

After the Higgs discovery

Looking for the Universe
behind the particle

VISION TALK

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Higgs Hunting

Paris'26



A decade ago, the Higgs was the object of the search
Today, it is an instrument for exploring the vacuum

This talk is a discussion on this evolution:

A bit of semi-historical view
a narrative of pre- and post-Higgs discovery

Why the Higgs is a unicorn in QFT
and why is screaming for a new paradigm

A gateway that connects Particle Physics, Cosmology,
Astrophysics and *who knows what else*

Contextualise this area

Looking ahead

Let's state the obvious

We **know** there is new physics beyond the SM

Empirical evidence of BSM

Neutrinos

Dark Universe

Matter-antimatter asymmetry

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Then the questions are whether
will be able to access it with our experimental capacities
or even to think of the *right* theory

Those are **two different limitations**
and lack of ideas is not good excuse for paralysis
eg the Higgs mechanism and GWs were thought of
decades before their empirical discovery



Prester John

A pseudo-historical narrative



There was a time we had a beacon
W / Z mass + unitarity + QFT consistency

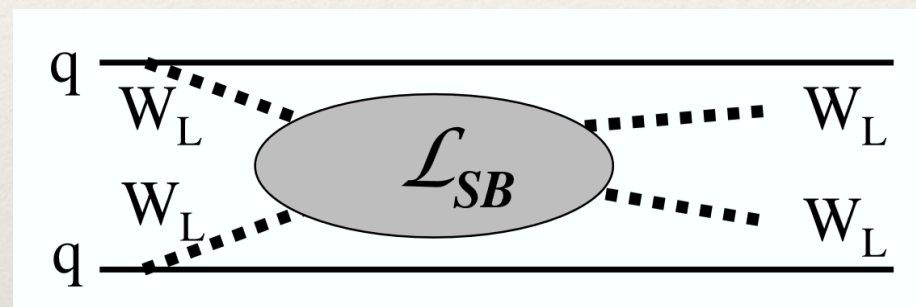


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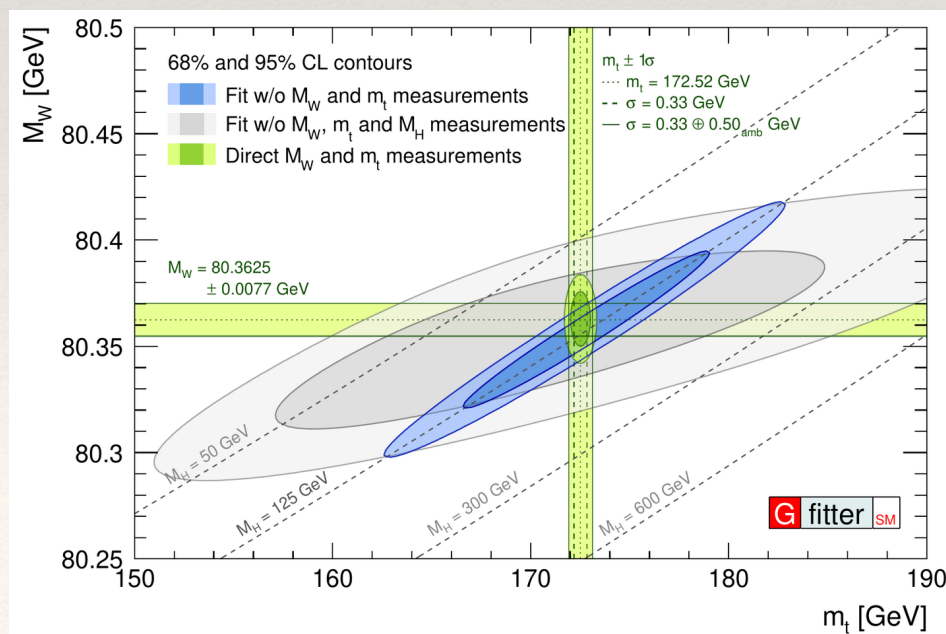
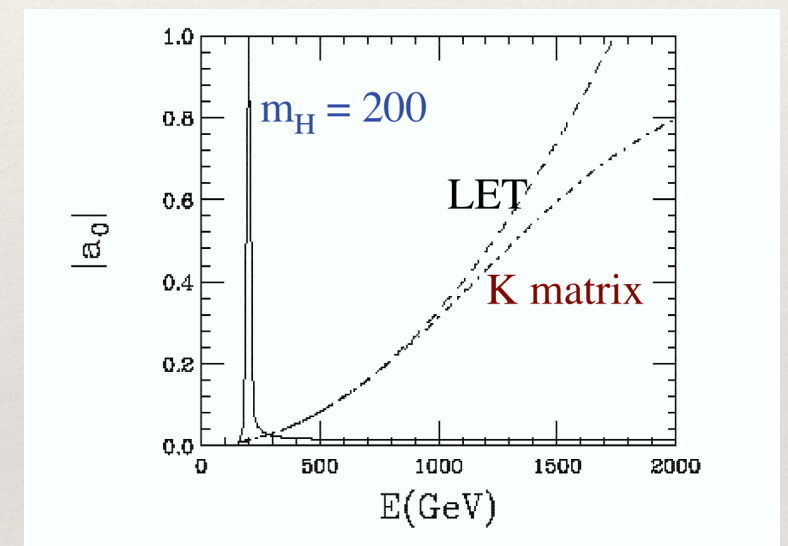


