1 More on Gravity

In this chapter, I explain some of the more advanced topics of Gravity such as understanding the difference between the Gravity field and the force. The purpose of the chapter is mainly to represent existing physics ideas of Gravity using the Pi-Space notation and show some formulas. However, an amendment to the radius shortening formulas is proposed and begins to lay the foundations for the later Advanced Formula section where new versions of Kinetic and Potential Energy are proposed.

1.1 Newton's Gravity Force versus the Gravity Field

One of the pieces of physics that can be a bit confusing is differentiating between the Gravity Field and the Gravity force. In the Newtonian world, Gravity is seen as a force and is quite intuitive. In the Einstein world, it is seen as a field and we have this idea of a Space Time fabric which is stretched by mass. Both ideas can be explained clearly in Pi-Space. Before I talk any more about Gravity, I want to explain how to describe this in Pi-Space. There are some very important points to understanding before moving forward.

$$F_g = \frac{GM_1 m_2}{r^2}$$

Here we see that the Gravity field is generated by Mass M1 of the planet. The strength of that field on Mass m2 is dependant on the distance from center of Gravity of that field. The first point to note about this formula is that it measures the Force that a Pi-Shell or Atom has as a result of the Gravity Field.

Each atom or Pi-Shell projects force on another Pi-Shell as a combination of its size (denoted by area change with respect to the observer) and the mass that it contains.

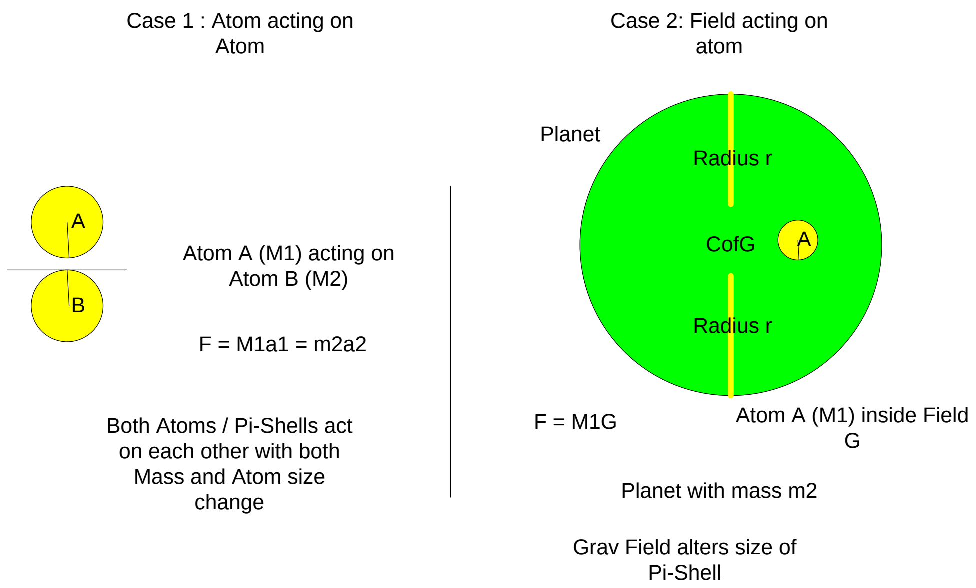
Also, if one moves within a Gravity field, up for example, one's Pi-Shells or atoms gain area. The reverse is true if one moves down. This is independent of the mass within the Pi-Shell. **This is a very important point.** If one drops an object under gravity, it does not care how much mass the object contains. Both will fall at the same speed. A Gravity field just alters the geometry of a Pi-Shell (area grain / area loss). To calculate the force, we multiply the mass of the object by the area change. If we move down, we have Kinetic Energy (area loss) and Potential Energy moving up (area gain) but the Gravity field making the change did not care about the mass. All that happens here is if the mass is large enough, the center of Gravity of the two fields is altered. So the field produces the acceleration part of the force.

Next, let's take the second example of lifting an object under gravity. When you attempt to physically lift something, you must take into account its mass. This is because you are pushing one Pi-Shell against another and Newton's Law comes into effect where every action has an equal and opposite reaction. When one lifts an object one applies a force and an equal and opposite one occurs. The mass of the object being moved matters in this case. This is different than the field effect.

Let's take a simple example; we have two objects held individually in our out stretched hands. One is a large metal ball and the other is a small ball bearing. It takes more muscle force to hold the heavier object. However, when we drop the two balls at the same time, the heavier ball does not fall faster. This is because the Gravity field is just altering the geometry of both balls. It does not concern itself with mass inside the ball.

In the first case, we have one Pi-Shell acting on another Pi-Shell producing two equal and opposing forces (hand holding up one or more balls).

In the second case, we have a field acting on a Pi-Shell / atom and producing a force by changing area with respect to an observer.



Please understand this before proceeding. To sum up, a field just alters the Geometry of a Pi-Shell / atom.

1.2 Newton's Gravity Formula and the Universal Gravitational Constant

Note: Key point. Gravity g is an area calculation, so it's g/c^2. Nothing to do with diameter!

