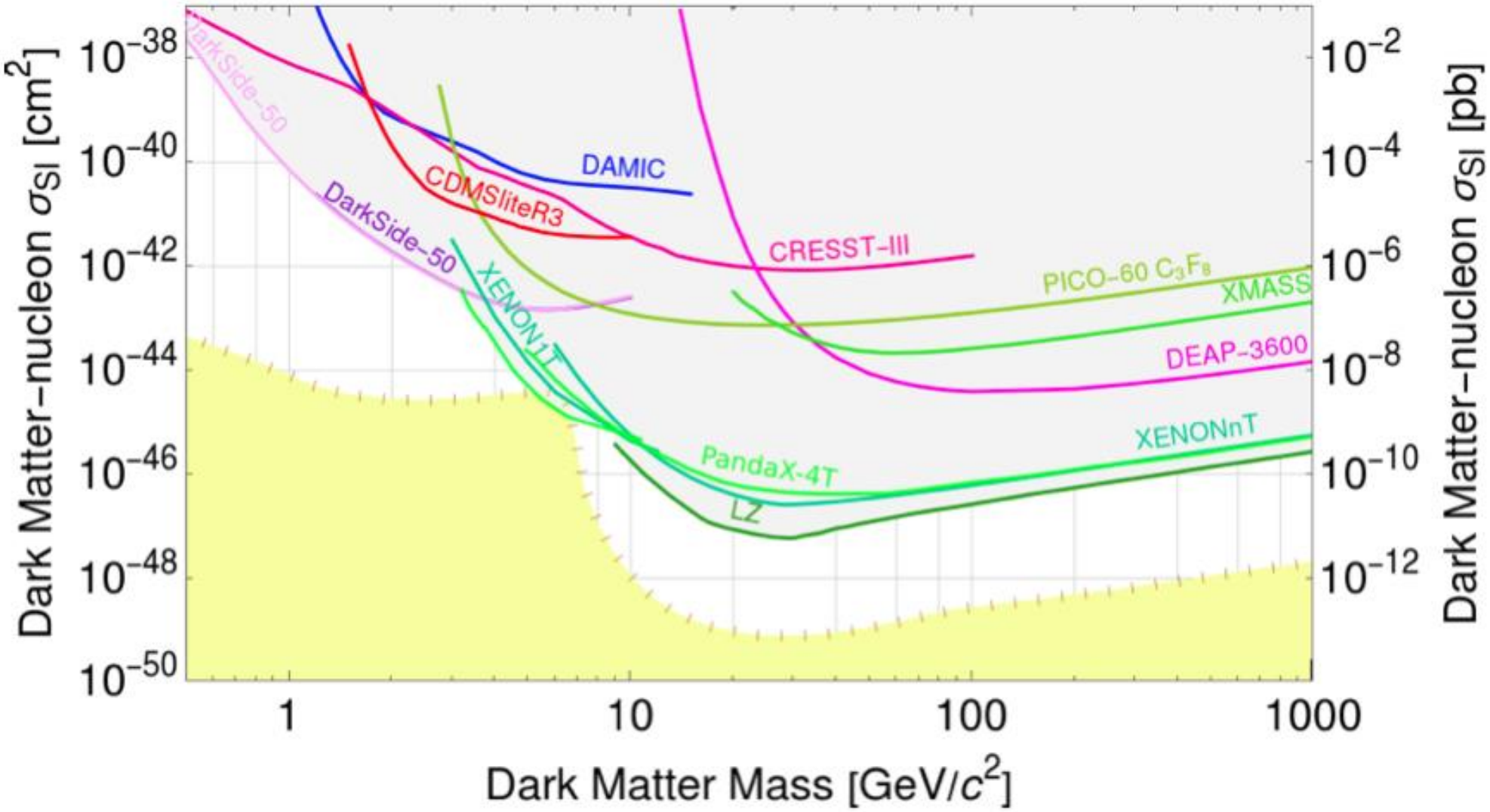
~20%

~35%

What is the origin of flavour?



Is dark matter a new particle?



Approaches towards the unknown

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The traditional (pre-Higgs-discovery) strategy: **top-down approach**

- Identify the guiding principles to address some of SM problems.
- Construct a theory that provides a solution.
- Identify its consequences and test its predictions.

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The lack of new physics at the LHC has challenged most of these theories and is suggesting a separation of scales. This motivates a different (post-Higgs-discovery) strategy: **bottom-up approach**

- Forget about theoretical motivations or bias.
- Look for new particles not yet ruled out out parametrise new physics using the most general basis of higher-dimensional operators (SMEFT).
- Investigate what can be tested.

