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English Course

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Theoretical and experimental physics.

Large Hadron Collider.

The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator and the largest single machine in the world, built by the European Organization for Nuclear Research (CERN) from 1998 to 2008. It first started up on 10 September 2008, and remains the latest addition to CERN's accelerator complex. The LHC consists of a 27 - kilometer ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

The LHC is truly global in scope because the LHC project is supported by an enormous international community of scientists and engineers. Working in multinational teams all over the world, they are building and testing equipment and software, participating in experiments and analysing data.

Its aim is to allow physicists to test the predictions of different theories of particle physics and high-energy physics like the Standard Model, and particularly prove or disprove the existence of the theorized Higgs boson and of the large family of new particles predicted by supersymmetric theories. The discovery of a particle matching the Higgs boson was confirmed by data from the LHC in 2013. The LHC is expected to address some of the unsolved questions of physics, advancing human understanding of physical laws. It contains seven detectors, each designed for certain kinds of research.

1. Findings

Higgs Boson

The combined mass of the Higgs boson is $m_H = 125.09 \pm 0.24$ GeV (in comparison with electron $m_e = 0.510998910(13)$ MeV), which corresponds to a measurement precision of better than 0.2%. The Higgs boson is an essential ingredient of the Standard Model of particle physics, the theory that describes all known elementary particles and their interactions. The Brout-Englert-Higgs mechanism, through which the existence of the Higgs boson was predicted, is believed to give mass to all elementary particles. Today's result is the most precise measurement of the Higgs boson mass yet and among the most precise measurements performed at the LHC to date.

QCD

Quantum Chromodynamics (QCD) theory goes some way to explain how the Strong Force works but it leaves a lot of questions unanswered. For example, free quarks do not exist in nature, but QCD predicts that they do at the kinds of temperatures and densities that were present at the start of the Universe.

Cp-Violation and dark matter findings

It plays an important role both in the attempts of cosmology to explain the dominance of matter over antimatter in the present Universe, and in the study of weak interactions in particle physics.

One of the most fundamental questions is why is our Universe made of matter? It is widely thought that initially equal amounts of matter and antimatter were created, and currently there is no evidence opposing this. Experimental measurements and theoretical calculations hint that almost all matter and antimatter would have annihilated each other leaving behind a residual amount of matter to form our Universe. The mechanism that would have favoured matter against antimatter is called CP violation.

2. Design

3. Future

VLHC

The Very Large Hadron Collider (VLHC) is a hypothetical future hadron collider with performance significantly beyond the Large Hadron Collider.

There is no planned location or schedule for the VLHC; the name is used only to discuss the technological feasibility of such a collider and ways that it might be designed. This machine can answer a lot of questions about physics laws and may improve our understanding of nature. But when and where will it implement?

About Black Holes in LHC

According to the well-established properties of gravity, described by Einstein's relativity, it is impossible for microscopic black holes to be produced at the LHC. There are, however, some speculative theories that predict the production of such particles at the LHC. All these theories predict that these particles would disintegrate immediately. Black holes, therefore, would have no time to start accreting matter and to cause macroscopic effects.

Vacuum bubbles

There have been speculations that the Universe is not in its most stable configuration, and that perturbations caused by the LHC could tip it into a more stable state, called a vacuum bubble, in which we could not exist. If the LHC could do this, then so could cosmic-ray collisions. Since such vacuum bubbles have not been produced anywhere in the visible Universe, they will not be made by the LHC.

