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7. Study of the Impact of Space-Time Curvature

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ABSTRACT

The purpose of this study was to put to the test the theory of the Graviton, the theorised elementary particle predicted by the standard model of physics that mediates the force of gravity.

The theory would be tested by measuring the speed at which gravitational force propagates and looking for gravitational time dilation, which would support the graviton theory.

KEYWORDS:

Space-Time Curvature, Curved space-time, geometric gravitation, gravitational waves.

Introduction:

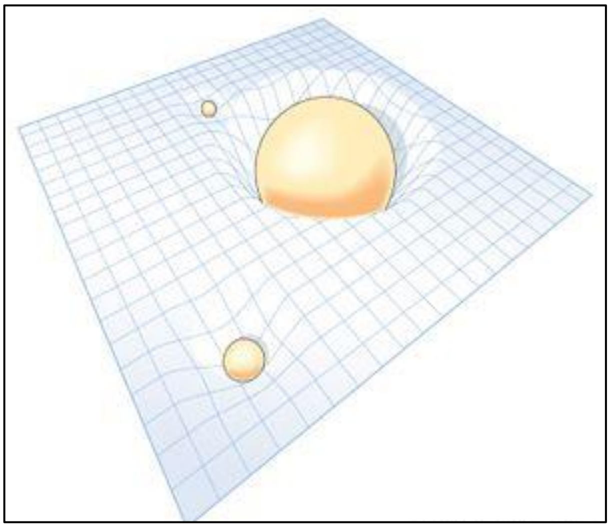
Curved Space-Time And Geometric Gravitation:

The geometric nature of Einstein's view of gravity is its distinguishing feature. (See also Geometry in Real Life.) Whereas Newton thought gravity was a force, Einstein demonstrated that gravity is caused by the shape of space-time.

While this is difficult to visualise, there is an analogy that can help—though it is only a guide, not a complete statement of the theory.

The analogy begins by imagining space-time as a deformable rubber sheet. Space-time is uncurved in any region far from massive cosmic objects such as stars—that is, the rubber sheet is completely flat.

If one were to send a ray of light or a test body into that region, both the ray and the body would travel in perfectly straight lines, like a child's marble rolling across a rubber sheet.

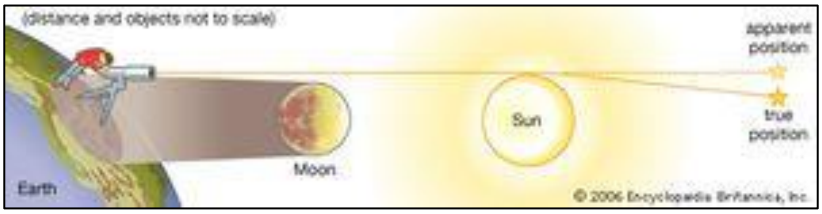


Curved Space-Time

The presence of a massive body, on the other hand, curves space-time, as if a bowling ball were placed on the rubber sheet, creating a cuplike depression. A marble placed near the depression, in the analogy, rolls down the slope towards the bowling ball as if pulled by a force. Furthermore, if the marble is pushed sideways, it will form an orbit around the bowling ball, as if a consistent pull towards the ball is swinging the marble into a closed path.

The curvature of space-time near a star determines its shortest natural paths, or geodesics, in the same way that the shortest path in two locations on Earth is not a straight line, which cannot be built on that curving surface, but the arc of a great circle route. Space-time geodesic domes define light deflection and planet orbits in Einstein's theory. Everything tells space-time how to curve, and space-time tells matter how to move, as American theoretical physicist John Wheeler put it.

Experimental Evidence for General Relativity:



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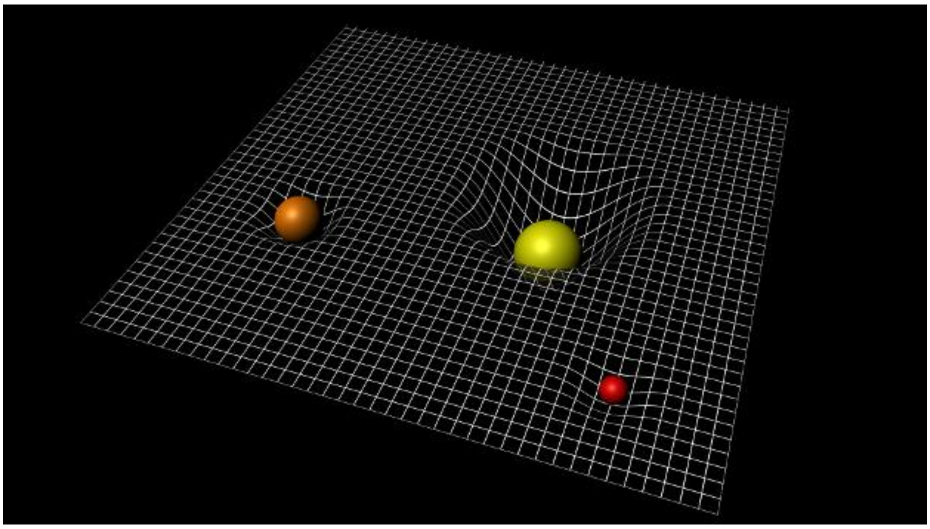
Experimental Evidence for General Relativity