no-lose theorem

New phenomena (Higgs or otherwise)
pointing at a TeV scale, a clear focus

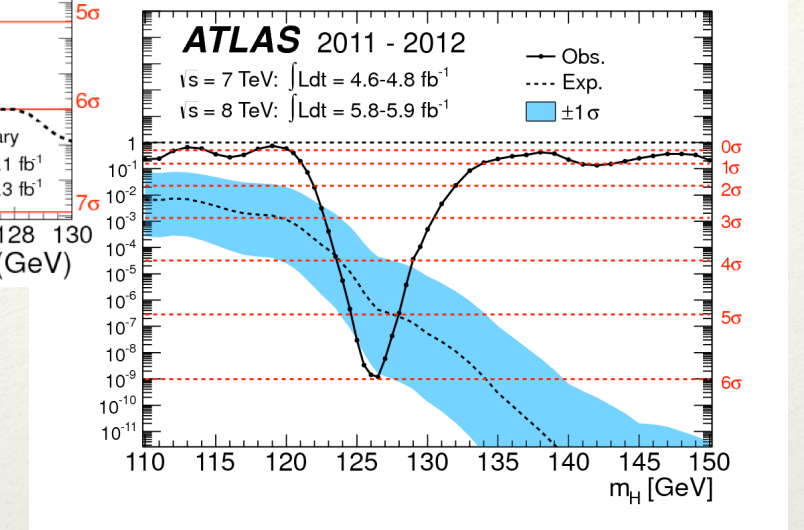
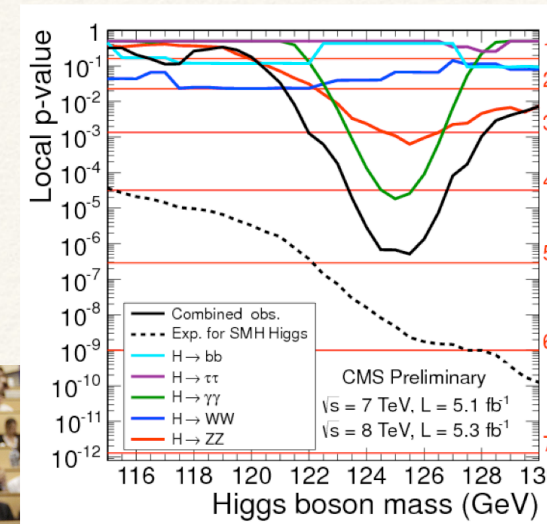


Chanowitz ph/0412203



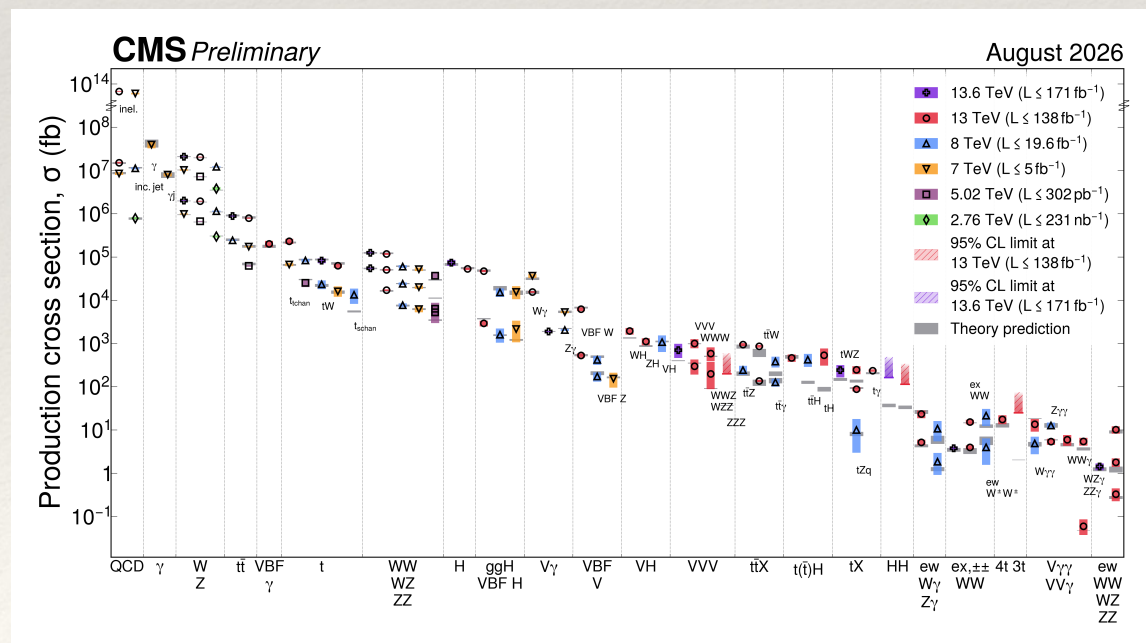
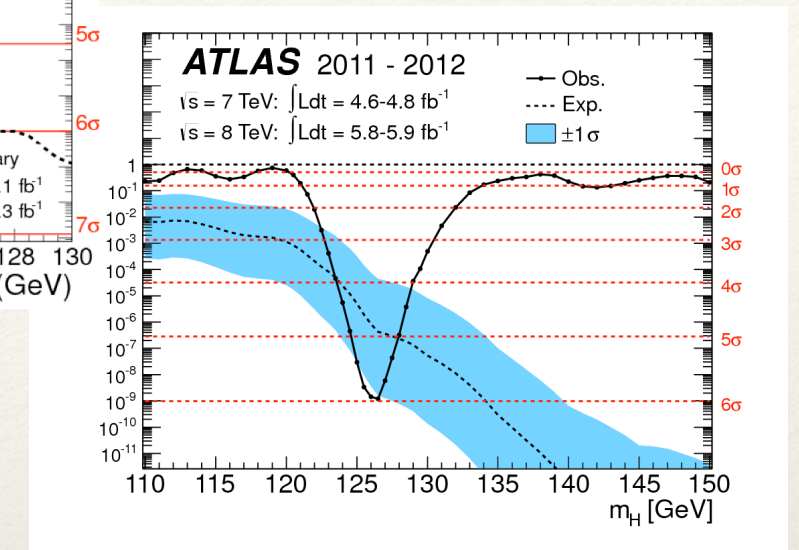
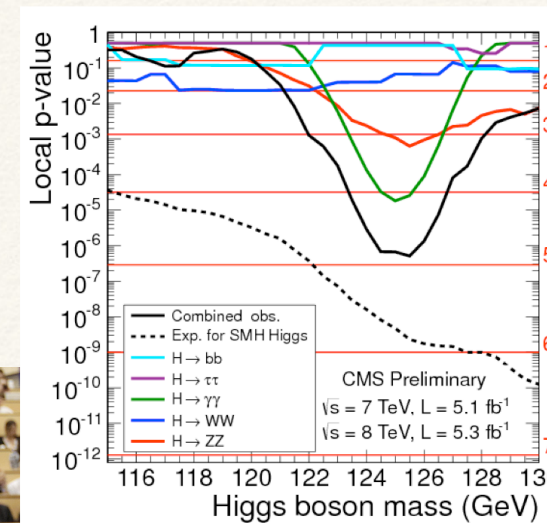
and with a light Higgs boson, clear
winner of the Occam's razor test

