A Simpler model for gravitation

by Carlos Mancia

ABSTRACT

Inconsistencies of the current model of gravitation are examined in this paper. A New method for combining Special and General Relativity time dilation effects is offered, and a new model of gravitation is presented that preserves the functionality of the current model.

November 2010

1.0 Einstein's theory of gravity

While Isaac Newton first postulated a law of gravity in 1687, gravity got better understood with Einstein's General Relativity early last century. According to Einstein, matter bends spacetime and bent spacetime determines how object move in space. The more massive the object, the greater the space curvature.

Listed below are some of the difficulties of the theory:

1.1 Gravity is needed to explain gravity

The image of Figure 1 is used to represent curved space, which is a two dimensional representation of 3-D space. This is perfectly acceptable, since most gravitational motion happens in 2-D.

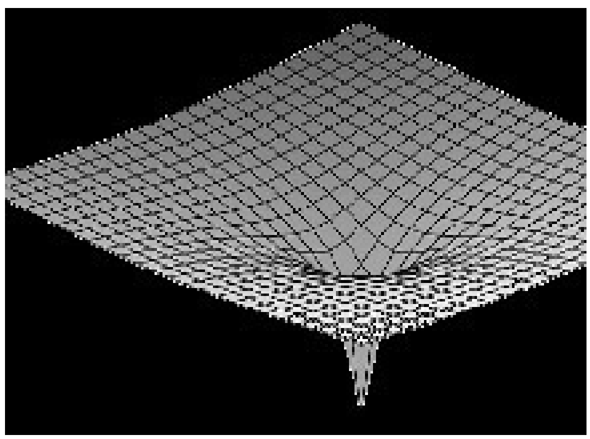


Figure 1 Curved Spacetime

The problem with this image is that to represent motion we need to take into account our daily experience with gravity on Earth. In effect, gravitation is two effects: Warping of space-time and pulling object in. Figure 2 shows what motion looks like in curved space with a downward gravitational pull.

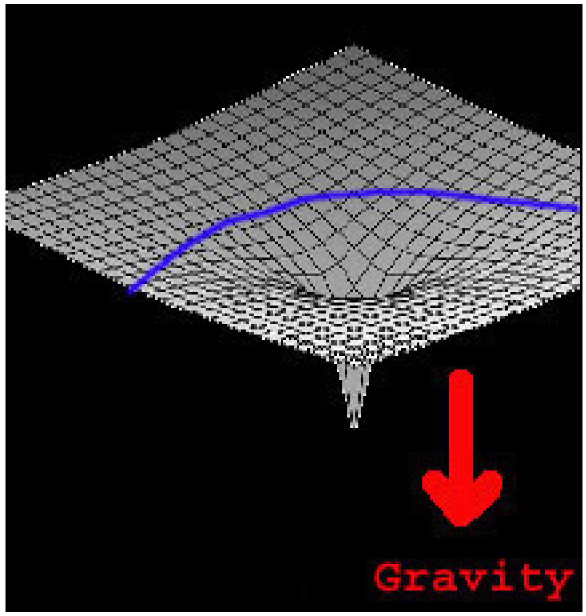


Figure 2: Motion in curved space with gravitational downward pull

In essence, gravitation pulls objects moving in curved space in, towards the massive object that creates the 'warping of spacetime' (otherwise called gravitational field). When we do not consider the inward gravitational pull of the motion of an object in curved space, the motion looks as shown in Figure 3. The object's motion is not a straight line, but the curvature of the path is not what we are used to seeing in a gravitational field.

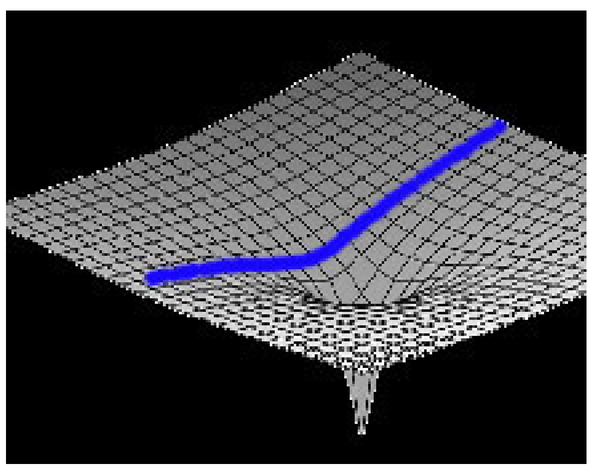


Figure 3: Motion in curved space without gravity's inwards pull

This is also illustrated in Figure 4, where a blue object is at rest in curved space-time. This object starts to move towards the massive object creating the warping of space because, from our daily experience, Earth's gravity pulls things down. Because the blue object is on a slope on curved space, it will move down towards the hole where the massive object is.

