

COSMIC QUESTIONS



UNIVERSITY OF
CAMBRIDGE

Public Engagement and Outreach



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Intro

As Andy Parker [laid out](#) at ERC Forum last April, decisions on a future collider will hinge on:

- Robust scientific case
- Unanimous support of global particle physics community
- Major discoveries at the LHC
- Continued technical success of CERN
- 'Reasonable' budget envelope

Public understanding and support definitely helps.

Most important is having a compelling and clear story to tell about why a future collider is essential.

This will also help build the science case and support among the community.

Will explore potential approaches in the next few minutes. More of a provocation for discussion than a proposal.

The LHC Story



We will find the Higgs or something else (no-lose theorem).

Expect to find new physics at EW scale (hierarchy problem).

A Future Collider Story?

The Higgs

First generation Yukawas
(i.e. origin of mass of the
stuff we're made from)

Origin of Higgs mass (SUSY,
compositeness etc)

HHH coupling

Is there a no-lose theorem?

Exploration

Search for new particles
and phenomena:

Dark Matter, Lepton Flavour
Violation, Massive
Neutrinos, EW baryogenesis
etc

No guarantees here so easy
to critique

Beyond Physics

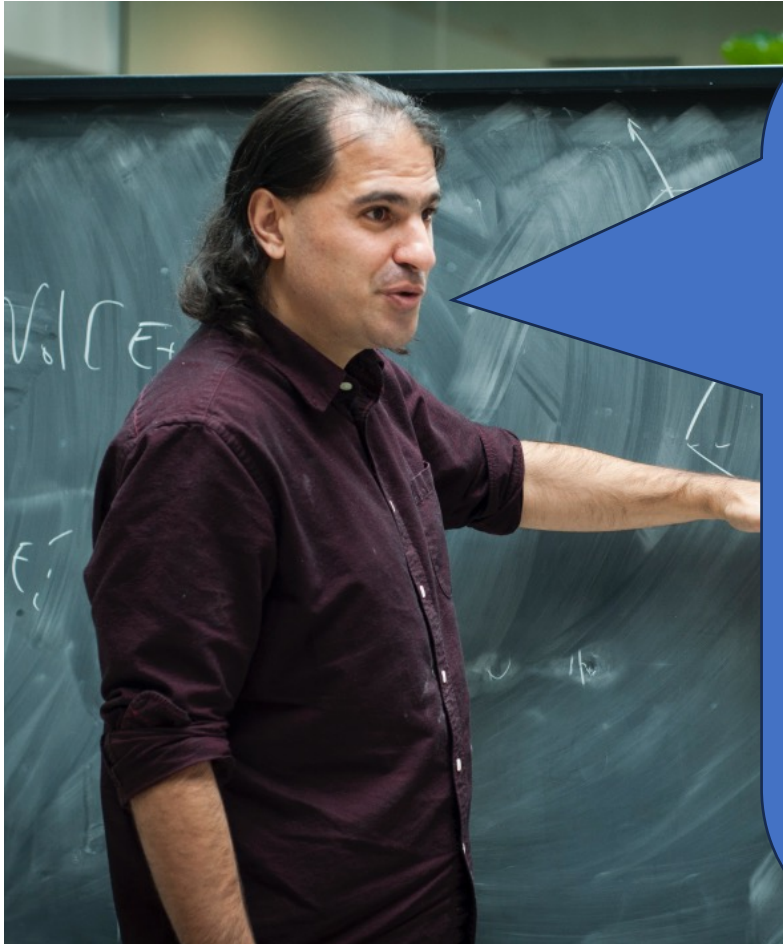
International Collaboration
for peaceful research

