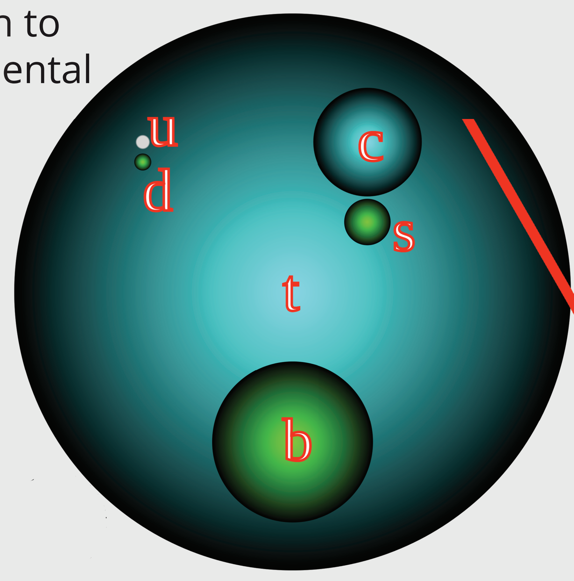
The Higgs Boson

What is the origin of mass?

One of the greatest quests of the last years has been to understand how fundamental particles gain mass.



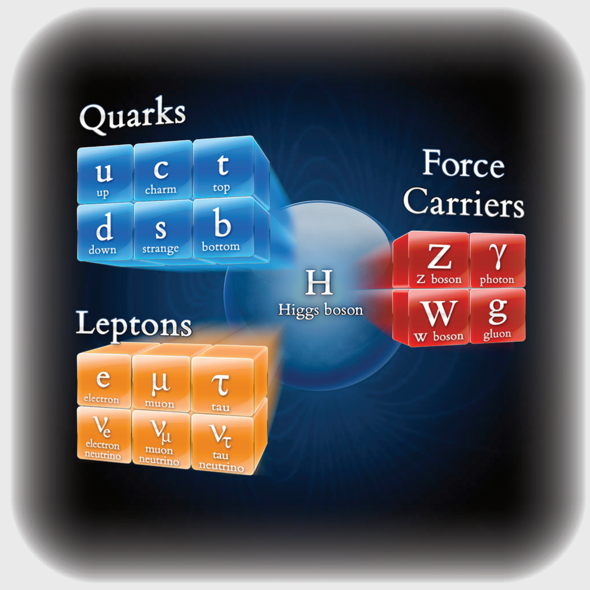
An explanation for that is that the Higgs field filled the entire Universe just moments after the Big Bang. Depending on their interaction with the Higgs field, the fundamental particles acquire more or less mass.

This is called the Brout-Englert-Higgs (BEH) mechanism.

What is the Higgs boson?

The Higgs boson is an excitation of the Higgs field. Its existence confirms the BEH mechanism.

Together with the other fundamental particles, it forms the Standard Model. So far, it is the best mathematical description of the known fundamental particles and forces (except gravity) of the Universe.



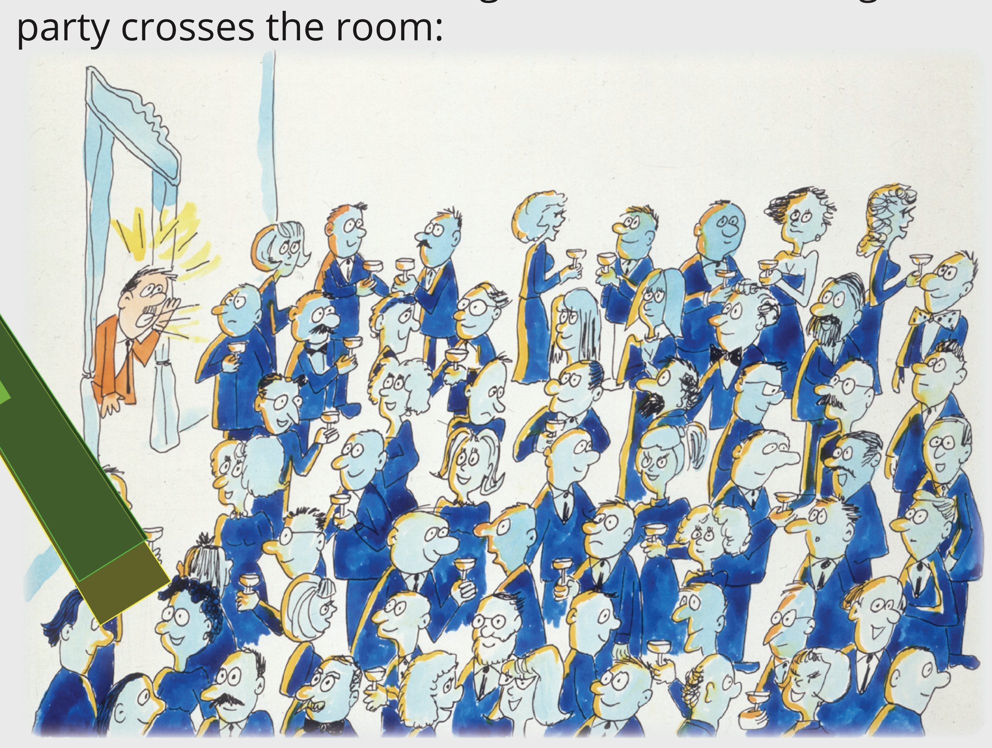
How does it work?