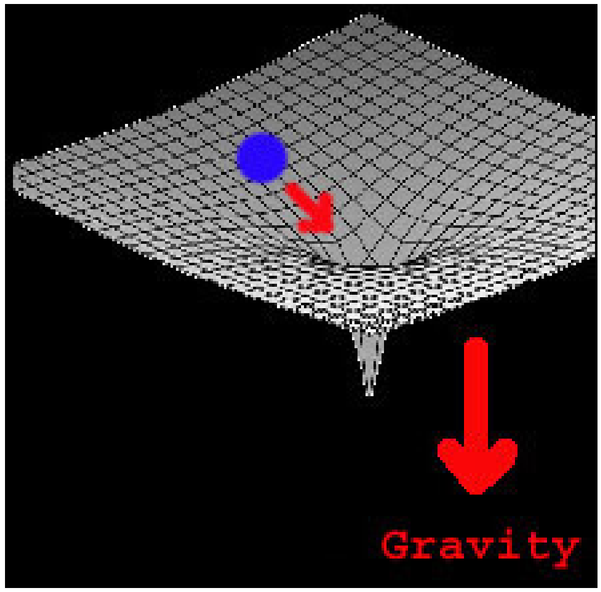
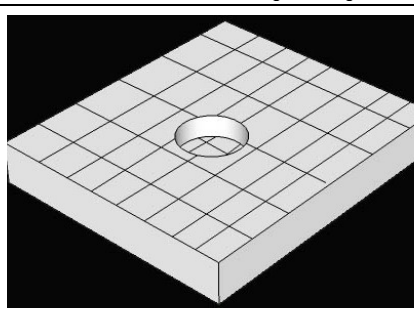


Figure 4: Object at rest in curved space

1.2 Non Equivalences of the Equivalence Principle

Another issue is the half way equivalences of the equivalence principle. Einstein's equivalence principle states that the effects on objects in a gravitational field are equivalent to those in a non-inertial system such as an accelerating rocket. This statements has implicit the assumption that gravitational mass is equivalent to inertial mass, which has been demonstrated to a large degree of certainty. Let's just say that is hard to visualize how



Warped space-time in an accelerating rocket?

space-time is warped inside an accelerating rocket as in Figure 1 above; while the space outside the rocket remains flat. Does it look something the illustration to the left? Gravitational fields also induce time dilation effects. A search for experimental data verifying time dilation in accelerating fields found no empirical data; and the theoretical explanations are confusing, with some claiming acceleration time dilations (for explaining the twin paradox for example) and others completely ignore the concept.[1] An experiment was conducted by the author to verify time dilations due to acceleration; this is documented in Appendix A. The experiment was not successful, but it was later determined that there is ample evidence for determining time dilation effects due to acceleration; this is discussed in section 2.5.

The second part of the principle states that objects in free fall in a gravitational field (where they are being accelerated towards a massive object) have effects that are equivalent to objects moving at constant velocity away from gravitational fields. These objects with gravitationally induced accelerated motion do not perceive being accelerated. The equivalence principle does not account for time dilation effects due to the gravitational field that are not present in inertial systems away from gravitational fields, or for Special Relativity time dilation effects that get greater as the speed increases.

While the two parts have some similarities, they are hardly equivalent.

1.3 How to exceed the speed of light

Let's go down an imaginary trip to the center of the Milky Way, where a supermassive black hole (**BH**) of 4 million solar masses resides. First, a little background. Earth's escape velocity at the surface is said to be 11.2 Km/s. The escape velocity decreases as the distance from the Earth's center of gravity (**CG**) increases. At a distance of the orbit of the Moon, Earth's escape velocity is about 1500 m/s. If we launch an object towards Earth at 1500 m/s from the Moon's orbit; Earth's gravity will pull on this object and by the time it reaches the surface it will have a speed of 11.2 Km/s. And if I launch at a greater speed, much greater that 1500 m/s from the Moon's orbit, the object will have a speed that is greater than 11.2 Km/s when it reaches Earth's surface. A BH is said to have an escape velocity equals to the speed of light at the event horizon. From a distance of 26,000 light-years away, where we are, the escape velocity from the Milky Way's BH is about 2.1 Km/s. What happens if we launch an object towards the BH at the center of the Milky Way at a speed greater than the 2.1 Km/s? Assuming no interactions with any other stellar masses, this object will slowly increase in speed due to the gravitational pull of the BH and, according with current theory, it will reach superluminal speed before arriving at the event horizon. There will be some time dilation effects due to the gravitational field and speed, as well as mass increases, but there is no avoiding the fact that the velocity will be superluminal outside the BH's event horizon. Can gravity do this? Gravity is said to be the weakest force, but we have seen gravity make things possible that the other forces of nature oppose: Nuclear fusion at the center of the stars, overcoming the electron-electron repulsion to make neutron stars and go even further to make black holes. Can gravity also make things go faster than the speed of light? This fact does not fit well with other aspects of current theory. It is not clear what happens to time dilation effects a this point, current formulas tells us that time becomes imaginary (square root of a negative number), not that time goes backwards.

