

Dark energy is a hypothetical form of energy that permeates all of space and tends to increase the rate of expansion of the universe.

- ✓ Dark energy constitutes approximately **70%** of the universe's mass-energy composition.
- ✓ Dark energy doesn't have a gravitational pull; instead, it acts as a force that repels gravity.

Unlike dark matter its presence is inferred from the accelerated expansion of the universe. Previously, physicists assumed that gravity would slow down this expansion over time, but dark energy's repulsive effect counters this

- ❖ **The visible matter we know (including Earth, stars, and galaxies) constitutes less than 5% of the universe.**

Black hole:

Cosmic body of extremely intense gravity from which nothing, not even light, can escape.

A black hole can be formed by the death of a massive star having mass 3 or 5 times more than the solar mass.

The escape velocity of Black hole is more than the speed of light. Hence, even light cannot escape out from the black hole.

When such a star has exhausted the internal thermonuclear fuels in its core at the end of its life, the core becomes unstable and gravitationally collapses inward upon itself, and the star's outer layers are blown away. The crushing weight of constituent matter falling in from all sides compresses the dying star to a point of zero volume and infinite density called the singularity.

Black hole is a very dense object in space-time, which means it has large mass in small volume. Hence, it bends the space time fabric to the great extent.

Gravitational wave:

Gravitational wave is disturbance in the curvature of spacetime, generated by accelerated masses, that propagate as waves outward from their source at the speed of light.

Gravitational wave transport energy as gravitational radiation (a form of energy similar to electromagnetic radiation).

Gravitational wave is also called gravity wave or gravitational radiation.

Gravitational waves were first directly detected by the Laser Interferometer Gravitational-Wave Observatory (LIGO) in 2015.

Properties of gravitational wave:

1. It is an invisible ripple in space that travels at the speed of light.
2. These waves squeeze and stretch anything in their path.
3. These waves interact very weakly with matter, so it can easily penetrate the materials.
4. These waves obey inverse square law.
5. The quantum of gravitational wave is called as graviton (not discovered yet).

Importance of Gravitational wave:

- Gravitational waves carry information about their origin (origin of universe) and about the fundamental properties of gravity that can't be seen through observations of the electromagnetic spectrum.
- It helps to provide the information about the measure of expansion of universe.
- It helps to estimate the future of universe (origin and end of universe).
- The discovery of gravitational wave may lead to the discovery of new devices and technologies.