To understand the BEH mechanism, imagine that a room full of physicists chattering quietly is like space filled with the Higgs field:

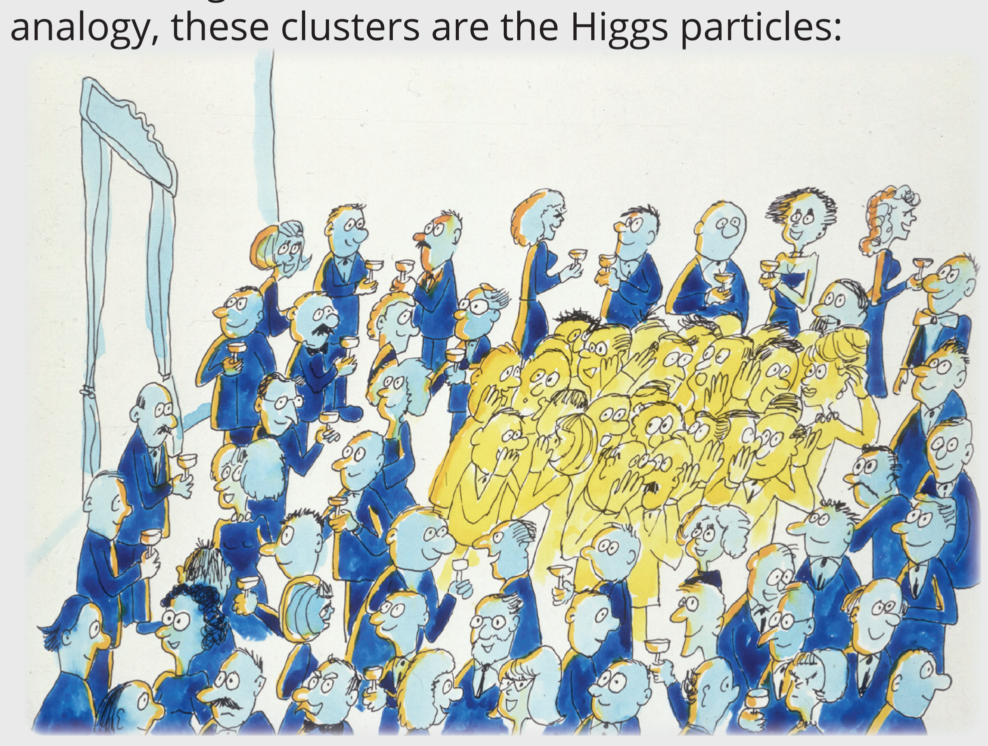
A well-known scientist walks in:

He creates a disturbance as he moves across the room and attracts a cluster of admirers with each step. This increases his resistance to movement. In other words, he acquires mass, just like a particle moving through the Higgs field.

Now, if a rumour about a great scientist arriving to the party crosses the room:

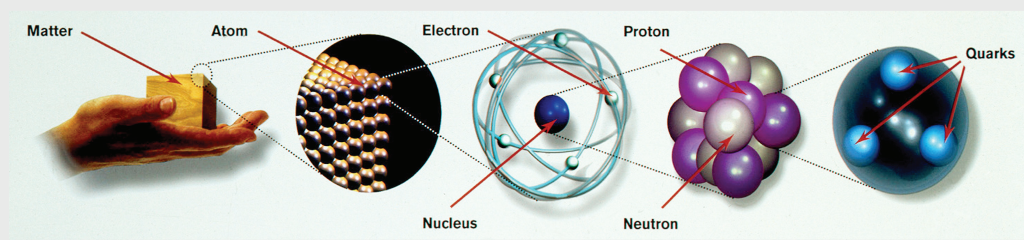


It produces an excitation in the room. It creates the same kind of clustering, but this time among the scientists themselves. In this analogy, these clusters are the Higgs particles:



Why is it important?