We also have to ask: Why is gravity the only force of nature to warp spacetime? Why the other forces are not capable of doing the same? What is so special about gravitation?.

General Relativity (**GR**) has been the most successful gravitation theory for almost 100 years, and the equations used to explain the curvature of space give results that match experimental data; but we must also admit that these explanations could use some improvement.

2.0 New model for gravitation

Over the next few pages, a new way for explaining gravitation is presented, and by the end of this document this paper hopes to provide a successful explanation to the items listed above.

2.1 The case for absolute speed

Let's start by addressing one issue about Special Relativity. If two objects are moving with respect to each other at sufficient speed, Special Relativity states that they perceive each other as running on slower clock than their own, and to experience some length contraction in the direction of motion. Lets take a closer look at a real life example to better illustrate the case. An estimated 10,000 muons fall to every square meter of Earth's surface every minute. Muons are created when cosmic rays strike molecules in the upper atmosphere and they have a very short life, about 2.2 microsec.[2] . See Figure 5 below for an illustration.

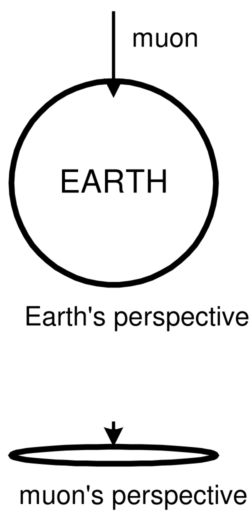


Figure 5: Special Relativity Earth/muon perspectives

Because muons are traveling very fast, near the speed of light, a muon experiences time dilation effects that allow it to travel much farther than the 660 meters that light would travel in 2.2 microseconds, mouns actually make it to Earth's surface and well below because they interact very little with other matter. That means that the life of a muon is lengthened to about 0.5 milliseconds. From the muon's perspective, because Earth is moving at nearly the speed of light, Earth looks like a flat pancake and Earth's atmosphere is only a few hundred meters; a muon's life is long enough for it to go through before it decays. These are logical explanations from their own perspective, the muon's and Earth's as to how events unfold. Both perspectives are assumed to be true, and it is only an issue of reality being relative. Now let's introduce a third element to this event. This element is in the form of a clock, let's say a pulsar some 1000 light-years away. Let's have this pulsar send out a pulse every 0.1 milliseconds. A real pulsar with a period that short could not be found, but let's assume that one exists. Let's also have the moun have a motion that is perpendicular to the direction of the pulsar, so as to have common Doppler with Earth. Now, from the Earth's perspective, as the muon falls through the atmosphere, an Earth observer will see 5 pulses from the pulsar, before the moun decays 0.5 ms later. From the muon's perspective, as it goes through Earth's atmosphere, it will also see 5 pulses in its 2.2 μs life. While Earth is seeing 0.1 ms pulses, the muon will see very short pulses, of only 0.44 μs long. It is clear the Earth's clock and the muon's clock are not running at the same rate. They are experiencing different time dilations. And since time dilations are due to their speed, we have to ask: With respect to what? Let's have another muon, 180º from the first on the other side of Earth, also moving near the speed of light and with about the same life as the first. The second muon's path will also be as long as the first, and will see about the same number of pulses as the first. There has to be a speed along the axis formed by the two muons, for which the period of the pulsar will be a maximum. This leads to the concept of absolute speed. A rocket moving with constant acceleration along the axis formed by the two muons will also see shorter and shorter periods for the pulsar as it approaches the same frame of reference as one of the two muons. This is a different type of blue shifting that is neither Doppler nor gravitational. And also pulsars on all sides perpendicular to the motion will be blue shifted and their apparent position will also change in the direction of motion.

More evidence for absolute speed can be found at particle accelerators. Consider two decaying particles like a pair of muons (twins). One muon stays stationary and the other one is traveling near the speed of light inside the accelerator (circular or linear makes no difference). It is the one moving fast with respect to the accelerator and the rest of the planet the one that experiences a longer life. This is an experimental proof to the twin paradox. If we consider the motion of Earth around the sun, and the sun's motion in the galaxy they are all very small compared to the speed of light, we can say we are almost stationary in space.

Based on this short discussion and for the rest of this paper, it will be assumed that the concept of absolute speed is valid. This concept is not incompatible with other aspects of Special Relativity, nor does it mean that there are fixed locations in space as will be discussed in later sections.

