What is dark matter?

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In news– Scientists have recently begun the search for what so far has been unfindable: dark matter using a titanium tank filled with a rare liquified gas placed in a former gold mile that is over a kilometre underground.

About Dark matter-

- **All interactions in the universe are a result of four fundamental forces acting on particles** – strong nuclear force, weak nuclear force, electromagnetic force and gravitation.
- **Dark matter is made up of particles that do not have a charge** which means they do not interact through electromagnetic interactions.
- T**hese particles are "dark", namely because they do not emit light**, which is an electromagnetic phenomenon, and **"matter" because they possess mass like normal matte**r and **interact through gravity.**

- Gravitational force, besides not being fully integrated and understood by particle physicists, is extremely weak. For one thing, a particle that interacts so weakly becomes rather elusive to detect. This is because interactions from other known particles could drown out signals of dark matter particles.
- **Many physicists strongly believe that the entire visible part of the universe forms only 5% of all matter in it.**
- They believe the rest is made up of dark matter and dark energy.
- Once this was convincingly demonstrated through various indirect observations and calculations, experiments started being set up to hunt for these elusive particles.
- The latest to hit the news in the field of dark matter is a **dark matter detector experiment named LUX-ZEPLIN**

(LZ) in South Dakota in the U.S. As of today, this is the **most sensitive dark matter detector in the world**.

Why do physicists believe strongly that dark matter exists?

- **There is strong indirect evidence for dark matter,** and this evidence is **reflected at various levels** (or distance scales, as physicists would explain). At the shortest distance scale, consider the **rotation of galaxies.**
- If you look at **stars all the way from the centre of any galaxy to its rim**, the way the velocities of the observed stars change may be plotted.
- In the lab this same function may be plotted on a graph by assuming the visible matter is all that exists.
- There is a marked difference between the observed plot of star speeds and the calculated value as you move from the inner part of the galaxy towards its rim.
- One may argue that it is the model that is at fault and there is some other way to reconcile this discrepancy between the calculated and observed value of velocities in rotating galaxies. This is where evidence from other distance scales comes up.

The evidences from other distance scales-

- **The universe can be observed at various levels – at the level of electrons and nuclei or atoms, or galaxies,** or **galaxy clusters**, or even larger distances where the entire universe can be mapped and studied.
- **Cosmologists, people who study the physics of the universe,** typically work in the last mentioned three scales, and particle physicists study the lowest and even smaller scales.
- In this context, **the second evidence came from observations of the so-called Bullet cluster of galaxies.**
- The **Bullet cluster is formed through the merging of two**

galaxy clusters.

- Physicists found from their calculations that the way these mergers took place could not be fully explained if we believed that the visible universe were all that existed.
- Therefore, there should be something like dark matter as well as an estimate of how much dark matter there should be in the universe.
- **Similar arguments exist from mappings of the universe such as the Sloan Digital Sky Survey** and studies of the filamentous nature of the universe at a closer look.
- While fixing the model could help explain away one of these discrepancies, not all of them can be explained in the same manner.