Impressiveness of scale of
machines

Spin off tech

Putting costs in context

Studying the Higgs to death



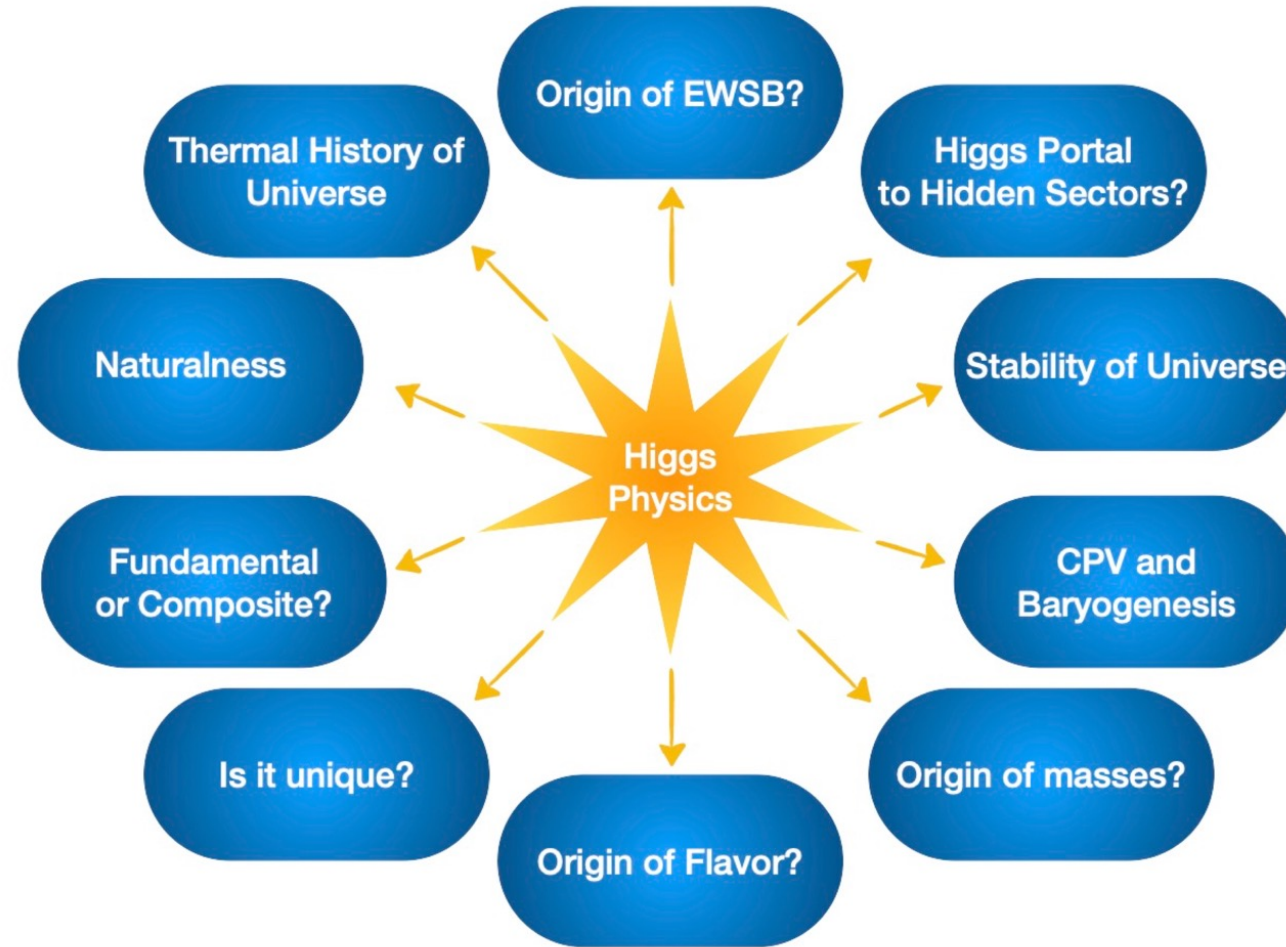
We have never seen anything like the Higgs before. This is not hyped, it's not like we're making a big deal about the latest particle.

The Higgs is the first elementary particle of spin zero we've ever seen, it's the simplest elementary particle we've ever seen, it doesn't have any charge, the only property that it has is mass and the very fact that it's so simple is what makes it really theoretically perplexing!

-Nima Arkani-Hamed

The Higgs at the Centre

Stolen from
Gavin Salam's
[FCC week talk](#)