2.2 The case against Absolute Speed

The problem with Absolute Speed is that no experiment to date has been able to detect Earth's motion through space. The most famous experiment by Michelson–Morley and repeated by many others[3] did not yield any results consistent with the concept of Earth moving through space as it orbits the sun, or the sun's orbital motion within the galaxy. The experiment is based on a light interferometer; light was expected to travel at different speed depending of the direction of motion when Earth orbital velocity is taken into account. When light is traveling in the same direction as Earth, the speed would be different than when moving in another direction as measured by an Earth observer. The interferometer was supposed to detect changes in light speed from two beams of light previously split from a common source as Earth's rotation changes the angle of motion with respect to Earth orbital velocity. All experiments have failed to measure a speed of motion anywhere close to the known value. For all practical purposes is as if Earth were not moving and the rest of the Universe is revolving around us. The Theory of Special Relativity is based on the assumption that all motion is relative (a shared concept with Newton's.) This makes it possible, for instance, for GPS constellation of satellites to remains synchronized for all Earth observers, while for an observer outside Earth's frame of reference, these satellites will experience different time dilation effects as their respective orbits take them in the same direction or opposite to Earth's motions around the sun, and fall out of synchronicity with each other. The complexity of the motion and synchronization is more sophisticated when the sun's orbital motion around the galaxy is taken into account, but that can also be accounted for, and satisfactorily explained, by SR.

This presents a serious conflict with the previous sections, as they cannot be both true. These two different concepts and their respective experimental evidence will be reconciled in later sections

2.3 Stopping time twice

A very interesting identity is that time dilation effects due to gravity and time dilation effects due to motion at the escape velocity are nearly identical for any given distance. The same formula can be used for calculating both. This is the result of plugging the formula for escape velocity

$$\sqrt{\frac{2GM}{R}}$$

into the Lorentz factor

$$\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

we get the approximation for gravitational time dilations

$$\frac{1}{\sqrt{1-\frac{2GM}{Rc^2}}}$$

Let's go back to the imaginary trip to the BH at the center of the Milky Way as described on section 1.3. Let's say we launch a clock at the BH's escape velocity of 2.1 Km/s towards the BH. This clock would experience two time dilation effects acting on it: one due to the gravitational field and another one due to the speed. These two effects will get progressively larger as the clock gets closer to the BH and speeds up, but they remain identical to each other. When the clock arrives at the event horizon time will stop twice: both the strength of the gravitational field and the speed of travel will each stop time separately.

2.4 Combining Gravitational Time dilations with Special Relativity Time Dilations

An attempt was made to find out if the identity in section 2.3 may be used to represent gravitational time dilations with an equivalent escape velocity vector (henceforth abbreviated as **EVV**.) Let's apply it to the GPS system. Figure 6 illustrates a GPS satellite in its orbit. The gravitational time dilation component is represented by an EVV at 26,500 Km. Adding this vector with its orbital speed vector and calculating the resulting time dilation, we get the exact time dilation given to the satellites in the current system[4]. Notice that the angle of the gravitational component is at a radial direction from Earth's CG. Because the satellite's orbit is nearly circular, the two vectors will be at a right angle**.** This matches the current method used when combining velocity and gravitational time dilations. This method works very well with all experiments and applications involving gravitational time dilations where it was applied.

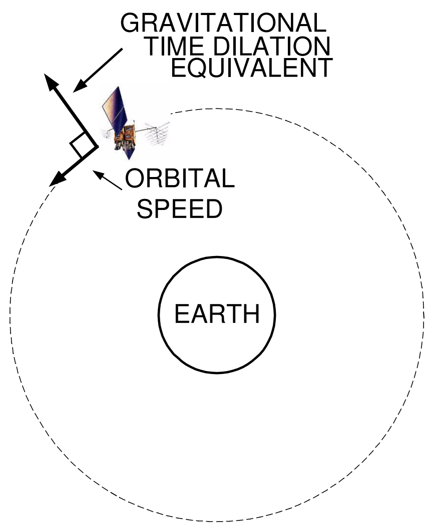


Figure 6 GPS satellite time dilation vectors.

2.5 Time dilations due to acceleration

Now let's do something unorthodox. Let's send a rocket to the same altitude as a GPS satellite orbit, but let's have this rocket just hover in space like a space helicopter, with no side to side motion. The force exerted by the engine on the rocket equals the gravitational attraction; therefore the rocket is not moving. The gravitational time dilations for both the GPS satellite and the rocket are the same; but the occupants of the rocket are in an accelerated state. We have to conclude that there are no time dilation effects due to acceleration. The acceleration is real, think what would happen if the planet below were to suddenly disappear: the satellite would abandon its orbital path but the occupants would feel no changes to their inertial state; there are no new accelerations. The rocket, freed from the gravitational pull, would start to move, but the occupants would feel no difference in their accelerated state. The gravitational time dilations disappear for both them, and only Special Relativity time dilations would be present. Admittedly, no rocket has been sent to hover like a helicopter and measure the gravitational time dilations in space, but in a way this experiment has already been done. The gravitational time dilations for an orbiting GPS satellite and for a ground based GPS receiver are calculated using the same formula; no additional time dilations are added due to the accelerated state of the receiver. There is good certainty that this discussion has already happened. See Figure 7 for an illustration of this event.