And then, there was the discovery



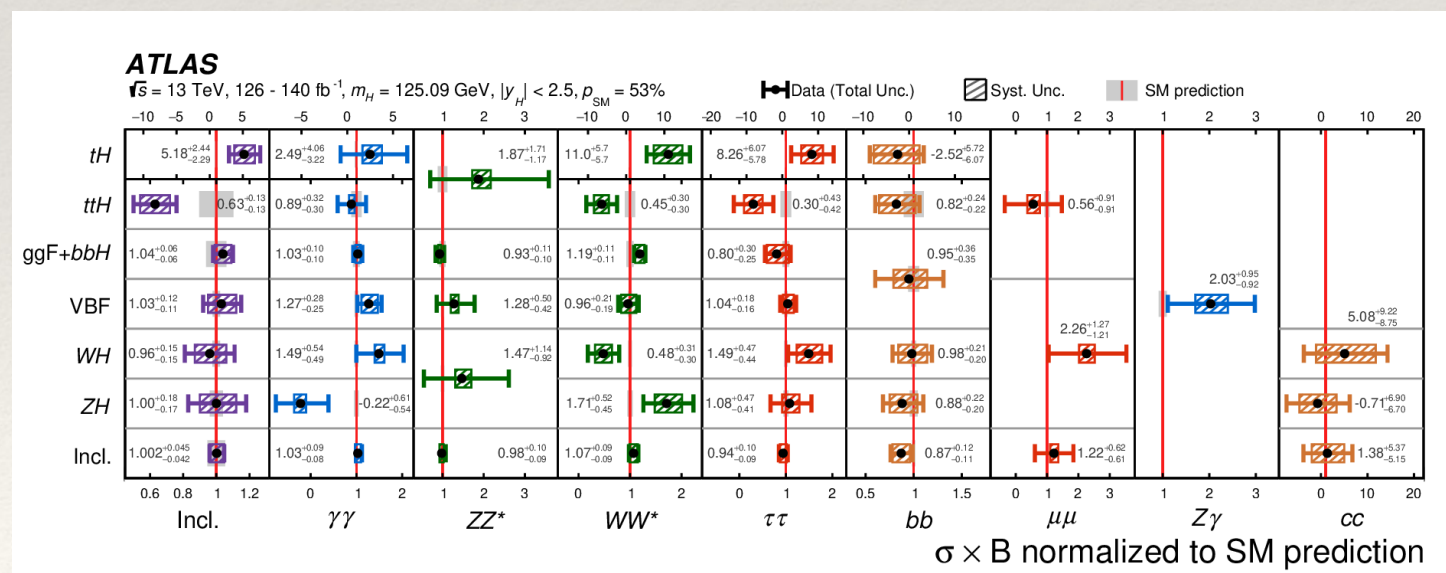
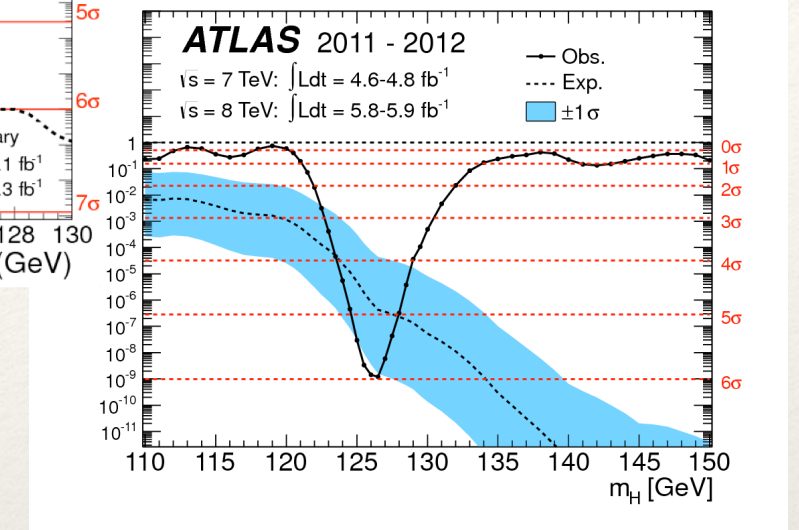
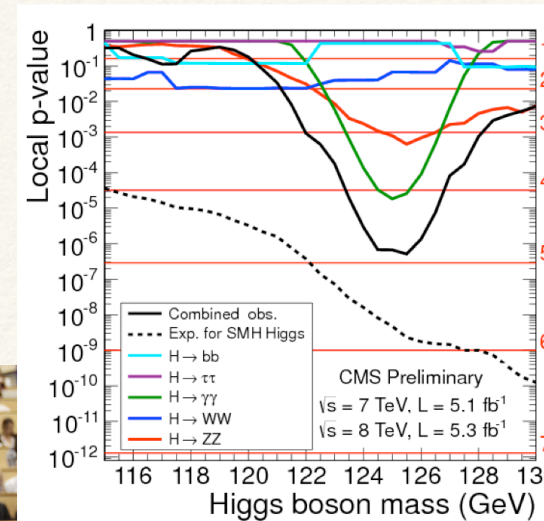
With a Higgs particle already walking and quacking like a SM-Higgs

And then, there was the discovery



Nature chose a scalar
 the LHC discovered it and went from
 a hadron / discovery / dirty machine to
 a precision machine to test the
 boundaries of the SM