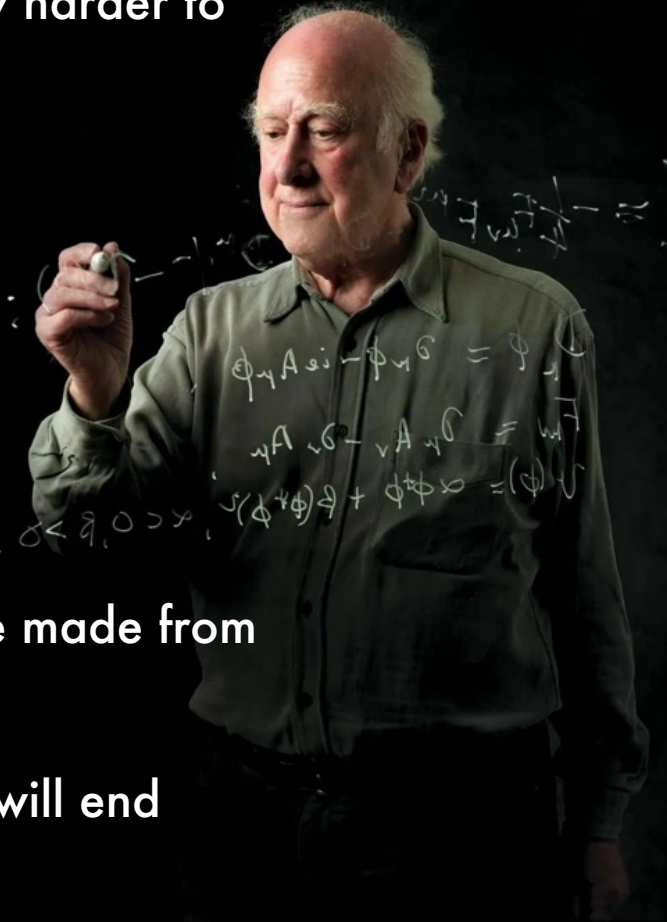
Towards a story for the Higgs

Scientific questions related to the Higgs tend to be highly abstract. Definitely harder to convey that 'we're going to discover a new particle' e.g.

1. Does the Higgs couple to the first generation as expected?
2. What is the natural width of the Higgs?
3. What is the form of the Higgs potential?

Can we boil this down to a set of comprehensible phrases? e.g.

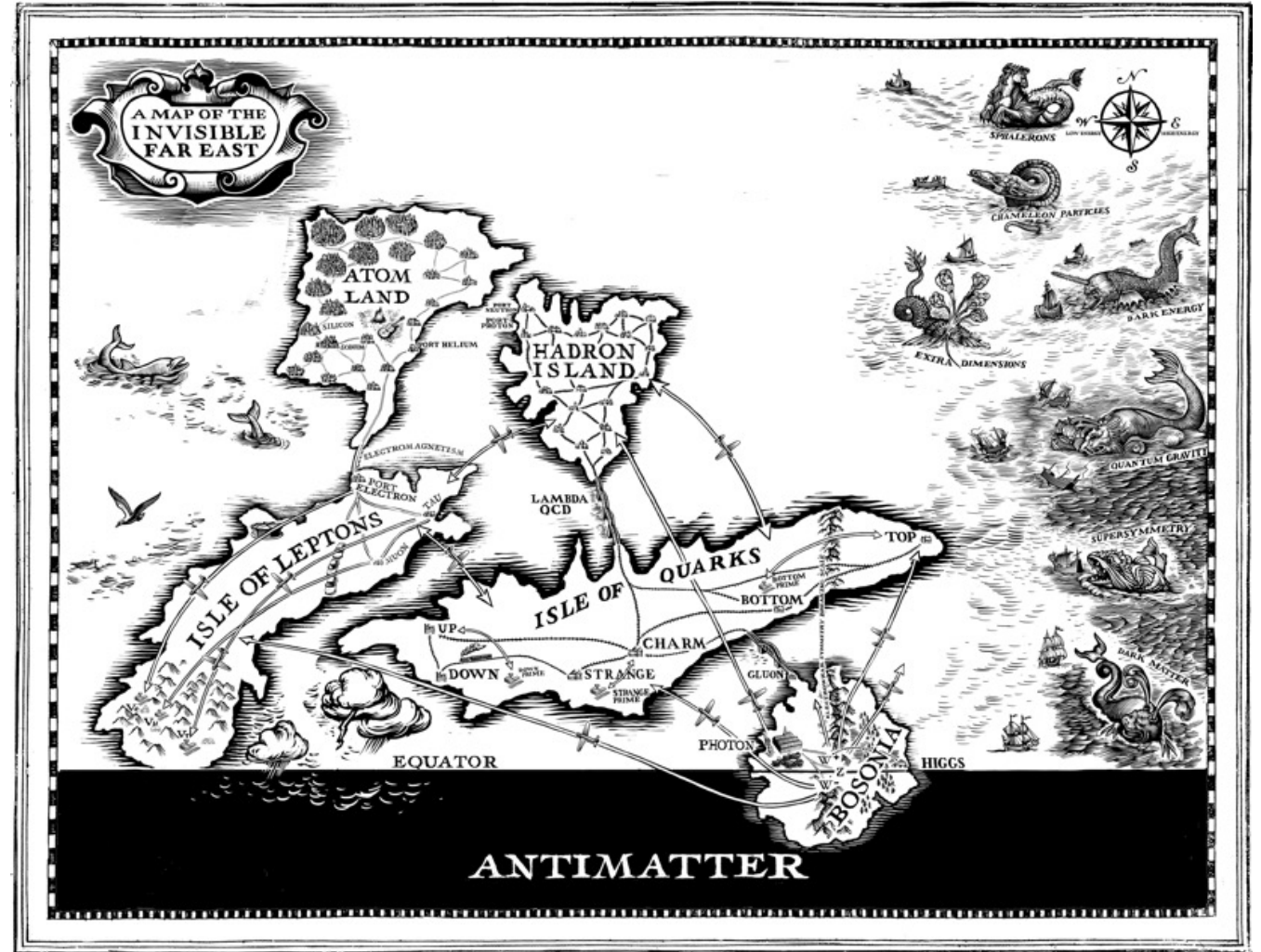
1. Studying the Higgs will tell us whether it gives mass to the particles we're made from
2. The Higgs *could* tell us about the dark universe
3. Understanding the Higgs will tell us how our universe formed and how it will end



Exploration

Argument made by Jon Butterworth after FCC Week Event (my paraphrasing):

We should be more prepared to make the case that colliders are for exploration – in the same way as big telescopes.