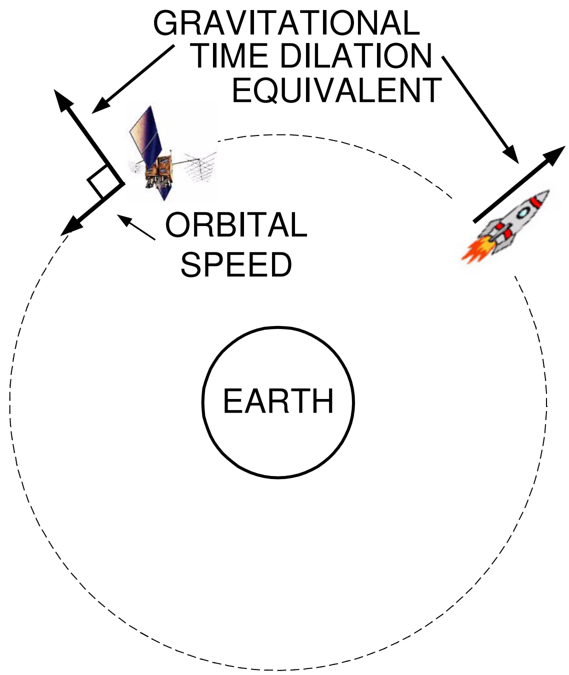


Figure 7 GPS satellite and rocket time dilations

Another piece of evidence comes from the Pound-Rebka experiment performed at Harvard University in 1959[5]. When doing the calculations for gravitational time dilations for this experiment, no consideration is given to any additional time dilations due to the accelerated state of doing the experiment on the ground. If R. Pound and G. Rebka Jr. had boarded the zero gravity plane; this is the plane that takes you high up in the air and then accelerates downwards simulating zero gravity, and they had done their experiment while in free fall, they would have done the same calculation and the results would be expected to be the same (assuming negligible free falling speeds). This again confirms that there are no additional time dilations by doing the experiment on the ground in an accelerated state.

It is also important to note that there is no formula for time dilations due to acceleration. GR does not provide such formula, nor has any real or thought experiment associated a relation between the two.

2.6 Free falling clocks do not slow down

Lets say that the rocket on Figure 7 turn around 180º and accelerates downwards, and that when it reaches 20,000 Km from Earth's CG at a speed of 6.3 Km/s (escape velocity) it runs out of fuel and it begins to free fall to Earth. As it begins to pick up speed and gets closer to Earth, the gravitational field also increases. See Figure 8 for an illustration of the event, where gravitational time dilations are represented by an upward EVV and the speed by a downward vector. These two vectors, as described earlier, grow at the same rate. The sum of these two vectors is always zero. Time dilation is zero. This means that clocks in free fall at the escape velocity do not slow down. Is this a point where the model breaks down or where it really shines? This effect makes part of the equivalence principle a true identity, it says that objects in inertial state are identical to objects in free fall. It is important to note, that at speeds other than the escape velocity (higher or lower), the difference between the vectors gets smaller as the object falls. Time dilation effects get smaller for both cases. Earlier it was discussed in section 2.3 that launching a clock towards a BH at the escape velocity would make time stop twice at the event horizon. It turns out that not only it never stops, it doesn't even slow down.