And then, there was the discovery



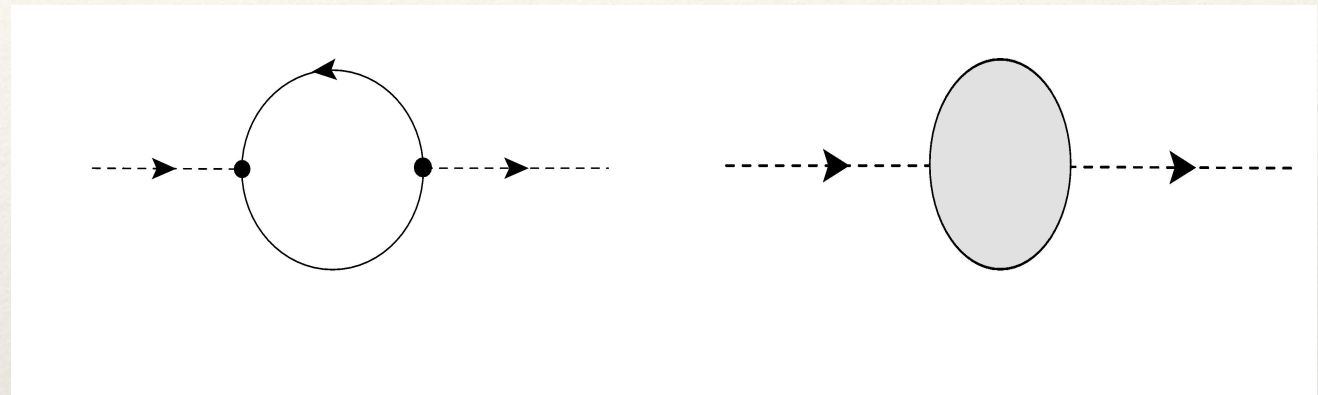
14 years on, the Higgs is no longer at **exploratory stage**, but in full exploitation campaign mode



The Higgs is a QFT unicorn

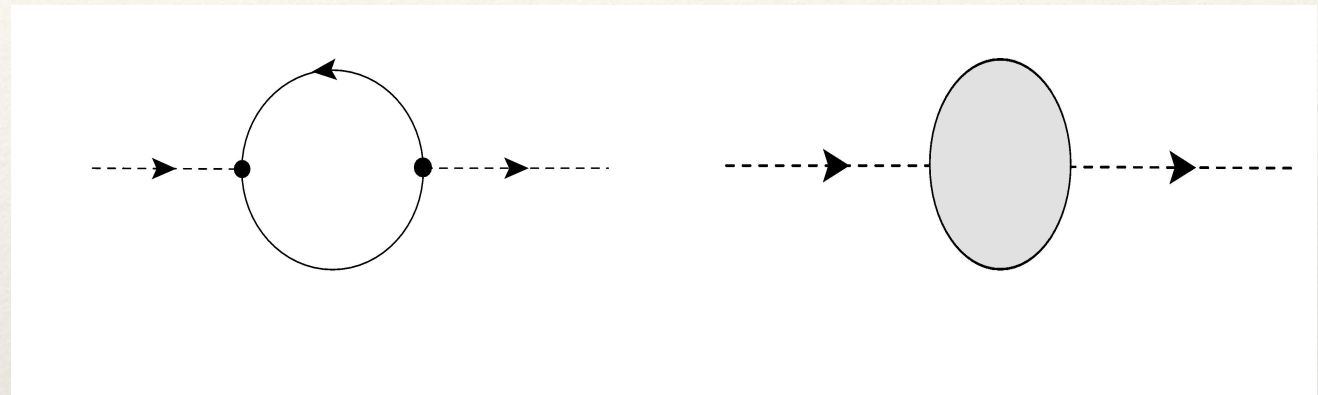
With the Higgs, Nature's chosen mechanism

We must face that
a light fundamental scalar is a **quantum** conundrum



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$$\delta m_{\phi}^2 \propto c_1 \Lambda_{NP}^2 + c_2 M_{Pl}^2$$

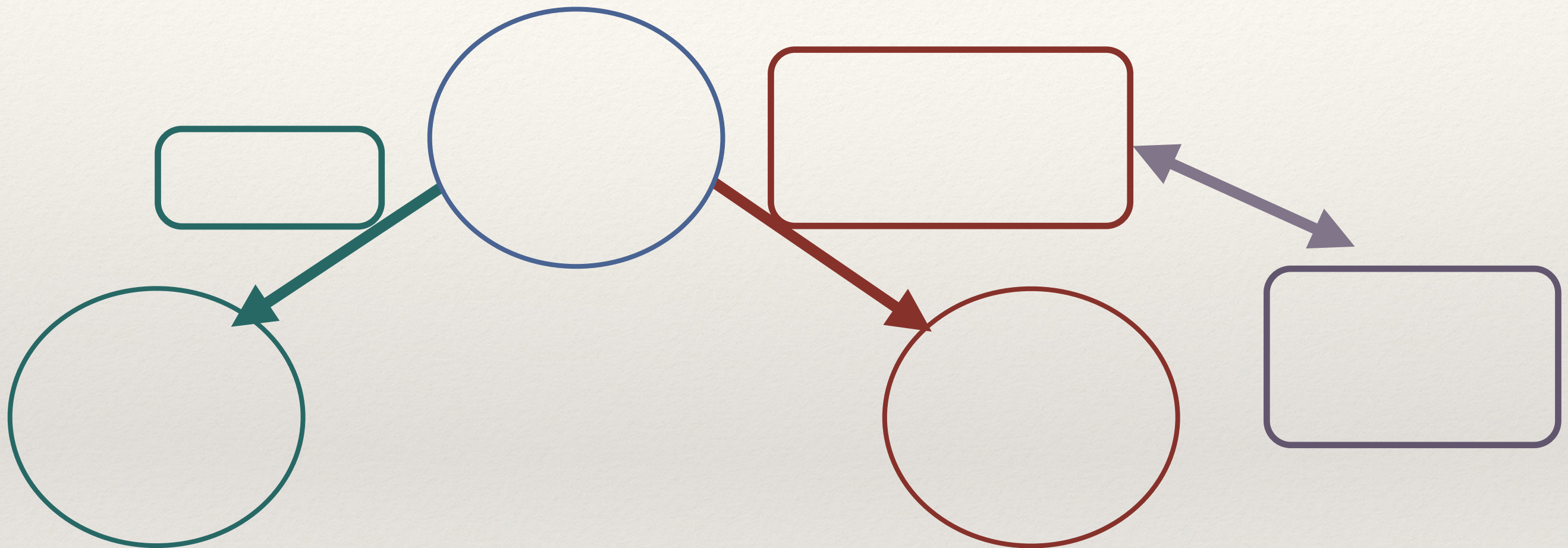
In contrast with **fermions** or **vector bosons**, where a quantum symmetry can be called for, fundamental scalars have no protection