Newton published his famous (non-relative) formula for Gravity in his Principia. The assumption is that Gravity is a constant. Let's take a look at the formula.

$$F_g = \frac{GM_1 m_2}{r^2}$$

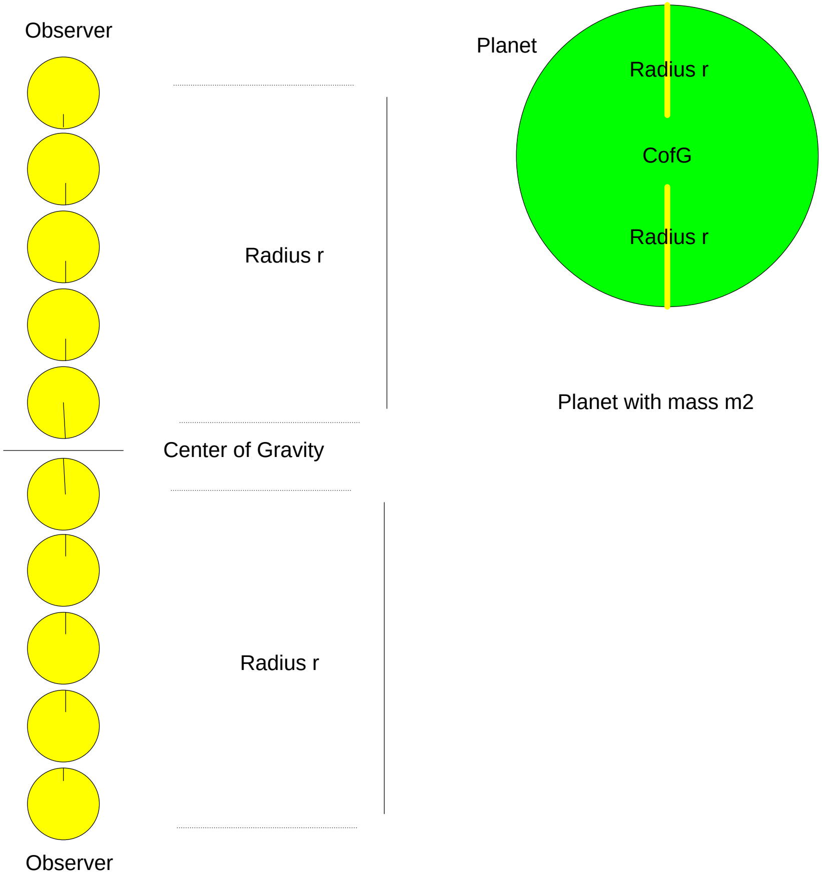
Gravity is described as a force. G is The Universal Gravitational Constant. The value m2 is the mass being acted upon within a Gravitational field, what Einstein called Space Time.

$$F_g = m_2 g$$

Therefore, g is the acceleration due to the Gravity field

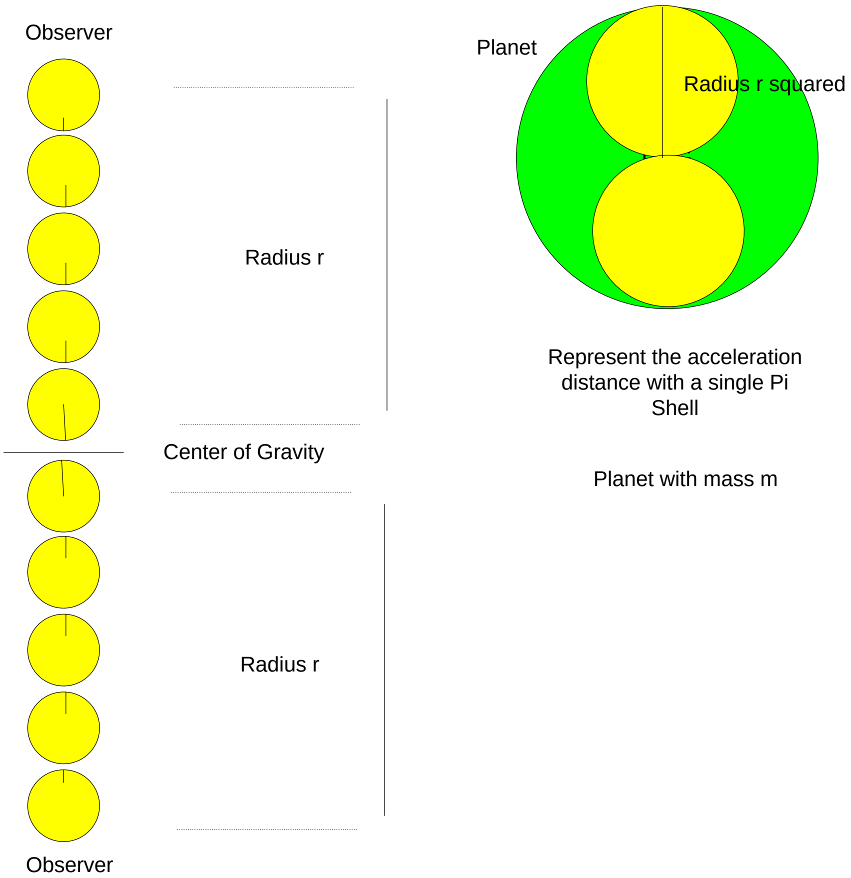
$$g = G\frac{M_1}{r^2}$$

The value m2 relates to the object producing the Gravity field, in this case it is the planet and r is the radius of that planet.