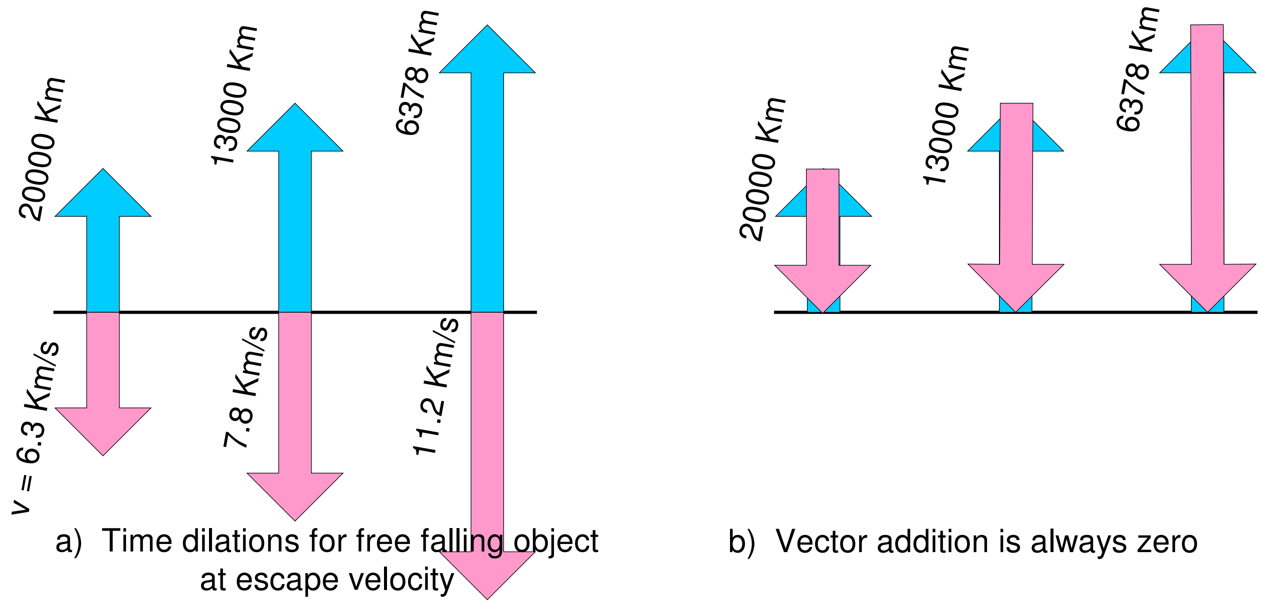


Figure 8

2.7 Are Gravitational time dilations Special Relativity time dilations?

This way to looking at gravitational time dilations (as EVVs) may lead to think that these are real Special Relativity effects, that space is falling to Earth at the escape velocity. The problem with this view is that geometry does not support the concept. The escape velocity would have to be an inverse function of the square of the distance and that is not the case. The only way that this could be true is if space is being *compressed* as it falls to Earth. Think of it as solar wind in reverse. This may sound very exotic; but, is it more exotic than the warping of space time? It is certainly no more exotic than exceeding the speed of light while falling into a black hole, a problem that it would solve.

Let's entertain this concept for now, and explore its consequences and evidence.

Current theory of the universe tells us that the universe is expanding due to the expansion of space[6]. New volume of space is coming out of nowhere. Given the symmetries that we have observed on other areas of nature, if space is capable of expanding, it should also be compressible. At this point there is no risk that we may run out of space, on the contrary, the current thinking is that the universe will expand forever[7].

If there is a source of new space in the Universe, there should be also sinks of space, again, invoking natural symmetry property. Is matter a sink for space?

We also need to change the fabric of space, from a rubbery stretchy sheet into something more akin to a gas. This change means that there are no fixed locations in space, as there are none in gaseous bodies.

Once we make these assumptions, gravity is not pulling on other matter, gravity is pulling on space itself; what we experience as gravitational pull is nothing but the effect of space accelerating through us as it falls to Earth. What we call gravitational time dilation is just a Special Relativity effect of the speed of space as it moves around us.

Let's call this hypothesis **Simple Model** or SM for short.

Here is list the consequences of the concept (not evidence):

- In this frame, objects that are placed at rest in space near the massive object, start to move towards the mass, are being carried towards the mass, even though the object cannot 'feel' any change in motion. That is what is normally called free fall. The object is not accelerating with respect to space, space is accelerating and dragging all objects along. It is the acceleration of space that causes the drag and not the speed or motion of space. Space has no viscosity for motion.

- Moving objects will also have their trajectory altered the same way as in a gravitational field or they could go into orbit around a massive object.

- All other predictions of gravity can also be equally explained; we will also see bending of lightwaves, red-shifting for waves moving away and blue shifting for falling waves. A BH is just a place where space is falling faster than light below the event horizon.

- It certainly does away with any distinction between gravitational and inertial mass.

- The model is quite good, in that it follows the current formulas for gravity. In most respects is equal to our experience with Einstein's General Relativity, but in this case, space is not warped, it is accelerated, compressed and absorbed by matter.

- The equivalence principle becomes more equivalent: rockets accelerating through space experience the same effects as stationary rockets in accelerating space, there are no time dilation effects in either case due to gravity or acceleration; clocks in free fall do not slow down, not for gravitational fields, nor for increasing speed. Free fall means that they are moving through accelerating space, and when moving at the escape velocity, there are no changes in time dilations. This point will need more elaboration in the future.

- This concept is capable of explaining the issues presented on Section 2.1 and 2.2. The Michelson-Morley experiment has been performed with light traveling a path that is parallel to Earth's surface. When the experiment is run with light following a path perpendicular to Earth's surface, the results maybe decidedly different. The GPS constellation of satellites does not go out of synch. Objects in the area where Earth's gravitational field is dominant, will not experience time dilations due to Earth orbital motion around the sun, they will only be subjected to the time dilations due to their motion with respect to Earth. But it really goes beyond that. It also means that they do not experience gravitational time dilations due to the sun's gravity either. The warping of space-time in the solar system should look as shown in Figure 9 below.