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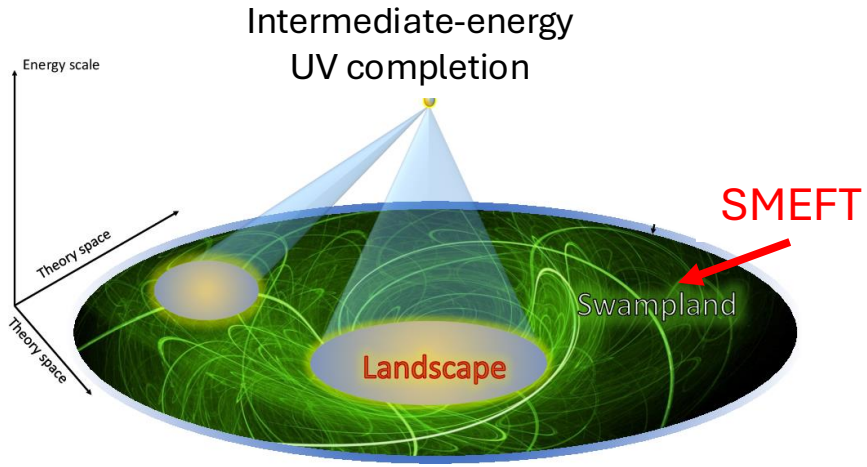
However, there are also limitations:

- it lacks a broad theory vision;
- it can lead experimentalists to believe that any search is equally important, regardless of the actual knowledge that is gained from a specific measurement;
- it creates a SMEFT Swampland.



Experimental searches should be valued for the scientific knowledge that can be extracted from measurements, rather than by the number of operators that can be tested or by the value of the corresponding energy scale.

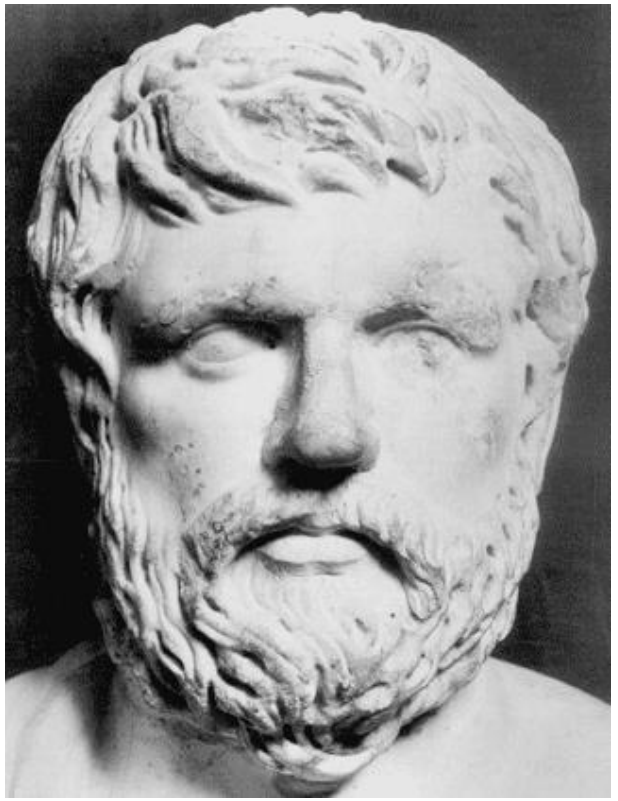
$$[Q_\alpha, P_\mu] = [\bar{Q}_{\dot{\alpha}}, P_\mu] = 0$$

$$[Q_\alpha, M_{\mu\nu}] = \frac{1}{2}\sigma_{\mu\nu\alpha}{}^{\beta} Q_\beta$$

$$[\bar{Q}_{\dot{\alpha}}, M_{\mu\nu}] = -\frac{1}{2}\bar{Q}_{\dot{\beta}}\bar{\sigma}^{\dot{\beta}}_{\mu\nu\dot{\alpha}}$$

$$\{Q_\alpha, \bar{Q}_{\dot{\alpha}}\} = 2\sigma^{\mu}{}_{\alpha\dot{\alpha}} P_\mu .$$

=



Cleisthenes

(570 – 508 BC ca.)

“Consumai li diciotto anni migliori di tutta la mia età”

(lettera a Fortunio Liceti in Padova, Arcetri 23 giugno 1640)