



Electron's Magnetic Moment with Precision

Why in News?

Recently, physicists have made a **groundbreaking achievement in metrology** by measuring the **electron's magnetic moment** with record-breaking precision. It is significant because it provides the **most precise test so far of the Standard Model of particle physics**.

- The measurement was reported to be **0.13 parts per trillion (ppt), which is 2.2 times more accurate than the previous best record** from 14 years ago.

What is the Standard Model?

- The **Standard Model (SM) is a theory that describes the properties of subatomic particles**, classifies them into groups, and determines how they are affected by three of the four fundamental forces: **strong-nuclear, weak-nuclear, and electromagnetic**.
 - But it can't explain gravity.
- The **SM predicted the existence of the Higgs boson**, which was discovered in 2012, and has **successfully predicted the properties of many particles**, making it one of the most successful theories in physics.
 - The **Higgs boson is an elementary particle, which means that it cannot be broken down into smaller components**. It has no electric charge, spin, or other intrinsic properties, but it does have mass.
 - The mass of the Higgs boson is around 125 billion electron volts, or about 133 times the mass of a proton.
- Despite its successes, the **SM is unable to explain certain phenomena, such as the excess of matter** over antimatter in the universe, dark matter, and dark energy.
- Further research in this field could help us understand more about the fundamental nature of the **universe and how it operates**.

What is Dark Matter and Dark Energy?

- The content of the Universe is widely thought to consist of three types of substance: **normal matter, dark matter and dark energy**.
 - In the currently popular 'concordance model' of the Universe, **70% of the cosmos is thought to be dark energy**, 25% dark matter and 5% normal matter.
- **Normal matter** consists of the atoms that make up **stars, planets, human beings and every other visible object in the Universe**.
- **Dark matter makes up most of the mass of galaxies and galaxy clusters**, and is responsible for the way galaxies are organized on grand scales.
- Dark energy, meanwhile, is the **name we give the mysterious influence** driving the accelerated expansion of the universe.

What is Electron's Magnetic Moment?

- This magnetic moment is a fundamental property of the electron and is related to the **electron's charge and its intrinsic spin**.
- The magnetic moment of an electron is an important physical property that is used to explain many phenomena in atomic and molecular physics, such as the **behaviour of electrons in magnetic fields and the magnetic properties of materials**.

UPSC Civil Services Examination, Previous Year Questions (PYQ)

Q1. The terms 'Event Horizon', 'Singularity', 'String Theory' and 'Standard Model' are sometimes seen in the news in the context of (2017)

- (a) Observation and understanding of the Universe
- (b) Study of the solar and the lunar eclipses
- (c) Placing satellites in the orbit of the Earth
- (d) Origin and evolution of living organisms on the Earth

Ans: (a)

Q2. The efforts to detect the existence of Higgs boson particle have become frequent news in the recent past. What is/are the importance/importances of discovering this particle? (2013)

1. It will enable us to understand as to why elementary particles have mass.
2. It will enable us in the near future to develop the technology of transferring matter from one point to another without traversing the physical space between them.
3. It will enable us to create better fuels for nuclear fission.

Select the correct answer using the codes given below:

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

Ans: (a)

Q3. Recently, scientists observed the merger of giant 'blackholes' billions of light-years away from the Earth. What is the significance of this observation? (2019)

- (a) 'Higgs boson particles' were detected.
- (b) 'Gravitational waves' were detected.
- (c) Possibility of inter-galactic space travel through 'wormhole' was confirmed.
- (d) It enabled the scientists to understand 'singularity'.

Ans: (b)

Source: TH