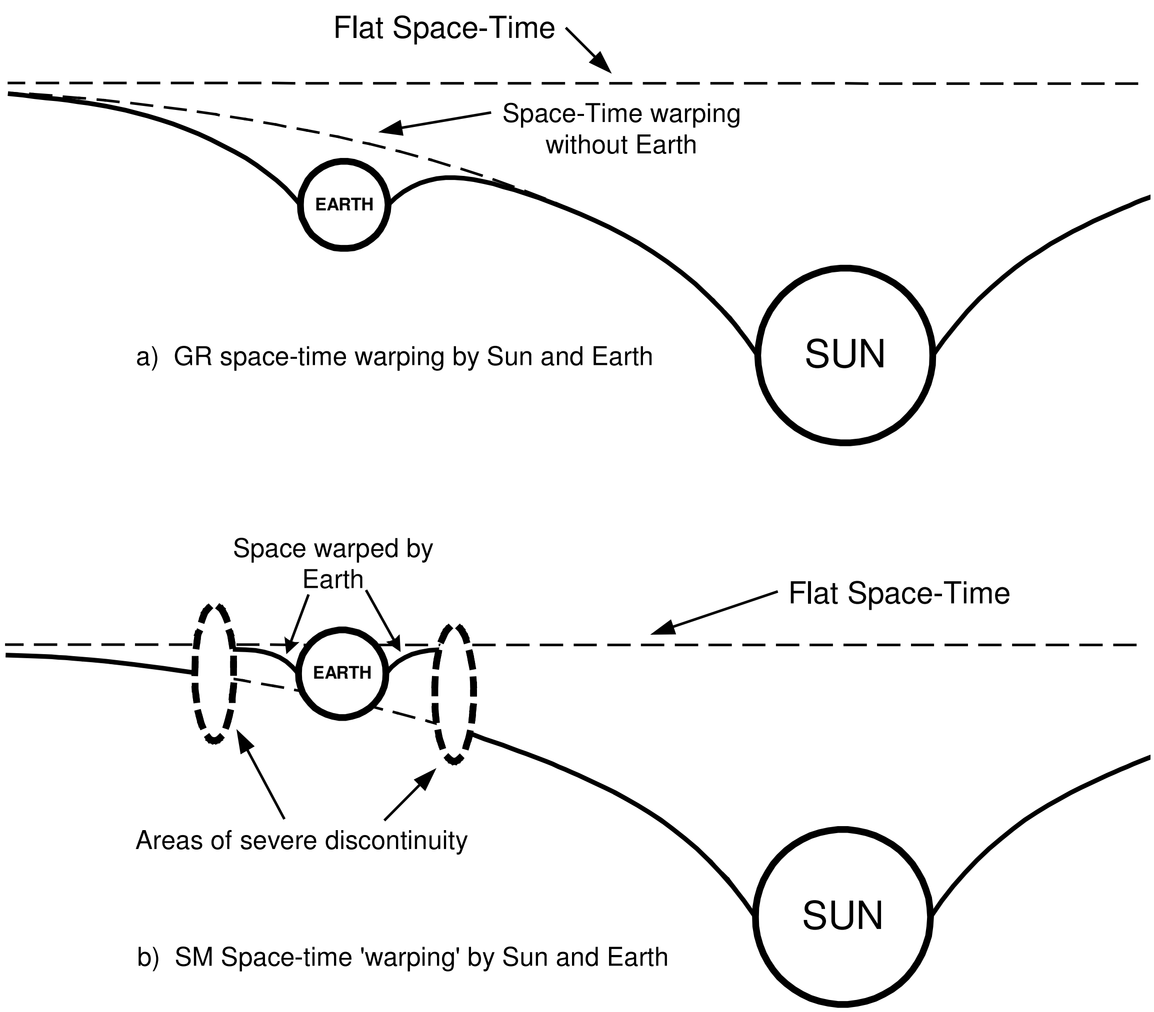


Figure 9

- Since gravity is nothing more than accelerating space, gravitation is not a force of nature, and gravitons are not needed.

2.8 Evidence for Simple Model hypothesis

There is not much direct evidence for SM hypothesis but listed below are some facts that argue for it:

- Consider the poor correlation between the strength of gravitation and gravitational time dilations: Here on Earth's surface we have a gravitational pull of 9.8 m/s^2 and a time dilation effect equal to an EVV of 11.2 Km/s. But consider an object orbiting the sun from a distance equals to 1 AU. The sun's gravitation is less than 0.006 m/s^2 and the gravitational time dilation equals an EVV of 42 Km/s. The disparity is outlandish. On the other hand, the correlation between the escape velocity and gravitational time dilation is one to one.

