Eddington and the Bending of Light

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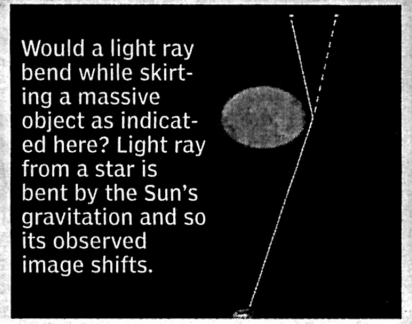
part-44

THE UNIVERSE YOURS TO DISCOVER

INTERNATIONAL YEAR OF ASTRONOMY 2009

DNA special

When Isaac Newton proposed the law of gravitation, he termed it a 'universal law', thus implying that it was applicable to all things, big and small, in the universe. But what about light? Is it also subject to gravitational attraction? If a light ray passes close to a massive body, will it be bent round by the gravitational attraction of the body as shown in the diagram?



Would a light ray bend while skirting a massive object as indicated here? Light ray from a star is bent by the Sun's gravitation and so its observed image shifts.

Newton agonised over this question. He may have had ideas on it but, being a true scientist, without experimental proof, he could not express them. He therefore left it as an unanswered question, amongst other such queries. The issue remained unresolved until Albert Einstein appeared on the scene. With his new theory of gravitation, the so-called general theory of relativity, he was able to assert that light also is affected by gravity.

A detailed calculation of the problem led him to predict that a light ray passing close to the surface of the Sun will be bent by a very small angle. This predicted angle was slightly less than 2,000th part of a degree, the unit commonly used for measuring angles. Meanwhile, physicists had worked out that if one assumed light to be made of tiny particles, then those will be attracted by a massive body and in the case of the Sun, the net effect on the light ray, according to Newton's law, would be to bend it by half the value that Einstein's theory gave. Thus, here was a challenge to experimentalists: to devise an experiment which would tell us who was right: Newton, Einstein or neither? Because of the smallness of the expected results, scientists were not confident that they would be able to decide.

From l: Newton, Einstein & Eddington

Nevertheless, an experiment was performed by two teams of astronomers led by theoretical astronomer Arthur Stanley Eddington from Cambridge. Eddington was one of the few scientists, who in those early days, understood Einstein's theory. He argued that light rays coming from a few select stars would graze the solar surface and in the process get bent. The result would be a shift in the observed positions of those stars in the sky. With accurate telescopes, Eddington hoped to measure those slight shifts. Of course to be able to carry out such measurements, one needed a total solar eclipse to block the Sun's rays.

There was going to be an eclipse in 1919 and to use it, Eddington proposed two observing teams. One would observe from Sobral in Brazil and the other from the island of Principe in the Gulf of Guinea. Eddington himself opted for the latter believing it to be more weather-friendly. There were several hiccups on the way but he did come back with useful data.

The data after due analysis was presented by Eddington at the joint meeting of the Royal Society and the Royal Astronomical Society, on November 6, 1919. The results, he announced, favour Einstein rather than Newton. And this announcement heralded a revolution of ideas wherein Newtonian concepts made way for the more bizarre ideas of Einstein.

However, the bending of light by the Sun actually took several decades to confirm, since there were numerous possible errors and uncertainties in Eddington's early findings. By the late 1970s, astronomers began to find instances of these phenomena on a grander scale.

Today, known as gravitational lensing, it is seen in the bending of light by stars, galaxies and clusters of galaxies. It is being realised that distortions produced by the bending of light make celestial sources look very different from what they are. So much so, that the old adage 'Seeing is Believing' needs to be treated with caution.

Next week: CV Raman and the Raman Effect

Astrophysicist Jayant Narlikar and theoretical physicist Thanu Padmanabhan will contribute to DNA's special series through 2009, designated the International Year of Astronomy.