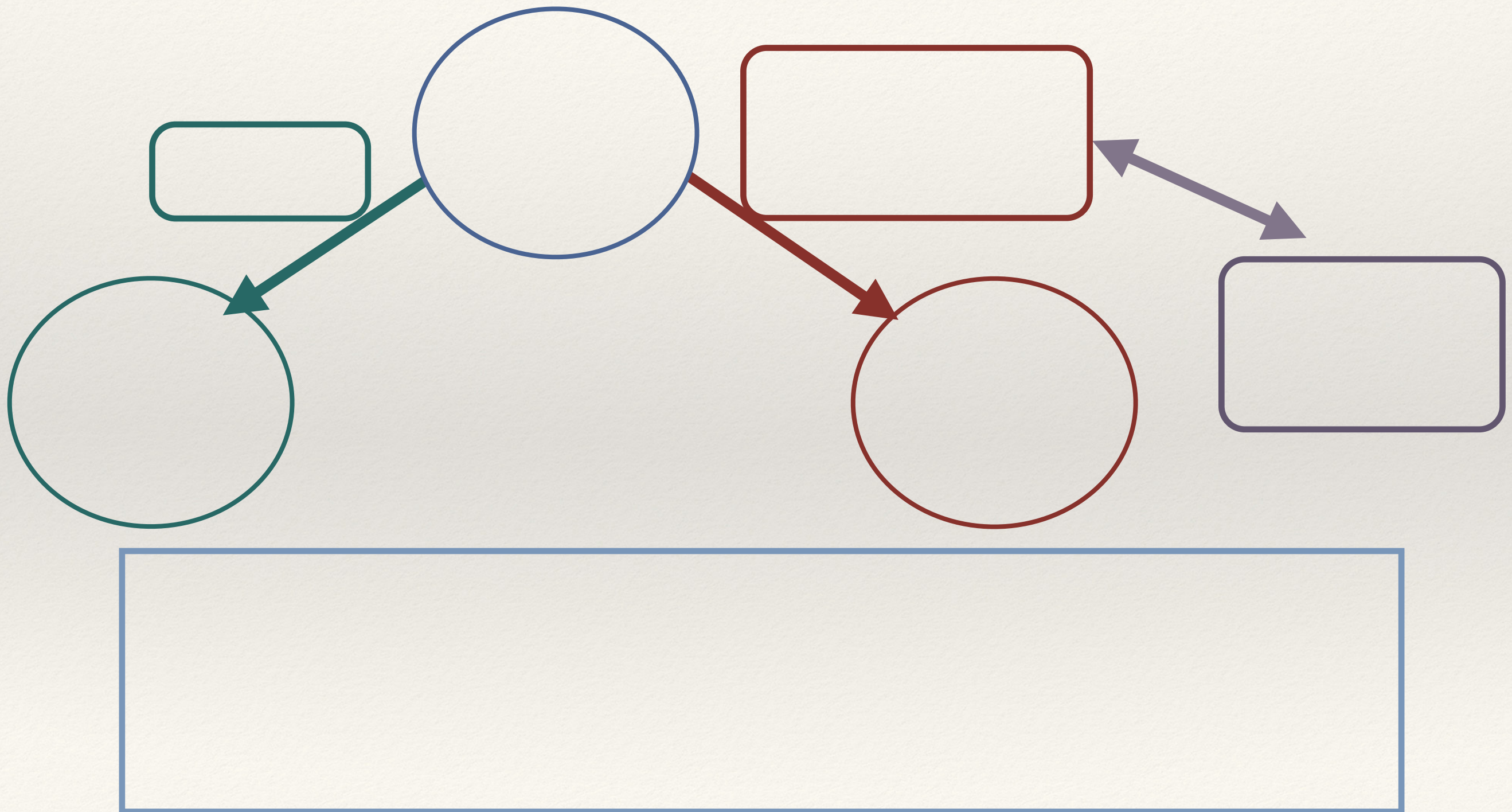
Rosetta Stone

The Higgs is a gateway

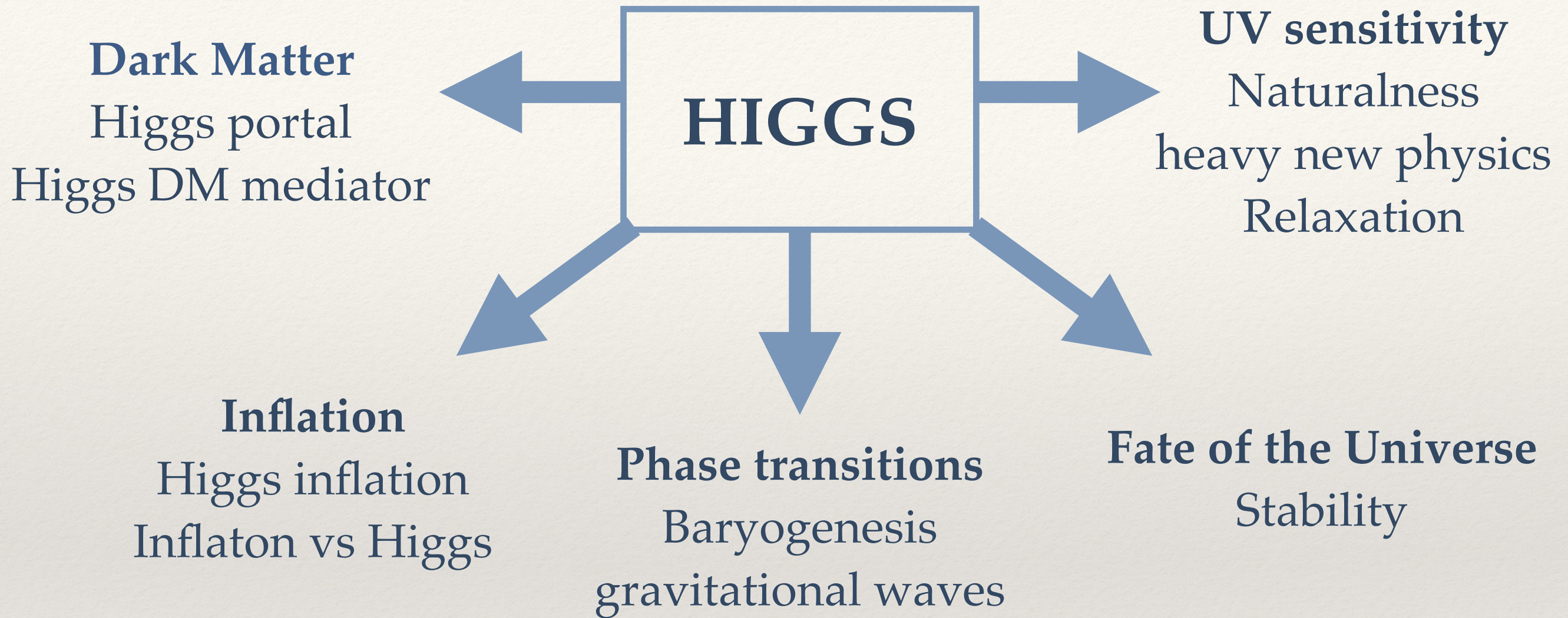
This **unicorn** can be made a **regular horse**
We can stabilise the Higgs through symmetries or dynamics