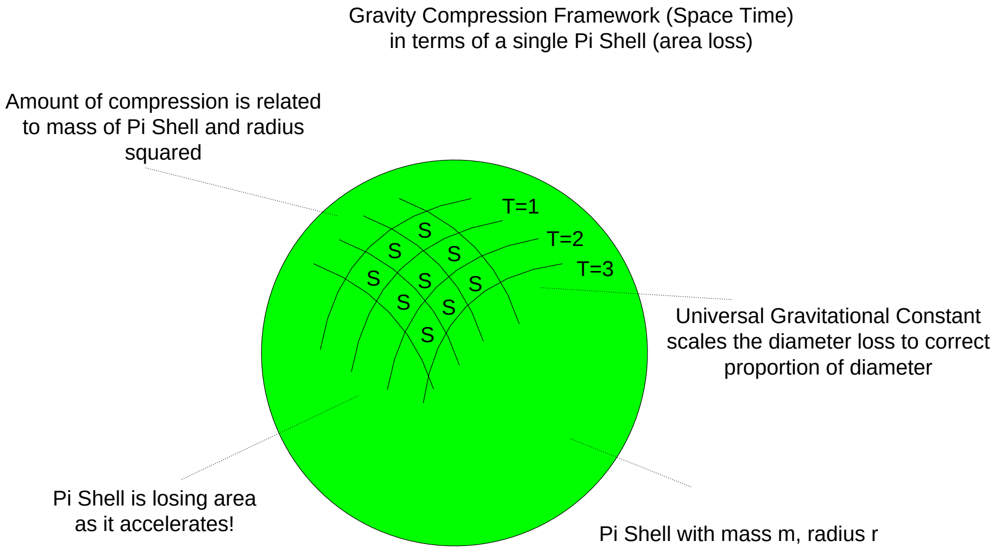
Gravity represents the rate of change of Pi-Shell diameter as it falls under Gravity. The diameter change can be represented in terms of time squared or distance. In the equation, the radius of the planet is squared. This uses two Pi-Space Principles. The first Principle used is the Pi-Shell equivalence Principle. The second Principle is the Square Rule. The rate of change of Pi-Shell diameter (aka acceleration) is generalized into the area of a single Pi-Shell which is characterized by the radius squared. Gravity is the rate of loss of area of this Pi-Shell. However, Gravity g is related to the diameter but it is essentially the Pi-Shell which is losing area.

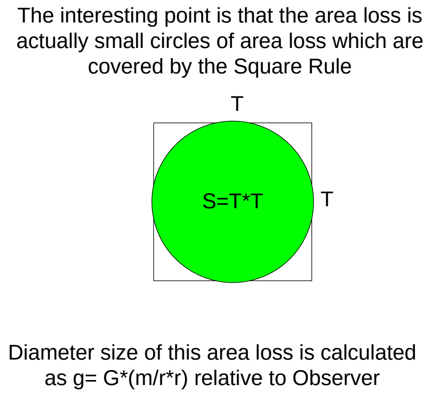
If we run an imaginary line from the center of the planet to the edge of the planet, what we essentially have is a line segment. So what are line segments in Pi-Space? Recall from the section on Pythagoras' Theorem: A line segment is a series of aligned Pi-Shells of a constant diameter. The combined diameters form a line segment.



Therefore, the length r is assumed to have Pi-Shells of the same length (and is therefore non-relativistic).

The next part of the equation to consider is G, which is the Universal Gravitational constant. Mass contained within an area produces a Gravity field g. G represents the scaling factor between mass and the area of the object in terms of the rate of change of Pi-Shell diameter loss. For example, if we have more mass in the same area, the rate of change of Pi-Shell diameter change is greater over distance d. The value G is relative to the Observer and assumed a constant.





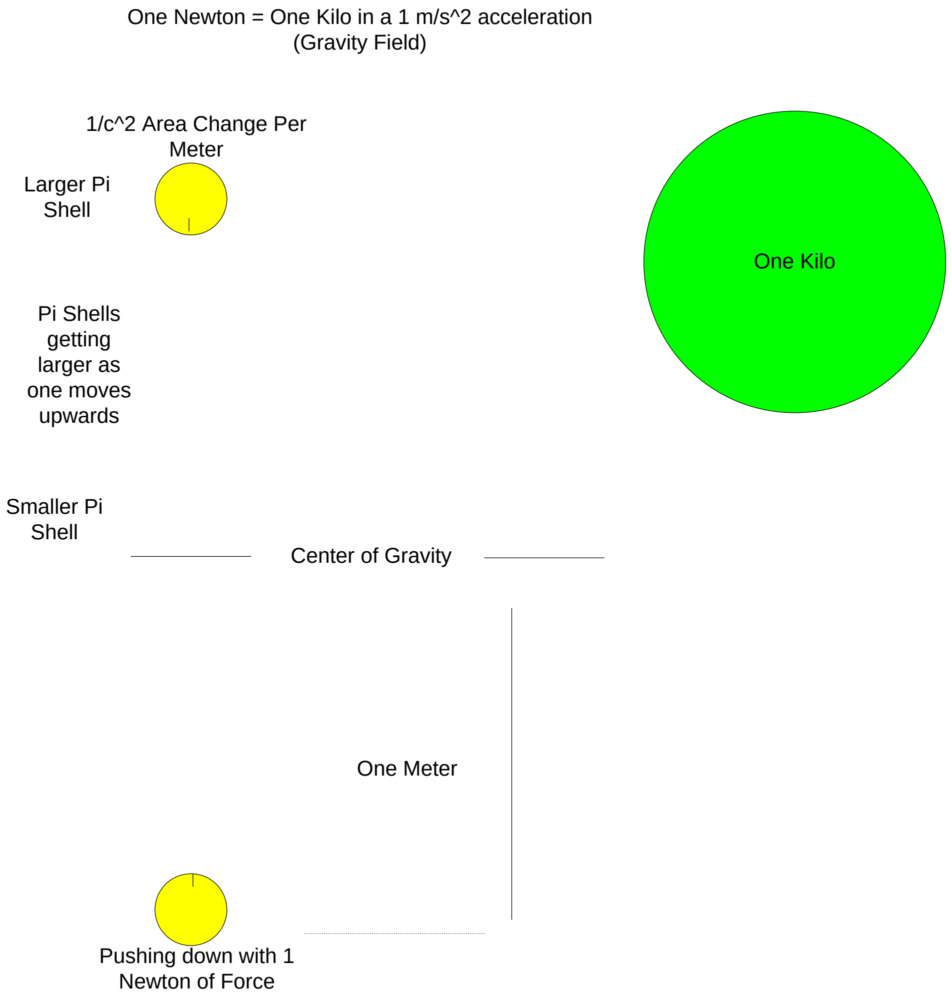
Note: This equation won’t work for a strong Gravity field as it’s non-relativistic and is only suitable for weak Gravity fields where the rate of change of Pi-Shell diameter is assumed to be a constant, g <<C. The Pi-Shell area loss in terms of the diameter is not a constant over distance d, for example and requires relativity.