Soon after the general theory of the concept of relativity was published in 1915, the English astronomer Arthur Eddington considered Einstein's prediction that light rays bend near a massive body, and he realised that it could be confirmed by carefully comparing star locations in images of the Sun taken during a solar eclipse with images of the same region of space taken when the Sun was in a different part of the sky. World War I delayed verification, but a wonderful chance presented itself in 1919 with a particularly long total solar eclipse in the vicinity of the bright Hyades star cluster, visible from northern Brazil to the African coast.

Eddington led one expeditions and to Prncipe, an African island, and Andrew Crommelin of the Royal Greenwich the observatories led another to Sobral, Brazil. Eddington declared that the starlight had been deflected about 1.75 seconds of arc, as predicted by general relativity, after carefully contrasting photographs from both expeditions with reference photographs of the Hyades. (The same effect is responsible for gravitational lensing, which occurs when a massive cosmic object focuses light from something beyond it resulting in a distorted or increased image. The discovery of gravitational lenses by astronomers in 1979 provided additional support for general relativity.)

Gravity, as defined by Isaac Newton's universal law of attraction, is no longer a force that acts on massive bodies, according to Einstein's general theory of the context of relativity Instead, general relativity connects gravity to the geometry of spacetime, specifically its curvature.



Time moves constantly and without interruption for all objects in classical physics. Spacetime is a four-dimensional continuum in relativity, integrating the familiar three-dimensional nature of space with the dimension of time.

To account for attraction in relativity, also known the framework of this four-dimensional spacetime must be expanded beyond the rules of conventional geometry, which states that parallel lines never intersect and the sum of a triangle's angles is 180°. The universe is not 'flat' in general relativity, but is curved by the presence of massive bodies.

This artistic representation depicts spacetime as a streamlined, two-dimensional surface that is distorted by the existence of three massive bodies, which are depicted as coloured spheres. Each sphere's distortion corresponds to its mass.

The curvature of spacetime impacts the movement of massive bodies within it; as massive bodies move within spacetime, the curvature modifications and the geometry of spacetime evolves. Gravity then describes the dynamic interaction between matter and spacetime.

Methods/Materials:

The computer was outfitted with Microsoft Excel and Maple 7. The information was obtained from the NASA JPL HORIZONS ephemeris. The ephemeris was used to obtain the position vector, velocity, and light-time.

The time span and interval between points of the sets varied. The vectors of gravitational acceleration acting on the Earth as a result of each object were calculated and added.

The Earth's accelerated vector and the rate of alteration in the Earth's acceleration vector were calculated.

A value equal to the light-time would corroborate the hypothesis, while a value equal to the distance to the sun divided by c would contradict my hypothesis.

Any other value would be meaningless.

Results:

The average time delay in the first set of data was 1.77E+3 seconds, with a standard deviation of 2.68E+5 seconds.

The average time delay in the second set of data was 8.18E+3 seconds, with a standard deviation of 2.42E+6 seconds.

The average time delay in the third set of data was 1.07E+5 seconds, with a standard deviation of 2.11E+6 seconds.

The average time delay in the fourth set of data was -4.87E+3 seconds, with a standard deviation of 1.32E+6 seconds.

Conclusions:

Overall, the data was inconclusive in terms of supporting my hypothesis. All four data sets had too much statistical uncertainty to provide conclusive evidence. The greatest source of error was most likely a lack of understanding of the Earth's instantaneous acceleration and rate of change of acceleration.

Further research indicates that, while gravity is unlikely to propagate at the speed of light, the gravitational field of the solar system does not change, making gravity's propagation speed appear to be infinite to any experiment of this type. In order to test this hypothesis further, it would be necessary to either measure the values for systems that are rapidly losing mass or the speed of gravitational waves.

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