by invoking new principles and new particles



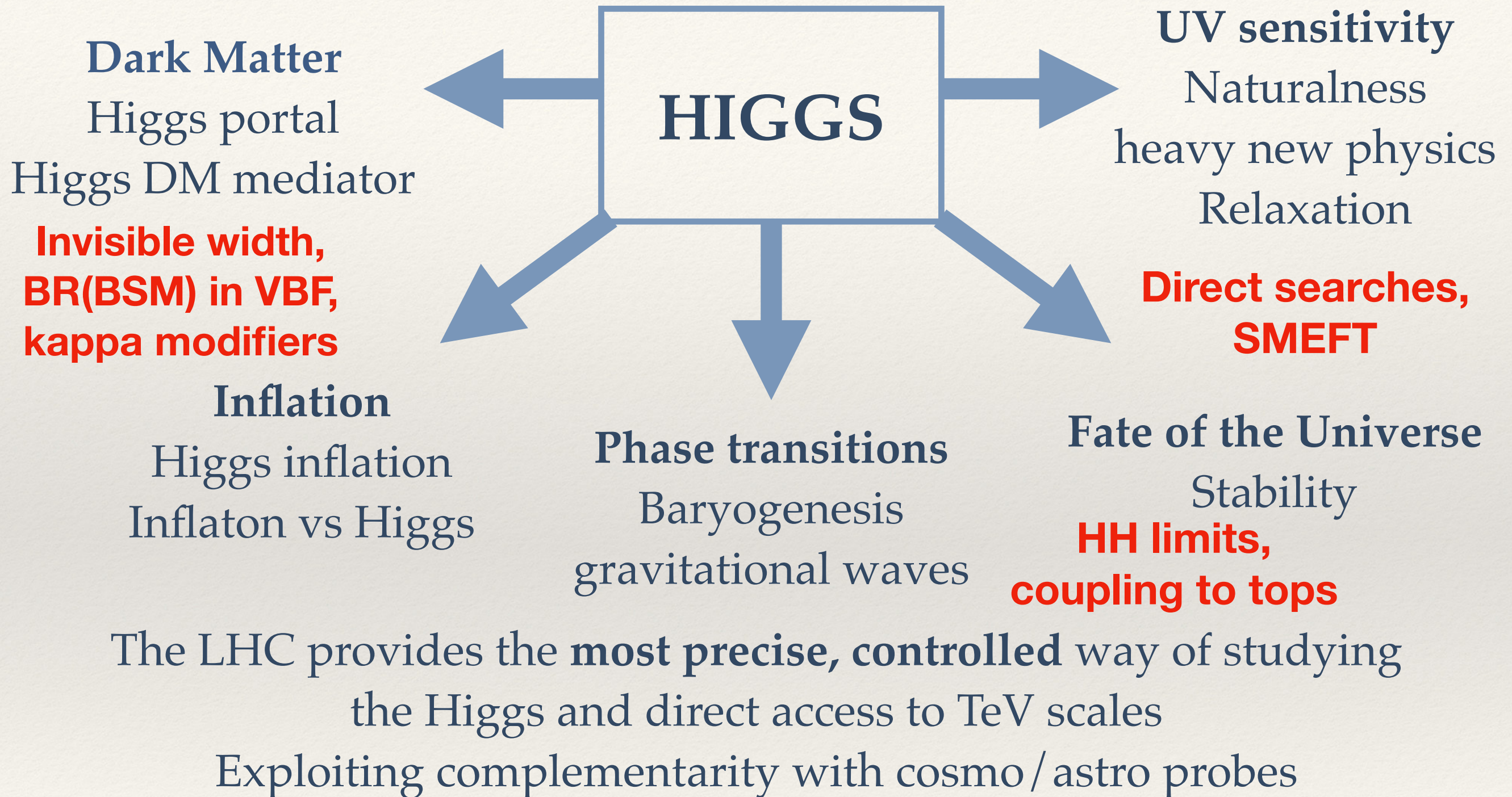
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Higgs as a Rosetta stone for the vacuum