1.3 One Newton of Force

Let's understand what 1 Newton of force is in the Pi-Space Theory. It is roughly one tenth of a kilo of mass under Gravity. So hold an apple in your hand under gravity and that is roughly one Newton. Gravity in the metric system is 9.8 M/S^2. Let's assume it's 10 M/S^2 for the purposes of this article. Force is mass times acceleration. So it's 1/10 of a kilo (mass) of mass times 10 M/S^2 (acceleration). This works out at 1 Kilo of Mass per metre/second^2. So let's convert this into Pi-Space.

Imagine a Pi-Shell roughly the size of an apple, containing the mass of an apple. The amount of area loss that this Pi-Shell experiences as it moves in the direction of the center of Gravity of the planet is always g/C^2 per meter. So total Force is 1/g * g/c^2 = 1 / c^2 Kilo of Force.

Finally, this means we could draw a draw a Pi-Shell containing a 1 Kilo apple (or any object with this mass) and it would experience 1/m/s^2 acceleration. This means it loses 1/c^2 of its area relative to the stationary observer per meter in Pi-Space as it moves toward the center of Gravity.



1.4 The Gravitational Potential (Total Area gain due to a Gravity Field)

Note: Gravitational Potential is the total area change for the Gravity field going straight up. We can represent this as a velocity by doing some square rooting if needed but it's not diameter.

Note: Multiply the Gravity area per atom against 'r' atoms which is what the integration does so 1/r^2 becomes 1/r for all atoms. What we're doing is summing up the area.

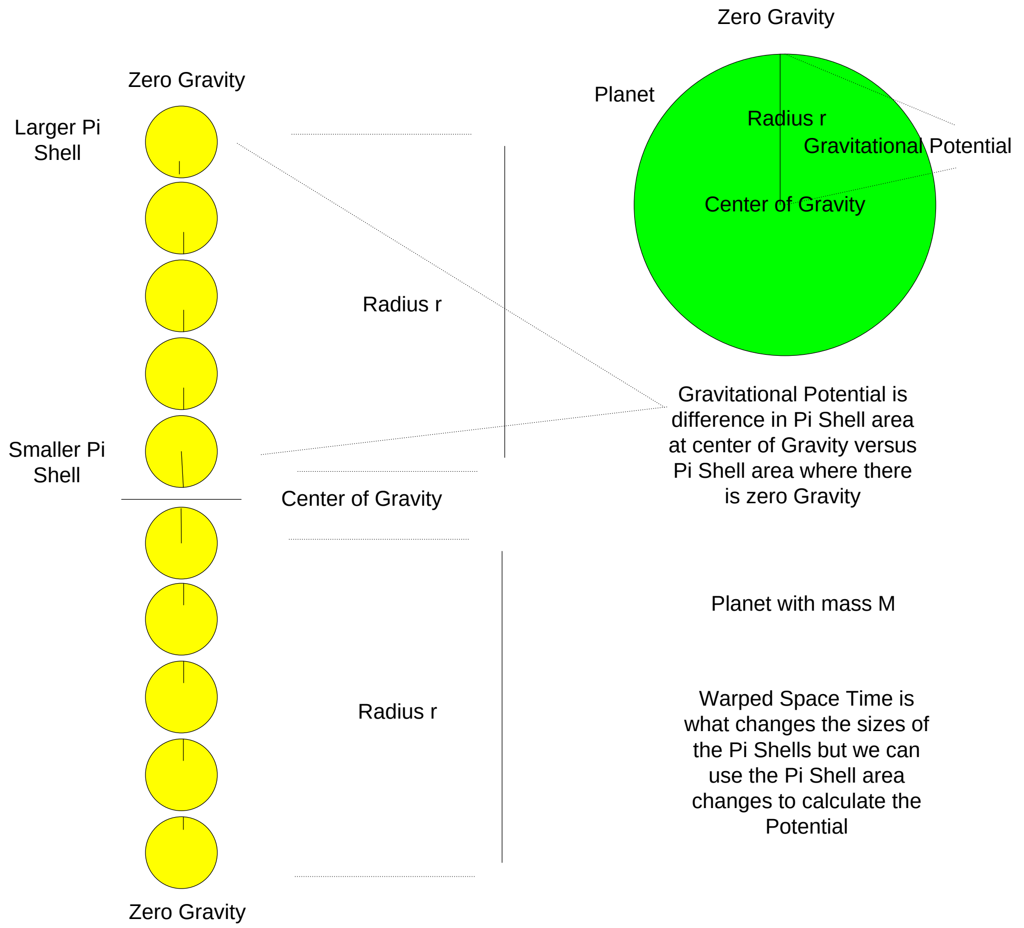
The Gravitational Potential is the sum of the Pi-Shell area gain as an object of mass m moves from the center of the planet to the outer edge of the planet's Gravity field. In Math, this is expressed as Infinity but it means the place where Earth's Gravity field has no effect.

$$U(r) = -\frac{GMm}{r}$$

The amount of Pi-Shell gain is from the center of the planet to infinity (AKA outer boundary of the planet's Gravity field). This is expressed in terms of a Pi-Shell's diameter change.

$$PiShellDiameterGainDueToGravity = -\frac{GM}{r}$$

In other words, this is the amount of Pi-Shell gain relative to the notional observer at the center of the planet. As one moves upwards within Gravity one's diameter grows larger.