- Astronomers tell us that the universe is expanding due to the expansion of space[6], that is, space can and does move. Galaxy clusters are moving away from each other, carried away by accelerating space, no less. These galaxies are in free fall. Processes within these galaxies are not slowed down by their moving away speed as SR would predict.

- Lets also consider the discussions of section 1.3 (exceeding the speed of light) and section 2.3 (stopping time twice.) These events challenge logic for them to be true as GR would predict. These events never take place in SM hypothesis.

2.9 Final Comments

There are some very profound implications to what is being proposed here, and much more that needs to be proven, some of these predictions are very perplexing, think of absolute speed, compressed space and no GR time dilations; but it also allow us to view the universe with a new look that extends all the way to the Big Bang.

But before we get carried away with the implications of SM hypothesis, it is more important to prove it one way or another. Theories of gravity are very numerous and it is all too easy to produce a hypothesis and leave to other to prove. The author will now concentrate on producing experimental data that follow methods that meet standard scientific practice.

Appendix A

An experiment to determine time dilation effects due to acceleration

Given the lack of empirical data for acceleration time dilation effects, an experiment was attempted to isolate acceleration time dilation from other effects. This experiment uses an electric motor that spins at 3600 rpm, a 25 cm cooking pot and three regular wrist-watches. Two of the watches fall behind a few seconds per month, as compared to time.gov website, but they diverge by only one second every ten days. It was verified that they are very consistent, diverging by same amount every ten days. The slower watch is labeled A, the faster is labeled B. The third watch (labeled C) is a bit more accurate than the other two, but still falls behind a few seconds per month. A counter weight was used to balance the pot on the other side of the watch. The set up for this experiment is shown in the picture below.

Figure 10 Acceleration time dilation effects experimental setup

A few calculations ($a = v^2/r$) will show that spinning a watch in the pot driven by the motor will subject it to over 1700 g's; letting it run over a ten day period, should yield a time dilation of about one second, which is measurable by these watches. This is assuming that acceleration produces the same time dilations as gravity. (Note that Earth gravity at the surface induces a time dilation of 0.7 nsec/sec.)

On January 12, 2010 and over the following few days, the experiment was started by synchronizing watches A and B to time.gov and to each other. It was determined, with the use of a video camera, that they were running within 0.1 sec of each other. Watch B (the fast watch) was selected to be run in the pot. The expectation was that after 10 days, if there were the time dilation expected, the watches will still be in synch; otherwise, watch B will be ahead by one second with respect to watch A. After 24 hrs, the experiment was paused to verify that the watch was still working. It was observed that the watch B had fallen behind by one second. This was unexpected.

In view of this event, it was decided to change the experiment and switch watch operation. The watches were synchronized again and watch A (the slow watch) was placed in the pot and let run for 24 hours. At the end of the 24 hour period, watch B was behind watch A by about ½ second.

At this point, watch C was enlisted for the experiment. The three watches were synchronized to time.gov and to each other, to the same previous mentioned accuracy. Watch B and C were selected to run concurrently in the pot. At the end of a 24 hours period, watch B was again behind by one (1) second, but watch C had leaped forward more than a second. At this point the experiment was stopped. The watches reverted to operating to the same accuracy as before the experiment.

The following conclusions were drawn from the experiment:

- It was concluded that acceleration does indeed affect the operation of clocks, but it is unlikely that the observed changes were due to any time dilation effects, given the variation of the results. It is suspected that it was due to a distortion of the geometry of the oscillating circuit; very likely caused by a length contraction that accelerations are notoriously known for causing.
- The length contraction of the oscillating circuit was an elastic deformation, since the watches operated as before after being subjected to high acceleration.
- It was also concluded that to accomplish the experiment will require more sensitive equipment.

References

[1] **Max Jammer** (2006). "*Concepts of Simultaneity: From Antiquity to Einstein and Beyond"*. The Johns Hopkins University Press. p. 165. ISBN 0801884225**.**

[2] **Mark Wolverton** (September 2007). **"***Muons for Peace: New Way to Spot Hidden Nukes Gets Ready to Debut". Scientific American* 297 (3): 26–28

[3] **Michelson, Albert Abraham & Morley, Edward Williams** (1887). **"***On the Relative Motion of the Earth and the Luminiferous Ether***".** American Journal of Science 34: 333–345)

[4] **Pogge, Richard W.**; "*Real-World Relativity: The GPS Navigation System*". Retrieved 25 January 2008

[5] **Pound, R. V.; Rebka Jr. G. A.** (November 1, 1959). "*Gravitational Red-Shift in Nuclear Resonance*" (abstract). *Physical Review Letters* 3 (9): 439–441.

[6] **Guth, Alan H.** (1997), *The Inflationary Universe*, Reading, Massachusetts: Perseus Books

[7] **Hough, Andrew.** (August 19, 2010), *The universe 'will expand forever'*, The Telegraph newspaper, UK