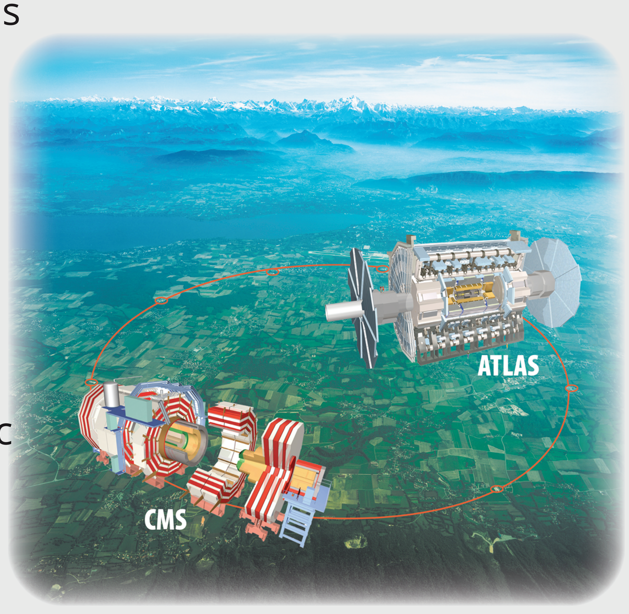
This quest is crucial for our understanding of the basic forces holding the Universe together.



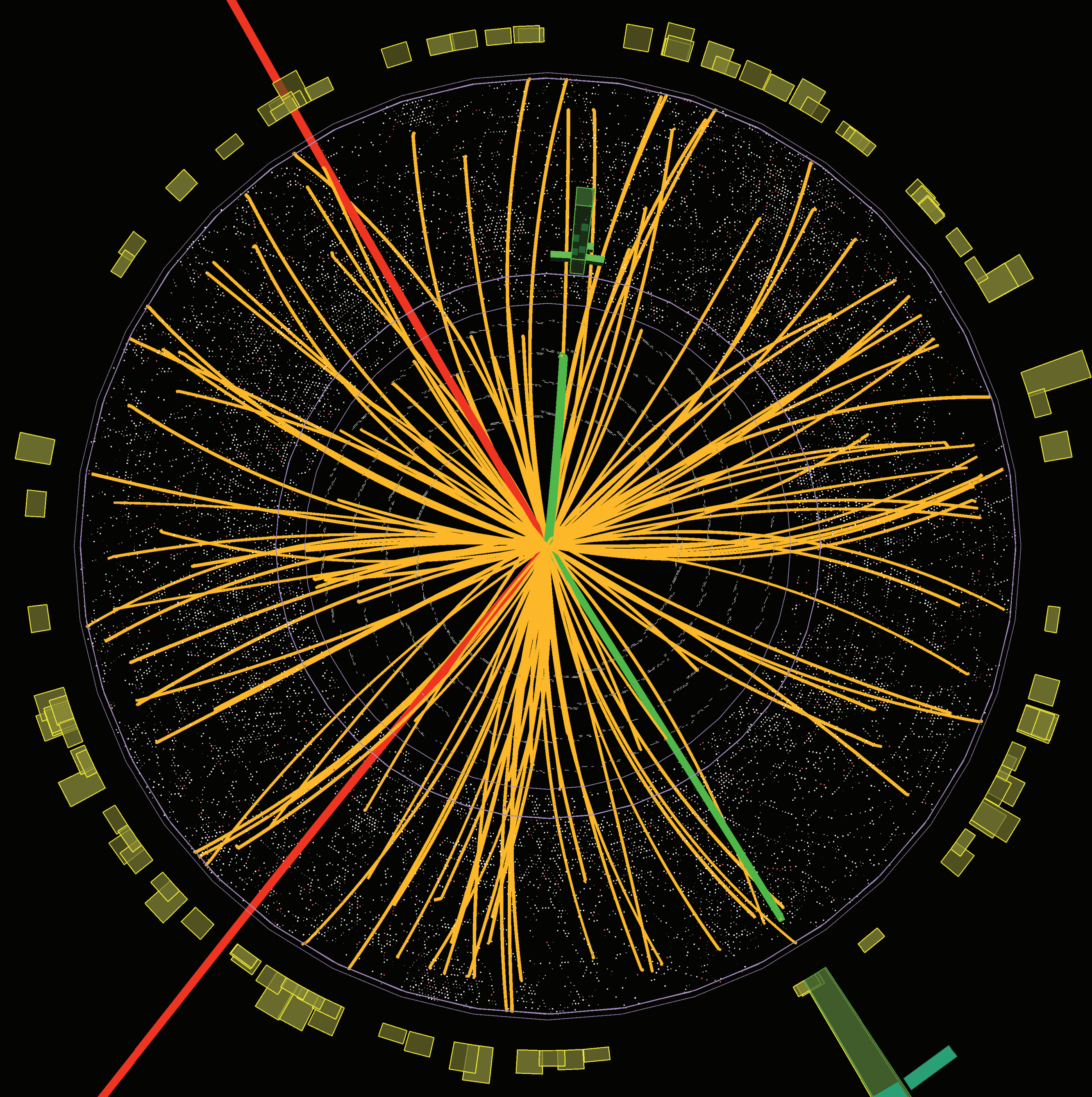
Without the BEH mechanism, the electrons would have no mass, they would travel at the speed of light and could not be bound into atoms. No atoms, would mean no stars, no galaxies, no life.