Note: For the purposes of this diagram, Gravity is seen to be large. On Earth, the change is so small g<<C it could not be noticeably drawn. This is for illustrative purposes only.

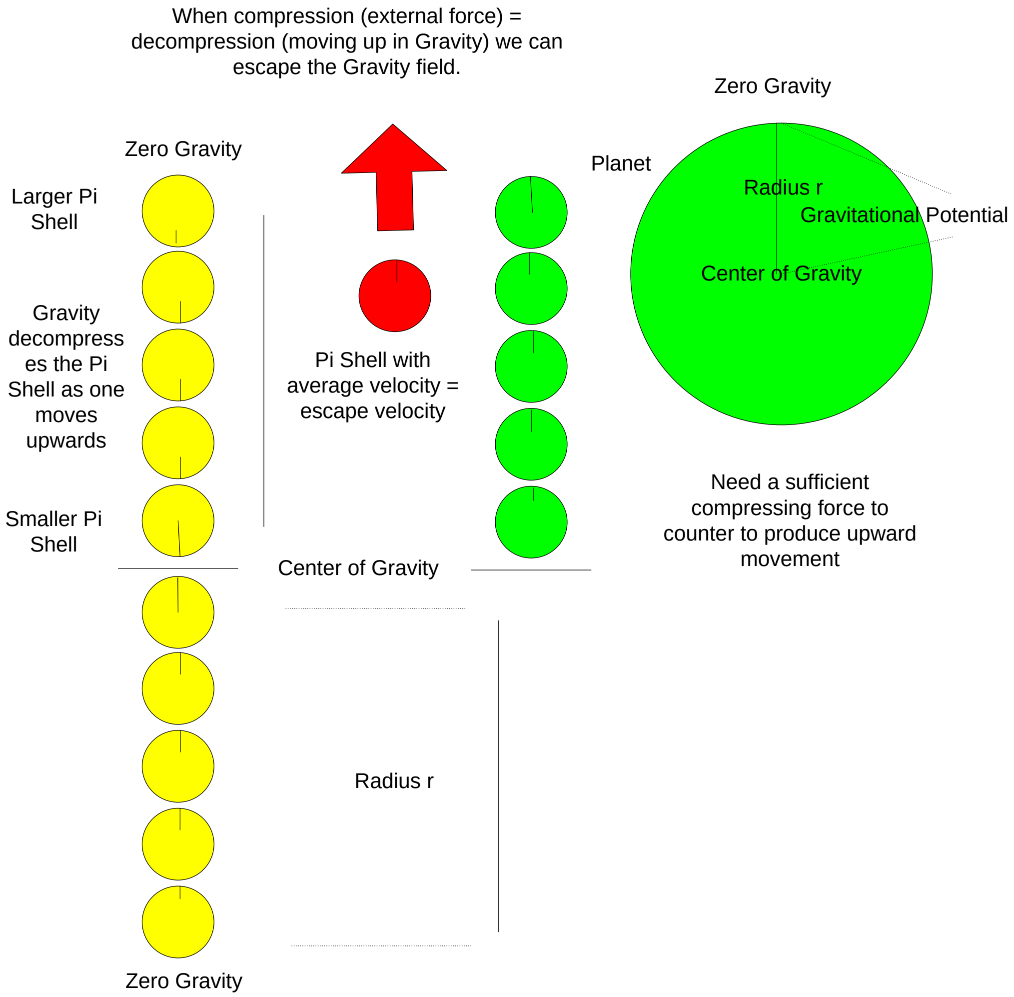
1.5 Escape Velocity (Calculating Diameter Loss to Get Off a Planet)

So we now have two types of energy from a Newtonian viewpoint. We have Kinetic Energy and Potential Energy.

Energy is to do with area of the atom but you can represent this as a velocity to figure out the escape velocity.

KE deals with a Pi-Shell shrinking area relative to an observer and moving 'faster'.
PE deals with a Pi-Shell gaining area (as one moves upwards within a Gravity field)

Therefore one can think that all one needs to do to escape Gravity is to apply a force in the correct direction which shrinks a Pie Shell by the correct amount to match the gain in diameter due to velocity. So we pitch the loss in Pi-Shell area (Kinetic Energy) against the Pi-Shell area gain (Potential Energy)



The non-relative version of this formula is therefore

$$\frac{1}{2} mv^2 = -\frac{GMm}{r}$$

Mass cancels on both sides of the equation

This produces, Pi-Shell Diameter Shrinkage = Pi-Shell Diameter Gain. Velocity represents the Pi-Shell diameter change (shrinkage), so we solve for the escape velocity.

$$v_{escape} = \sqrt{\frac{2GM}{r}}$$

Therefore we calculate the shrinkage of the Pi-Shell diameter relative to the observer to escape from Earth's Gravity field. The value is 11.2 km/s. As a proportion of the diameter of the Pi-Shell due to an observer, it's 11.2/C.

The Pi-Shell continues to move upwards so long as its Pi-Shell diameter loss is less than the Pi-Shell gain of the Gravity field. As the Pi-Shell moves upwards, its diameter increases within the Gravity field until they match and then the object falls back to Earth (center of Gravity). What is happening here is that the moving Pi-Shell is moving towards the place where the smallest wavelength (least action) is. This will be explained further in the Principle of Equivalence.

This formula is of course, non-relativistic and holds in the main for weak Gravity fields.

