Einstein Was Right: Astronomers Confirm Key Theory of Relativity

Astronomers have finally confirmed the ‘gravitational redshift or Einstein shift’ with observational data. They got this result by tracking the movement of a star S2 as it passed through the gravitational field of a black hole Sagittarius A* (the huge black hole at the heart of the Milky Way).

- S2 is one member of a star cluster that surrounds Sagittarius A*. These stars reach extremely high speeds when they approach the black hole - S2 comes very close to Sagittarius A* once every 16 years.
- The Very Large Telescope (VLT) of The European Southern Observatory, in Chile, was used to find this evidence.

Process of Prediction

- Astronomers followed S2 before and after it passed close to the black hole on 19 May 2018, tracking its progress hour-by-hour. They then calculated its velocity and position using a number of instruments and compared it with predictions made by Einstein that the light would be stretched by the gravity, in an effect called gravitational redshift.
- The astronomers have found that light from the star has been stretched to longer wavelengths by the very strong gravitational field of Sagittarius A*. The results are perfectly in line with the theory of general relativity - and not explained by Sir Isaac Newton's ideas - which exclude such a shift.

Note:

- Gravitational redshift occurs as particles of light (photons) climb out of a gravitational well like a black hole and the light's wavelength gets drawn out. This shifts the wavelength to the red part of the light spectrum - hence "redshift".
- In order to escape intense gravity, particles of light (photons) must expend energy. However, at the same time, these photons must travel at a constant speed - the speed of light. Therefore, the photons can't lose energy by slowing down but must expend it in another way. This lost energy manifests itself as a shift towards the red end of the light spectrum.

Practical Utility

- The result will help scientists better understand the physics of black holes.
- It is important in astronomy to check that those laws of physics are still valid where the gravitational fields are very much stronger.
- The results are also perfectly in line with the theory of general relativity and therefore is a major breakthrough towards better understanding the effects of intense gravitational fields.
- Astronomers hope they can make practical use of the latest confirmation of Einstein’s theory by tracking shifts in S2’s trajectory, which could yield information on mass distribution around the black hole (i.e till what extent the effect of gravity is felt by the star S2).