Beyond Physics

Need to have all the usual side-arguments up our sleeve:

- spin off tech
- value of international collaboration
- inspiration factor
- investment in high tech industries
- training of technical specialists
- far future applications of fundamental discoveries?

And ideas about how to respond to criticisms:

- That's very expensive!
- You promised to find dark matter/SUSY/black holes at the LHC and didn't!
- Particle physicists just make up hypothetical particles to justify expensive experiments!
- You're trying to open a portal to Hell! etc etc

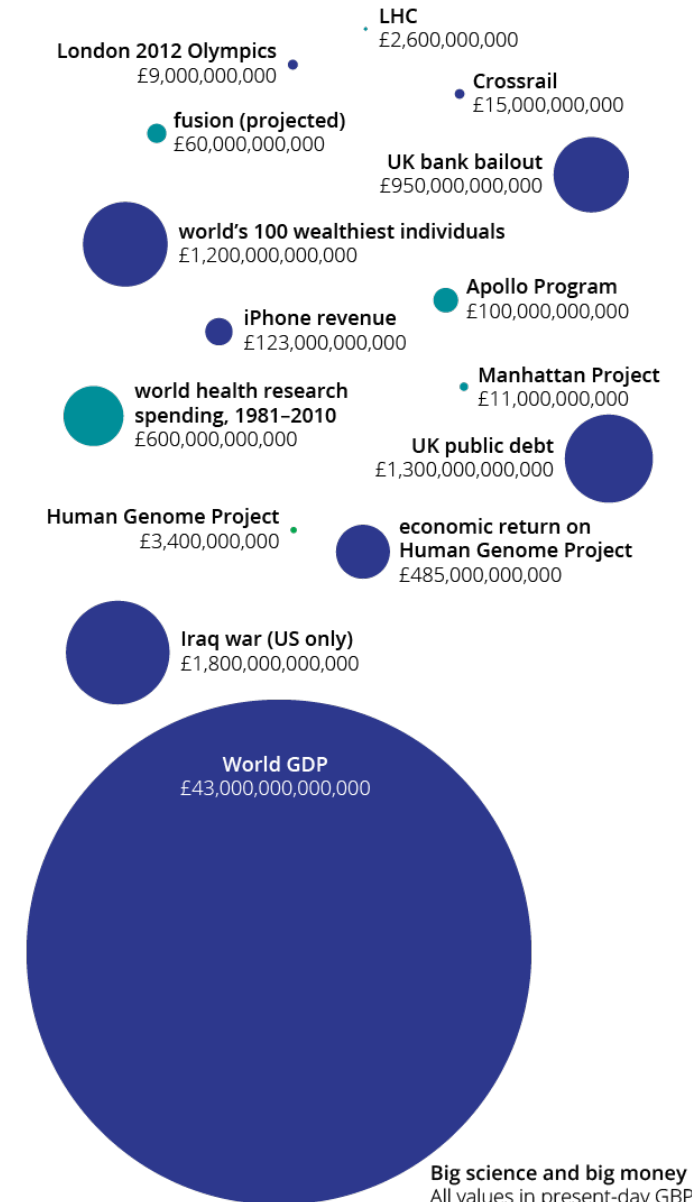


On Money

Costs of future colliders sound astronomical – tens of billions of euros/pounds/dollars.

Should try to put these costs in context – e.g. cost per citizen per year / comparison with other large projects.

Great work by Andrew Steele on this at www.scienceogram.org



Discovering the Higgs boson literally cost peanuts.

The UK subscription to CERN and the LHC costs us £1.50 per person per year; about the same as we spend on peanuts.

Big science and big money
All values in present-day GBP

Summary

Building public support will be an important part of making the case for a future collider.

First task is to distil physics program down to a compelling, easy to understand story about WHY we want to do this.

Personal (if rather obvious) take:

The Higgs must be at the center of how we communicate this

Benefits from being the real core of the physics case.

Also robust against common critique of 'you probably won't find any new particles'.

AND a strong story will help us persuade ourselves and our colleagues that we need a future collider.