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Similar story for Axions and ALPs, scalars are versatile

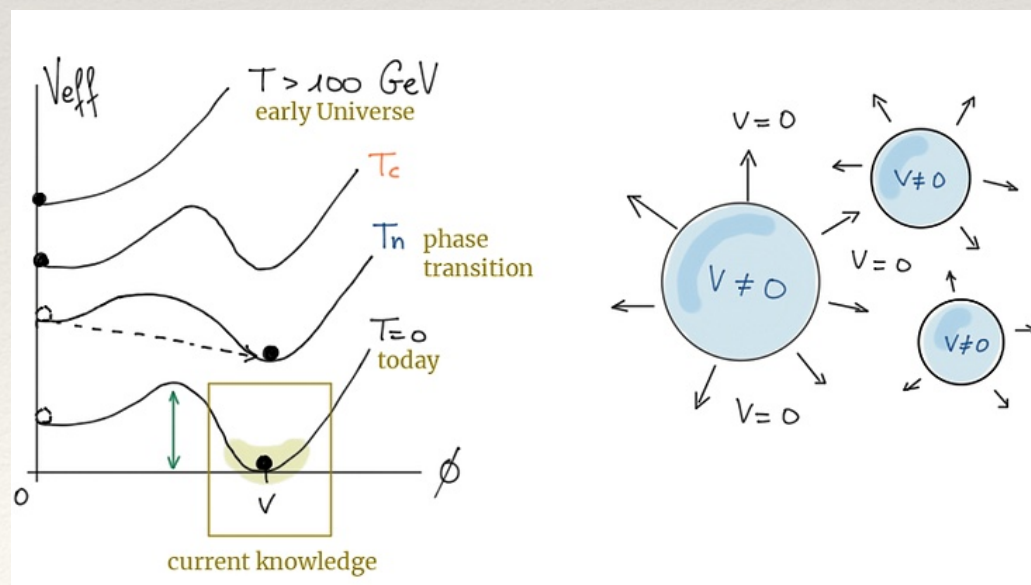
Higgs as a Rosetta stone for the vacuum

The Higgs, if a true fundamental scalar,
is **the first of its kind**

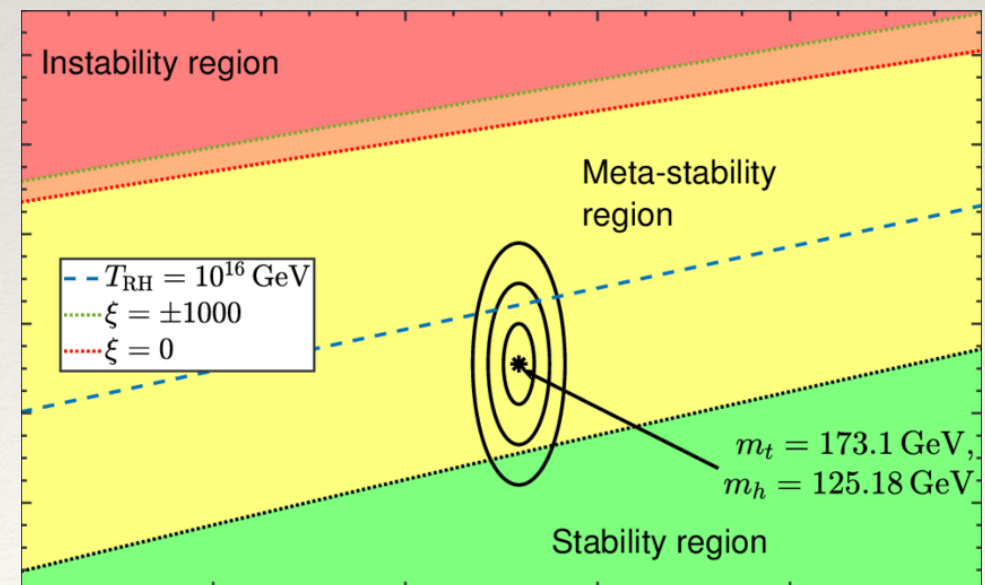
The **simplest object** from a spacetime perspective
rather unconstrained from the QFT framework
no symmetry protection for its overall scale,
a window to other scales

huge potential to **connect to other sectors**
and to have **nontrivial cosmological evolution**

Our probe into the vacuum



By Radchenko



Markkanen et al (2018)



Mirror maze from The Circus

Scientific context

Fundamental science in 2026

We are all aware that the
funding landscape for fundamental physics is changing

Not necessarily our fault but a result of other tensions
primarily the need to develop **new technological frontiers**
eg AI and QTech