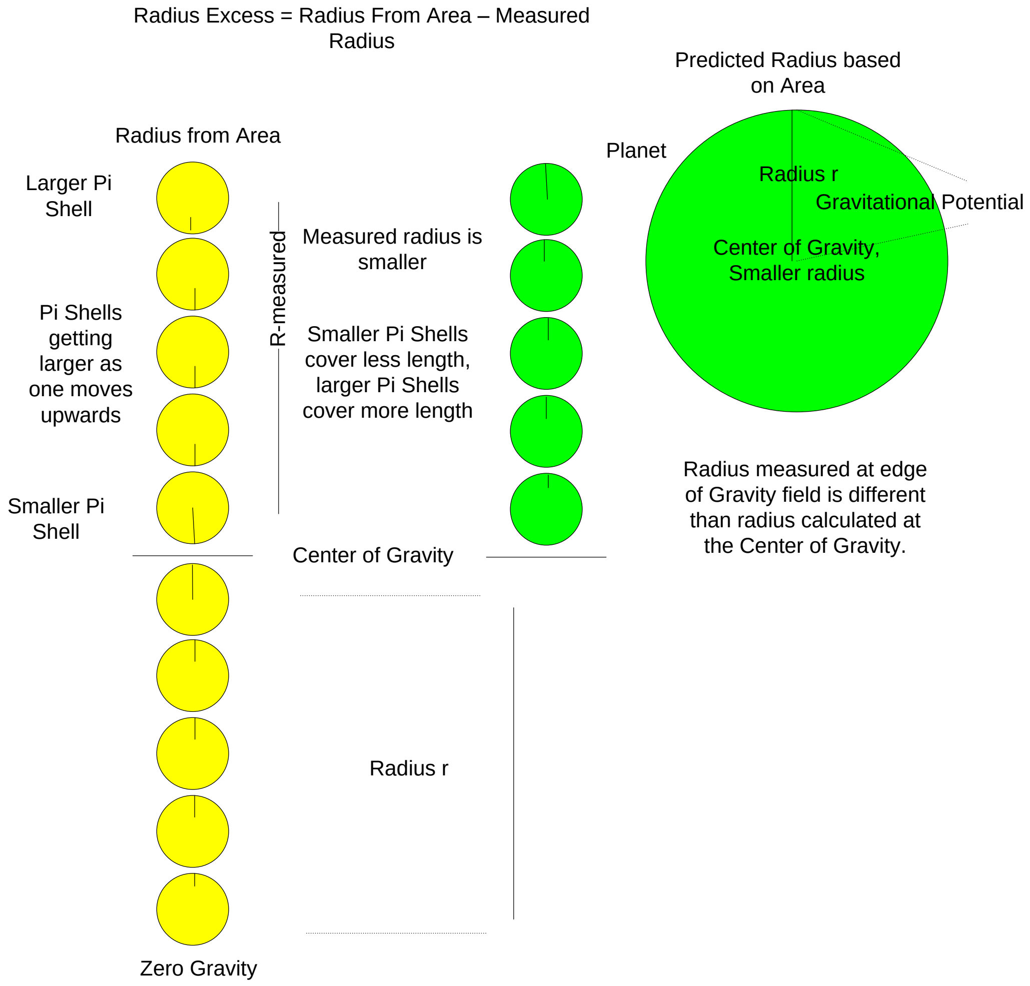
1.6 Calculating the degree of length shrinkage of all Pi-Shells due to Gravity

Note: The total area change is GM/c^2. So we're not dividing by area of atoms or summing.

One of the founding principles of General Relativity is the principle of Radius Excess as described in the Feynman Lectures, Volume II, Equation 42.3. This is not the typical equation shown in General Relativity as it does not involve tensors. It's one of the first steps of General Relativity as it relates Newtonian formulas to curved Space Time. Essentially, if you are an observer on Earth and you take a measurement there, you can predict the actual area of the Earth based on the radius of the planet. However, it turns out that the radius as determined from the area of the planet, one finds it is bigger than the radius of the observer on Earth who makes a calculation. Feynman talks about this as being due to the curvature of Space Time.

$$RadiusExcess = \sqrt{\frac{A}{4\pi}} - r_{meas} = \frac{G}{3c^2}M$$

The idea is that one measures the area of a planet and deduces the radius. Then on the surface of the planet, one measures the radius and there is a difference. The first part of the formula takes the area and derives the radius. The underlying assumption of this formula is that the radius of the Pi-Shells is a constant size. In curved Space Time, the Pi-Shells at the edge of space are the largest and this is the assumed Pi-Shell size. Each Pi-Shell covers a larger distance than the smaller Pi-Shells nearer to the center of Gravity. Therefore, when one measures the actual radius, one finds it is smaller than one expected. *The is because the Pi-Shells are getting smaller as one approaches the center of Gravity and each Pi-Shell covers a relatively smaller distance (based on the strength of the Gravity field).*



The equation that Einstein came up with for the curvature of Space Time due to the Earth is

$$\frac{G}{3c^2}M$$

Where G is the Universal Gravitational Constant, M is the mass of the Earth and c is the speed of light.

Turning this into a Pi-Space description, what is happening is that the observer on Earth has smaller Pi-Shells than those at the edge of space. Therefore the measurement will be slightly larger at the edge of space. The question is: by how much. This therefore relates to the shrinkage of Pi-Shells.

How can we show this using what I have shown already. Intuitively (using Pi-Space), the answer is to

(a) Calculate the Gravitational Potential which is the difference between the Pi-Shell diameter at the center of the Earth versus the diameter at the edge of Space
(b) Use the Lorenz (SR) length Transformation to calculate the length shrinkage as a proportion of one Pi-Shell versus the other (based on the diameter difference)
(c) Place the radius on the left hand side of the equation and the proportion of change of the radius on the right

(d) Divide the proportion of change by three to handle the fact that we have three orthogonal vectors. (Note: I don't agree with this step as described because length shrinkage is calculated in one dimension only, as it's the diameter shrinkage of the Pi-Shell, however this was the equation Einstein came up with so I accept it as he defined it.)

