10 Years of Higgs Boson

Why in news?

Ten years ago, scientists announced the discovery of the Higgs boson that marked the beginning of a new era of experimental physics.

How about the discovery of Higgs Boson?

- **Brout-Englert-Higgs (BEH) mechanism-** It describes how fundamental particles get mass.
- In this theory, fundamental particles acquire mass by interacting with a "field" that permeates the entire Universe.
- The more strongly the particles interact with the field, the more massive they are.
- **Higgs field**- This theory dubbed the Higgs field and such a field should also give rise to a Higgs particle.
- The particle was finally discovered on July 4, 2012, by researchers at the Large Hadron Collider (LHC) located at the European particle physics laboratory CERN, Switzerland.
- The LHC confirmed the existence of the Higgs field and the mechanism that gives rise to mass and thus completed the standard model of particle physics.

> *The CERN Laboratory was established in 1954 through international collaboration to provide a unique range of particle accelerator facilities and perform world-class research in fundamental physics.*

What is Higgs Boson?

- The Higgs boson is the fundamental particle associated with the Higgs field, a field that gives mass to other fundamental particles such as electrons and quarks.
- It is also popularly referred as "the God Particle".
- **Mass**- The Higgs boson has a mass of 125 billion electron volts— meaning it is 130 times more massive than a proton.
- **Charge**- The Higgs boson is also chargeless.
- **Zero spin**- Higgs boson, has an intrinsic angular momentum, or spin, of 0.
- The Higgs Boson is the only elementary particle with no spin.

Not all fundamental particles have mass. The photon, which is the particle of light and carries the electromagnetic force, has no mass at all.

What are the consequences of the discovery of Higgs Boson?

- **Origin of mass**- The Higgs boson has been the key in resolving the mystery of the origin of mass.

- **The Standard Model**- The Standard Model is the reigning theory of particle physics that describes the universe's very small constituents.
- The discovery of Higgs Boson is a confirmation that the theories we have now are right.
- **The electroweak force-** The confirmation of Higgs helps to explain how two of the fundamental forces of the universe — the electromagnetic force that governs interactions between charged particles, and the weak force that's responsible for radioactive decay can be unified.
- **Supersymmetry-** This idea posits that every known particle has a "superpartner" particle with slightly different characteristics.
- So far, though, scientists have found indications of only a Standard Model Higgs boson, without any strong hints of supersymmetric particles.
- **Validation of LHC-** Finding the Higgs boson was touted as one of the machine's biggest goals.
- **Space and time**- The mass of the Higgs boson is a critical part of a calculation that portends the future of space and time.
- **Unstable Earth**- The CERN results indicate that our universe isn't in a perfectly stable state.

The Large Hadron Collider is the world's largest particle accelerator that was built by the European Organization for Nuclear Research (CERN) to probe higher energies than had ever been reached on Earth.

What fundamental questions does the discovery pose?

- Could the unique properties of the Higgs boson make it a portal to discovering dark matter?
- Whether the Higgs boson might not be a fundamental particle after all?
- Could there be a new, unknown force beyond the other forces of nature – gravity, electromagnetism and the weak and strong nuclear forces?
- **Need of the hour**- A future high-energy collider, specifically designed to produce Higgs bosons, would enable us to precisely measure its most important properties, including how the Higgs boson interacts with other Higgs bosons.
- This in turn would determine how the Higgs boson interacts with its own field.
- These measurements will have a profound impact guiding or constraining our understanding of the origin of dark matter, the birth of our universe – and its ultimate fate.

References

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