Fundamental science in 2026

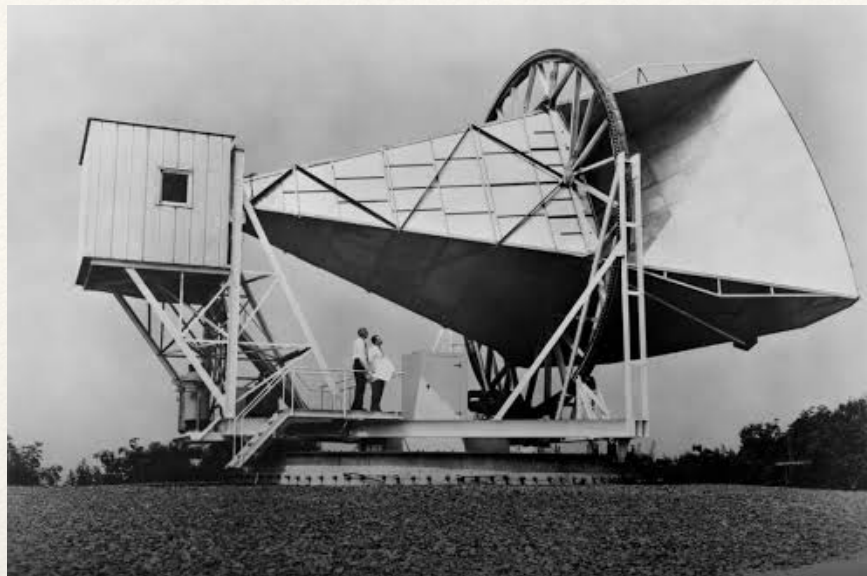
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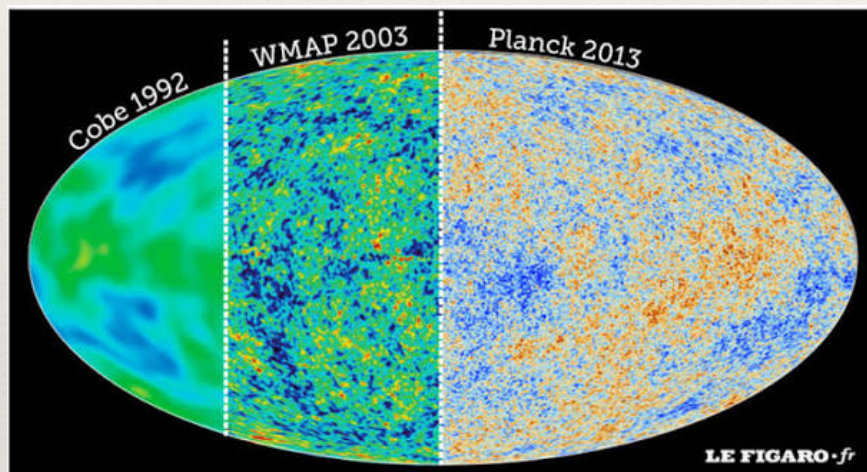
And, yes, yes, we all know those technologies evolved
from the basis of fundamental science
and a radical change in funding model may be **shortsighted**
But we live in the world of immediacy, **almost war-mentality**

Remember **funding is a social contract, not a theorem**
So, let's take this as a BC

The analogy of the CMB



Bell labs '64



With all the caveats, *the CMB is various steps removed from the fundamental theory the carry their imprint*

Discovery of a new cosmic signal

Establishment its basic properties

Precision anisotropies and polarisation

Infer the contents and history of the universe

Small deviations test physics beyond LCDM

Combinations CMB+other astro/
cosmo become powerful

The CMB programme is in full bloom, **60 years on** (eg 2607.15666)

It has become a **multiprobe observatory with multidecade scale**



SIMONS
OBSERVATORY

SPT BICEP3/Array

ACT FYST/CCAT

LiteBIRD, CMB-S4...



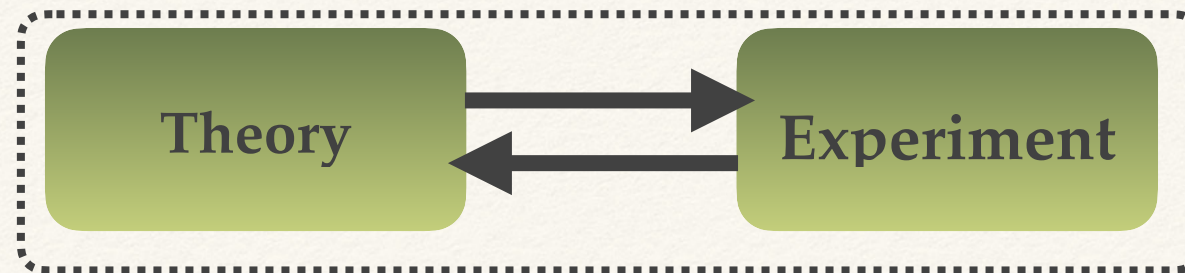
Funding: diversification. Now, few hundreds of millions. Projections next stage similar. Attempt to consolidate to billion scale failed



Theseus and the Minotaur by Burne-Jones

Looking ahead

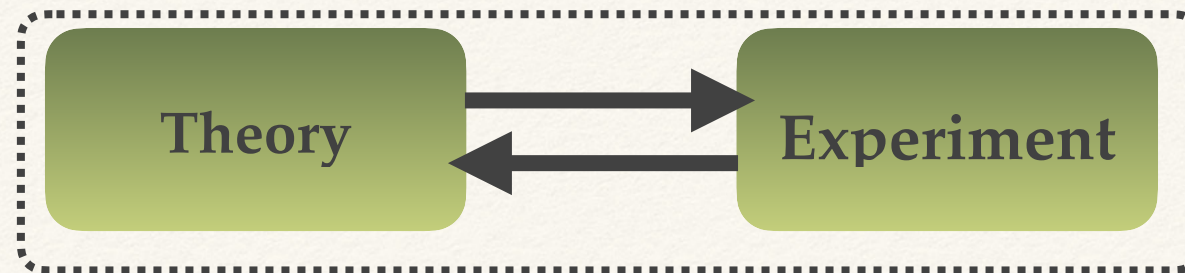
Sometimes we don't follow the script



Experiments can reveal the wholly **unexpected**
e.g. neutrino oscillations
the technologies they need can **transform society**
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Theory may pursue ideas with no foreseeable test
and still change how we see Nature
e.g. SUSY came from **asking how far a symmetry could be extended** and whether a no-go theorem could be wrong



How do we make room for exploration?

I believe encouraging this is crucial to the progress of the field

EXPERIMENTS

Without a clear no-lose theorem, **precision** is due diligence

Measure what is accessible as well as possible

even before we know why it matters

Theory can widen the questions each measurement addresses



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Long projects need **evolving physics cases**
Keep reinterpreting the data and repurposing the experiment,
avoid hubris from past successes
Give **people** time and resources to try new ideas, retain good intellect



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THEORY

Today, **disengagement** is the greater danger

Experiments probe Nature in more ways than EVER

Theory must help shape those probes and be ready to interpret a surprise



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Protect some time for ideas that may sound *crazy*

Let **young researchers** take intellectual risks without risking their careers

Original thinkers need difficult questions

Final comments

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nobody claims we will understand the human brain or find life in other planets, yet these research areas are strong because they are able to frame their goals properly

We may have lost some of this candid approach as we got bigger

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**We should work as hard to earn public support as we
do to design the next experiment**

Thank you!