Step (a)

For escape velocity (same as diameter change relative to Observer)

$$v_{escape} = \sqrt{\frac{2GM}{r}}$$

Step (b)

Place this in the Lorenz length contraction form to express as a proportion of length

$$x = x_0\sqrt{1-\frac{v^2}{c^2}}$$

Which gives us

$$x = x_0\sqrt{1-\frac{2GM}{rc^2}}$$

We solve using the Binomial expansion (because the square root term has high decimal places) and we get

$$x_0\left(1-\frac{GM}{rc^2}+...\right)$$

So, the first term '1' is the Observer Pi-Shell in outer space making the measurement of the planet's area and the second term is the shrinkage expressed as a minus term(s) using relativity. We focus on the shrinkage which is the second term times the x term

$$x_0\frac{GM}{rc^2}$$

The x term is actually the radius determined from the area of the sphere

$$x_0 = r$$

Replacing the term

$$r\frac{GM}{rc^2}$$

This produces

$$\frac{GM}{c^2}$$

Finally, we divide by 3 (in the Einstein case) because the shrinkage is over the three orthogonal directions. This gives us the Einstein radius excess equation.

$$r = \frac{GM}{3c^2}$$

In Pi-Space, there's no need to divide by 3 because a change in the diameter of a Pi-Shell is an automatic change in all orthogonal directions (we're dealing with Pi-Shells which are spheres).

The general Pi-Space solution for radius compression is (one must multiply the radius by this proportion to get the answer).

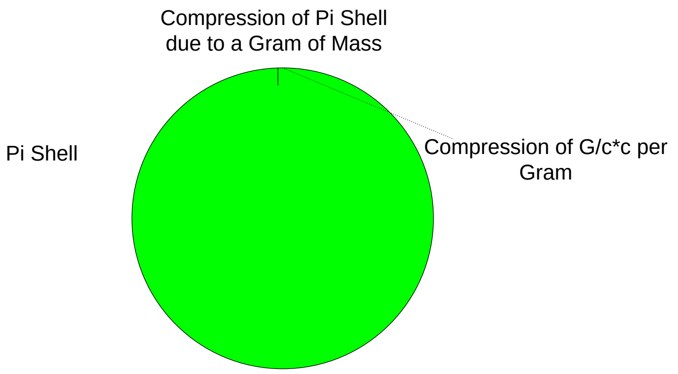
$$\frac{GM}{c^2}$$

Let's take a practical example; Earth's contraction is therefore 1.5 millimeters and on the sun it's 1. 5 kilometers (source Feynman lectures).

1.7 Compression of a Pi-Shell due to a gram of Mass

A simple question that needs to be answered is: What is the degree of curvature of Space Time with respect to a gram of mass? The answer is quite simple.

$$\frac{G}{c^2}$$



This is the amount of compression per gram of matter from a diameter viewpoint. It's derived from the previous section. From a Pi-Shell perspective, c squared represents the area of the Pi-Shell using the Square Rule. G is the Universal Gravitational constant. So, if there is an observer observing another Pi-Shell with a gram of matter, the area loss expressed in terms of the Observer's diameter is this amount.

Note: The shrinkage in the diagram is not to scale!

1.8 The Equivalence Principle

This is one of the foundational ideas of General Relativity. This is not to be confused with the Principle of Pi-Shell Equivalence. The core idea of this principle is that a non-inertial frame of reference is equivalent to a Gravitational frame of reference. The example used is a person standing on Earth in a Gravity field, feels the same force as a person on a Space Ship as it is accelerating. Up until the time of Einstein, it was thought that a non-inertial frame of reference was not equivalent to a Gravitational frame of reference. In the Newtonian equations, Gravity was thought of as a force which the planet projected onto the falling mass. Using the Einstein understanding, Gravity was explained by a curvature of Space Time and the falling object was finding its own path through this curved space. Essentially, non-Inertial frames of reference and Gravitational frames of reference are equivalent.

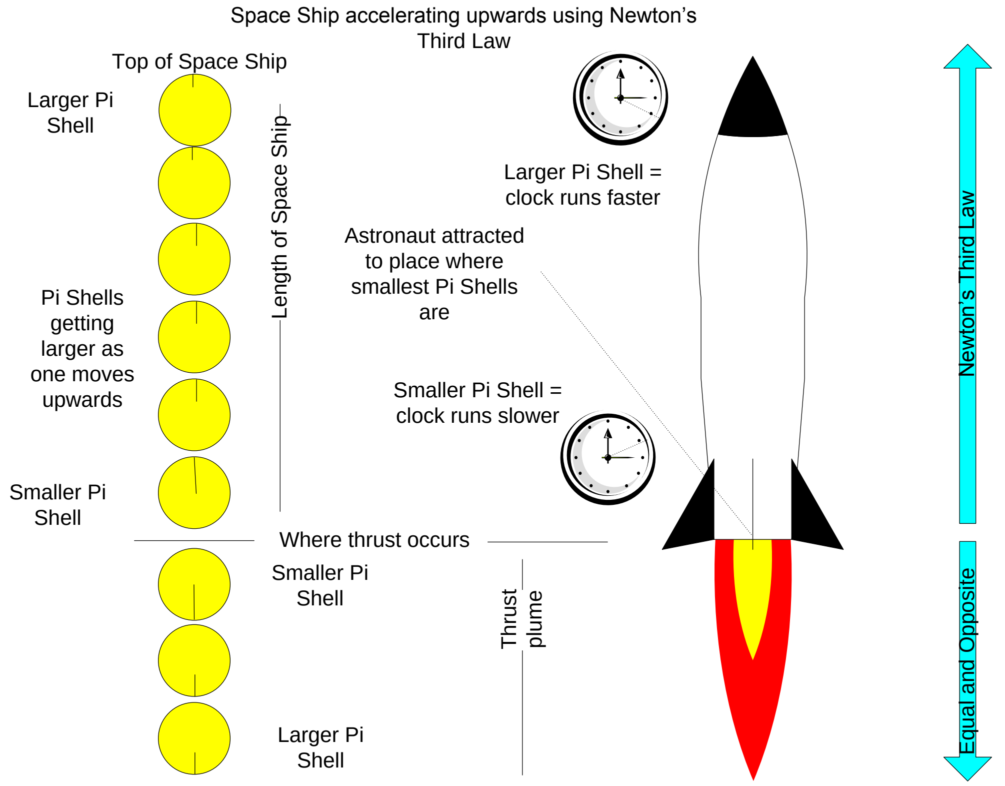
$$NonInertialFrame = acceleration = GravitationalFrame$$