How do we find it?

High energy collisions at the Large Hadron Collider, CERN, excite the Higgs field, causing the Higgs boson, to momentarily form.

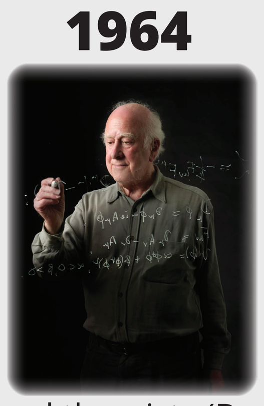


Huge detectors, as ATLAS, act as gigantic cameras and record the collisions which are then analysed to find the Higgs boson.



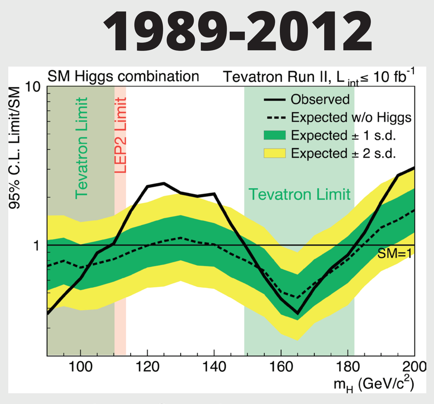
The Journey of the discovery

1964



Several theorists (Brout and Englert; Higgs; Kibble, Guralnik and Hagen) published three independent papers describing what we now call the BEH mechanism.

1989-2012

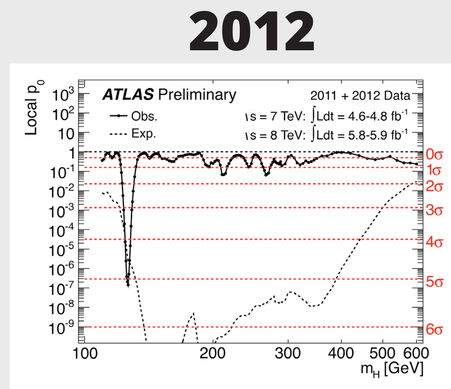


Searches for the Higgs have been performed at LEP (CERN) and Tevatron (Fermilab). The possibility of a Higgs having a mass < 114 GeV and between 147 and 180 GeV have been excluded.

2009

The ATLAS detector records its first collisions

2012



The ATLAS and CMS Experiments announced the first observation of a Higgs-like boson at a mass about 126 GeV. In 2013, it was confirmed to be a Higgs boson (spin 0 and parity +).

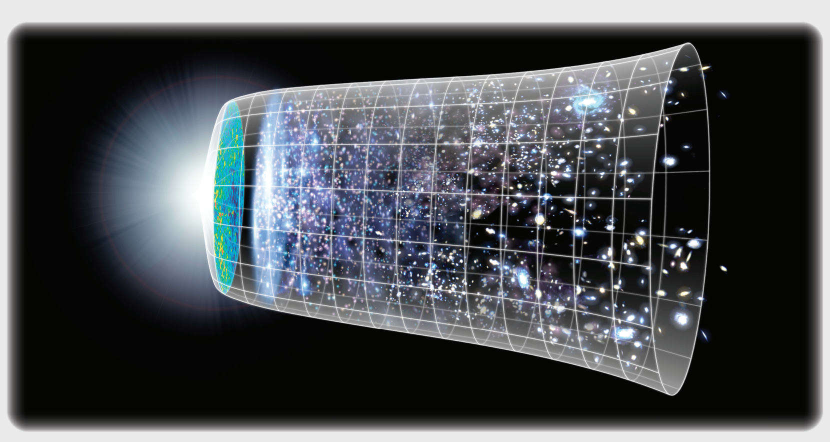
2013

The discovery of the Higgs boson was acknowledged when the Nobel Prize was awarded to François Englert and Peter Higgs for their work on the BEH mechanism.

Beyond discovery

The discovery of the Higgs particle marks the beginning of a new epoch in the history of physics.

The next stage of the experimentation is to determine if this Higgs particle corresponds to the Standard Model Higgs boson or if it is part of a new physics scenario.



There are different possible variants of the Higgs boson, corresponding to different descriptions of the Universe. It may act as a gateway to a whole new level of physics. It could also point a way towards the solution of mysteries such as dark matter and quantum gravity.

ATLAS EXPERIMENT
http://atlas.ch