5. How Gravity Distorts Our View of A Black Hole

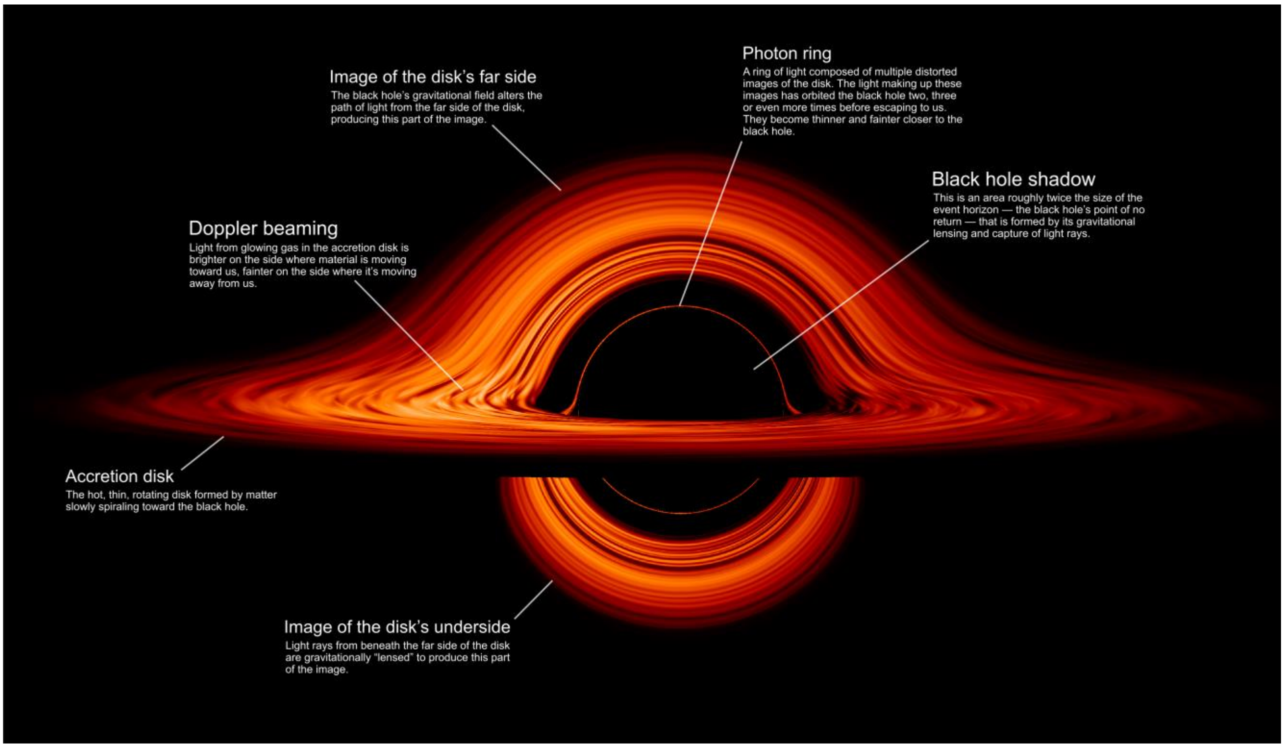
Prelims: Science & Technology- Space Technology

Mains: GS-III- Awareness in the fields of Space,

Context:

- A new visualisation of a black hole, released by NASA, illustrates how its gravity distorts our view by warping its surroundings.
- The visualisation simulates the appearance of a black hole where infalling matter has collected into a thin, hot structure called an accretion disc.
- The black hole's extreme gravity skews light emitted by different regions of the disc, producing the misshapen appearance, NASA explained in the release.

Explanation:



- As magnetic fields twist through the churning gas, bright knots form and dissipate in the disc. In the area closest to the black hole, the gas orbits at close to the speed of light.
- The outer portions spin a bit more slowly. This difference stretches and shears the bright knots, producing light and dark lanes in the disk.
- The black hole's extreme gravity alters the paths of light coming from different parts of the disc, producing the warped image. Exactly what we see depends on our viewing angle; the greatest distortion occurs when viewing the system nearly edgewise.

- Glowing gas on the left side moves toward us so fast that the effects of Einstein's relativity give it a boost in brightness.
- On the right side, gas moving away becomes slightly dimmer. This asymmetry disappears when we see the disc exactly face on because, from that perspective, none of the material is moving along our line of sight.

About Einstein's Theory of Relativity:

- In 1915, Albert Einstein presented his theory of general relativity, which proposed that gravity itself was the result of a warping of spacetime by massive objects like stars and planets.
- Einstein's theory of relativity indicates that all objects fall the same way regardless of mass or composition.

Things predicted by General relativity include:

- **As light gets closer to the sun, it bends towards the sun** twice as much as classical physics (the system used before general relativity) predicts.
- **The perihelion of the planet Mercury rotates along its orbit more than is expected under Newtonian physics**. General relativity accounts for the difference between what is seen and what is expected without it.
- **Redshift from gravity.** When light moves away from an object with gravity (moving away from the center of the valley), it is stretched into longer wavelengths. This was confirmed by the Pound-Rebka experiment.
- **The Shapiro delay.** Light appears to slow down when it passes close to a massive object. This was first seen in the 1960s by space probes headed towards the planet Venus.
- **Gravitational waves.** They were first observed on 14 September 2015.