This innocuous equation is quite profound because it unifies what had appeared to be two different cases. Essentially, the geometric frames in both cases are equivalent. This is where Pi-Shells comes into play to demonstrate this. The Equivalence Principle shows us that the Pi-Shell configuration of both cases (the Gravitational Frame and the non-Inertial Frame) are equivalent geometrically.

$$NonInertialFrame = PiShells\ \mathrm{Re}\ presentingAcceleration = GravitationalFrame$$

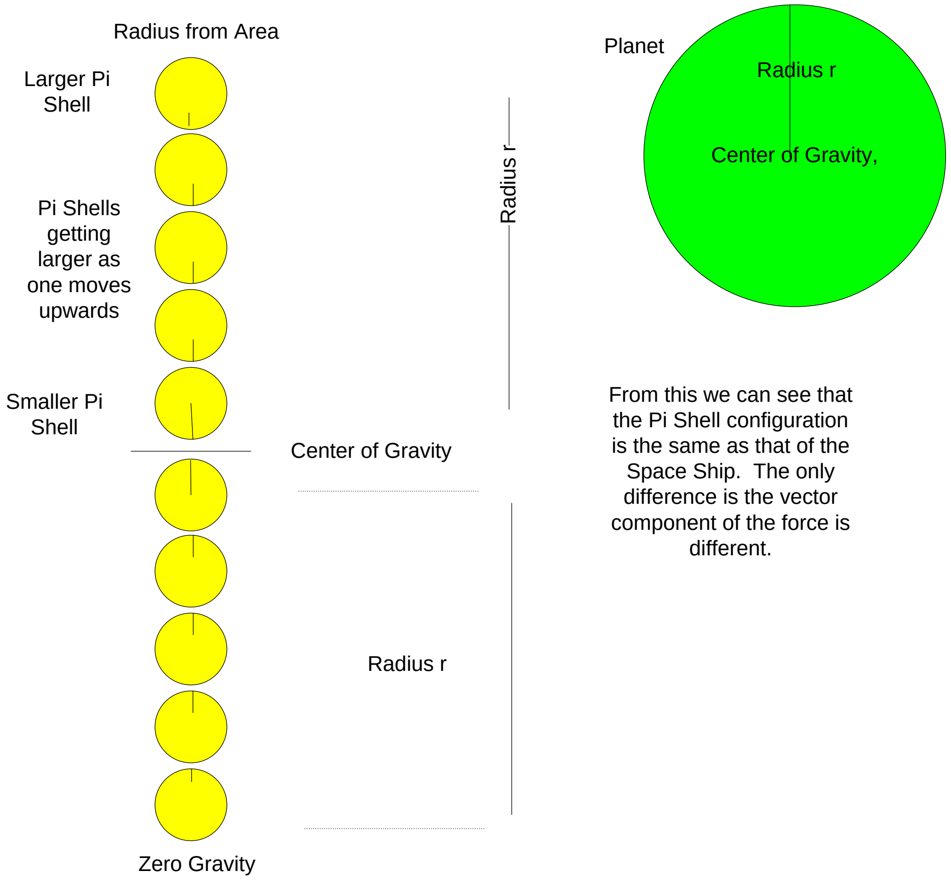
Let's take both sides of this association using Pi-Shells.

The Non-Inertial Frame means an accelerated frame of reference. The example shown is a Space Ship which blasts off from Earth. In the case of the Space Ship, it uses Newton's Third Law to achieve lift. I have already covered this law. The fuel exiting the bottom of the ship in one direction causes the Space Ship to move in the opposite direction. The astronaut is attracted towards the place of thrust because this is where the smaller Pi-Shells are and is the Principle of Least Action. From a Pi-Shell perspective, the smallest Pi-Shells are at the base of the Space Ship and the largest Pi-Shells are at the top of the ship. Therefore clocks run relatively faster at the top of the Space Ship in comparison to the base.



The difference between this and Gravity which represents acceleration is that the vector component of the Pi-Shells is pointed towards the center of Gravity. The key point to note is that the actual change in Pi-Shell sizes of the Pi-Shell diameters would be equivalent if the acceleration of the ship matched Earth Gravity.

Gravity as an acceleration



Newton's First Law covers the vector force of Gravity. The vector component of force of a Pi-Shell is encoded inside in the Space Time that it occupies. It will continue to move in this direction unless acted upon by an outside force or if it is moving through a Gravity field, which alters Space Time and therefore changes the vector.