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Gravity Waves, Discovery, Introduction, Causes of Gravitational Waves (For CBSE, ICSE, IAS, NET, NRA 2022)

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Gravity Waves

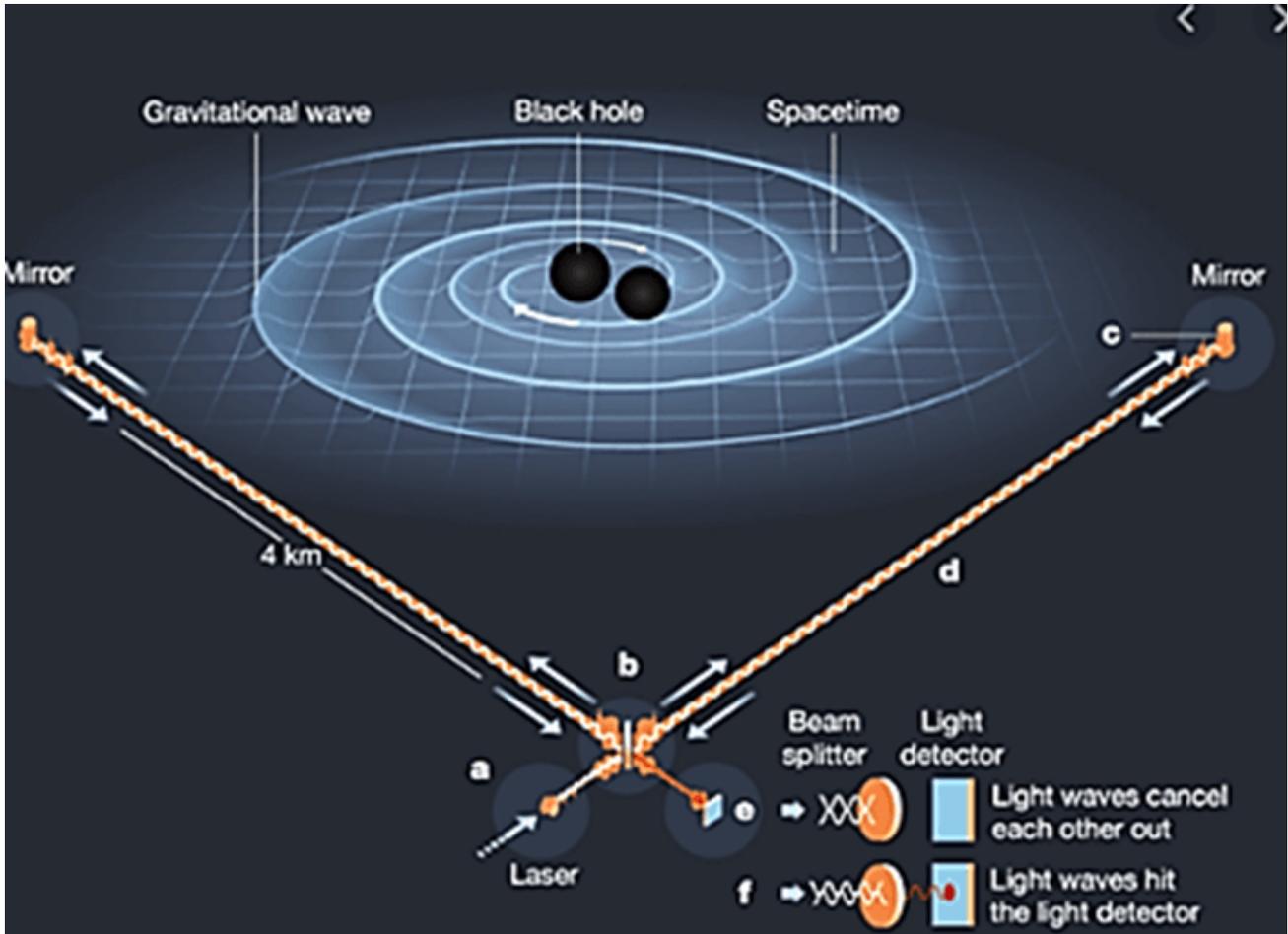
Discovery

- The first person to come up with such an idea was the French mathematician Henri Poincare, who in 1905 suggested accelerating masses must send waves of energy through gravity fields in the same way accelerating charges send energy waves through electromagnetic fields.
- By the late 1950s, it was accepted that such ripples in space time not only existed, but they carried enough energy to effectively make things move, meaning they could theoretically be detected.

Introduction

- Gravity waves or Gravitational waves are ripples in space time fabric, generated by accelerated masses.
- Simply, the presence of mass will result in a gravitational force.
- Definition: **When an object with mass accelerates, the gravity will propagate through the spacetime fabric, from the source to infinite outer space with the velocity of light in a wave-like fashion. This is called gravity waves.**
- The observational astronomy enfolds a branch named Gravitational-wave astronomy
- Gravity waves are recorded to collect observational data on Binary star systems, which may consist of neutron stars, white dwarfs, black holes, etc.
- These waves also studied to understand events like supernovae and the formation of the early universe (The universe that formed just after the Big-Bang)

Gravitational Waves



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- The gravity wave frequency spectrum, exhibiting source as well as detectors.
- Although the theory part of Gravitational waves was well established during the year 1916, it was observed practically after several decades.
- Joseph H. Taylor Jr. along with Russell A. Hulse was awarded the prestigious Nobel prize for the first indirect discovery of the presence of gravity waves during the year 1993.
- During the year 2015, the first direct detection of Gravity wave was made at LIGO.

Causes of Gravitational Waves

- Everything began once the entire universe was reformed from a completely new dimension by Einstein's.
- He modeled the universe in his revolutionary theory; The theory of relativity.
- He considered space and time as inseparable entities which spread across the universe like a fabric.
- Thus, he called it as space-time fabric. Everything in the universe is floating on this fabric.

- The gravity is considered to be an outcome of the curvature in spacetime and this curvature is due to the presence of mass.
- In general, More and more mass confined in a volume, greater will be the curvature near the boundary of the volume.
- Gravitational waves spread at the speed of light, filling the universe, as Albert Einstein described in his general theory of relativity.
- They are always created when a mass accelerates, like when an ice-skater pirouettes or a pair of black holes rotates around each other.
- Einstein was convinced it would never be possible to measure them. The LIGO project's achievement was using a pair of gigantic laser interferometers to measure a change thousands of times smaller than an atomic nucleus, as the gravitational wave passed the Earth.
- So far, all sorts of electromagnetic radiation and particles, such as cosmic rays or neutrinos, have been used to explore the universe.
- Though gravitational waves are direct testimony to disruptions in space time itself.
- A wealth of discoveries awaits those who succeed in capturing the waves and interpreting their message.
- When gravity wave propagates, the distance between the objects varies accordingly at a frequency same as that of a wave.
- The magnitude of such an effect is inversely proportional to the square of the distance from the source.
- Gravity wave can exist at any frequency range. Frequencies at extrema are not possible to detect as a result of the limitations of our instruments. But there are various frequency bands of gravity waves listed by Werner Israel and Stephen Hawking that could possibly be detected.
- The range lies between 10^{-7} Hz to 10^{11} Hz .

Importance of Gravitational Waves

- Opens a new window into the cosmos
- Disproves Newton's theory of gravitational events occurring everywhere at once
- Proves Einstein's theory of general relativity
- Contributed to the discovery of the gravitational wave spectrum
- Could lead to the discovery of potential new devices and technologies

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