

An Axiomatic Approach to Physics

By

Daniel L. Burnstein

dburnstein@quantumgeometrydynamics.com

Abstract

Quantum-geometry dynamics: a theory derived from a minimal set of axioms that can describe, explain and predict the behaviour of dynamic systems.

First, we will introduce a set of axioms and corollaries which will be used to fundamentally define space, mass, momentum, energy and forces. This will be followed by a discussion of quantum-geometrical space and its geometry. Then, we will show how gravity emerges naturally from the axiom set and introduce a new equation for gravity that can be applied at different scales. At the same time, we will provide quantum-geometrical interpretations of the laws of motion and use them to describe dynamic systems. We will follow by providing quantum-geometrical grounds for key predictions of special relativity, general relativity and Newtonian mechanics. Although quantum-geometry dynamics will be shown to be in agreement with physical observations and with the predictions of special and general relativity, quantum-geometry dynamics allows for distinct falsifiable predictions that set it apart from them.

1. Introduction

For several decades now, mathematicians and physicists have tried to reconcile quantum mechanics and general relativity, two of the most successful physics theories in history, but despite their best efforts such unification has remained beyond the limit of the scientific horizon.

The problem, we believe, stems from the fact that the axiom sets of quantum-mechanics and general relativity are mutually exclusive. It is a mathematical certainty that unification of axiom sets which contain mutually exclusive axioms is impossible, as is the unification of the theories derived from them. In other words, it is mathematically impossible to unify quantum mechanics and general relativity without abandoning some of the axioms of their respective axiom sets, but abandoning any of the axioms amounts to giving up on one, if not both theories. In fact, it is impossible to give up on one without giving up on the other since both are necessary to describe reality at all scales. Hence the impasse physicists have struggled with. Unification of the two theories requires that their axiom sets be unified, which in turn requires that their axioms be complementary and not, as are those of QM and GR, exclusory. QM and GR cannot be reconciled.

We propose here an alternative approach. Intuiting that at its most fundamental, reality is also at its simplest, we construct the simplest possible axiom set that can describe a dynamic system; one where each axiom corresponds to a fundamental aspect of reality agreed upon by all

theories of physics. That is, the existence of space and the existence of matter. We will show that from such a minimal set of axioms a theory can be developed that describes and explains all physical phenomena, thus is in agreement with the predictions of quantum-mechanics and general relativity. Most importantly, a theory that is in complete agreement with physical reality.

In the next section, we will introduce the axiom set and some corollaries of the individual axioms. Subsequently, we will show how these axioms and their corollaries can be applied. It is important to remember that it is not the existence of the fundamental particles and forces we introduce here that we will question (these must be treated as axioms, that is, propositions that are assumed to be true), but rather the consequences of assumption of their existence.

The questions one must ask about any proposed theory are:

1. Do its axioms form an internally consistent set?
2. Is the theory rigorously derived from the axiom set?
3. Are all descriptions derived from the axiom set consistent with observations?
4. Can we derive from the axiom set explanations of observations?
5. Can we derive from the axiom set unique testable predictions?

The reader should keep them in mind when getting acquainted with the approach we are presenting here.

2. Axioms and Corollaries

It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience.

Albert Einstein

In mathematics, an axiom is “a proposition that is assumed without proof for the sake of studying the consequences that follow from it”. But this definition is not sufficient when it comes to physics. Within the context of an axiomatic physics theory, an axiom will also be understood to be a proposition about the existence of a fundamental aspect of reality. QGD is based upon the following axioms¹:

1. **Axiom:** An aspect of reality is fundamental if it remains absolutely invariant under any changes of the physical system. This implies that:
 - i. a fundamental particle never transmutes or decays into other particles,
 - ii. a fundamental particle cannot be the result of the combination of other particles, and
 - iii. the intrinsic properties of fundamental particles are invariant

¹ For a detailed discussion, see [Introduction to Quantum-Geometry Dynamics](#)

2. **Axiom:** There exist only two types of fundamental particles:
 - i. $preons^{(-)}$, which are the fundamental particles of space, and
 - ii. $preons^{(+)}$, which are the fundamental particles of matter.
3. **Corollary:** From 1 and 2, regardless of any changes of state or physical transformation or event:
 - i. the number of $preons^{(-)}$ is constant. Therefore space is conserved.
 - ii. the number of $preons^{(+)}$ is constant. Therefore matter is conserved.
4. **Axiom:** There exist only two fundamental forces, n-gravity, a repulsive force which acts between $preons^{(-)}$ and p-gravity, an attractive force which acts between $preons^{(+)}$.
More specifically:
 - i. The interaction between any two $preons^{(-)}$, denoted g^{-} , is the fundamental unit of n-gravity.
 - ii. The interaction between any two $preons^{(+)}$, denoted g^{+} , is the fundamental unit of p-gravity.
 - iii. $|g^{+}| = k|g^{-}|$, where k is the proportionality constant between the magnitudes of g^{-} and g^{+} .
5. **Corollary:** From 2i and 4i, spatial dimensions emerge from the n-gravity interactions between $preons^{(-)}$. We will call such space quantum-geometrical. Hence:
 - i. There exists nothing between $preons^{(-)}$ except the force that acts between them. There is no space between them, only force.
 - ii. $preons^{(+)}$, the fundamental particle of matter, exist within $preons^{(-)}$

Note: One could think of space as discrete regions where matter exists.
6. **Axiom:** The $preon^{(+)}$ is a strictly kinetic particle whose momentum causes it to move by leaping between $preons^{(-)}$ at a rate of one leap per state change of the universe.
7. **Corollary:** From 1, though the direction of the momentum vector of a $preon^{(+)}$ can change, its magnitude is fundamental and thus never changes.
8. **Corollary:** From 2i, all particles and material structures are composed of $preons^{(+)}$ bound by p-gravity. This implies that all even particles we currently consider to be elementary are composite.
9. **Corollary:** From 5, all $preons^{(+)}$ exist in quantum-geometrical space, and from 6, as they move, they transitorily form $preon^{(+)} / preon^{(-)}$ pairs, denoted $preons^{(+/-)}$. Since all fundamental intrinsic properties are conserved, $preons^{(+/-)}$ must interact

- i. with other $preons^{(+/-)}$ through both n-gravity and p-gravity and
 - ii. with $preons^{(-)}$ through n-gravity.
10. **Axiom:** All changes in a physical system are strictly causal. A physical system evolves through causally linked changes of states.
11. **Corollary:** From #10, it follows that physical systems are strictly deterministic.
12. **Corollary:** From #3, all dynamic systems tend to resolve themselves so as to remain in agreement with the laws of conservation.
13. **Definition:** The mass of a particle or structure is equal to the amount of matter it contains, thus equal to the number of $preons^{(+)}$ it composed from. For an object a we will denote this number, its mass, by m_a .
14. **Definition:** The momentum vector of a $preon^{(+)}$ is represented by \vec{c} and its magnitude corresponds to its momentum, thus $\|\vec{c}\| = c$.
15. **Definition:** The momentum vector of a particle or structure a is the vector sum of the momentum vectors of its component $preons^{(+)}$ or $\vec{P}_a = \sum_{i=1}^{m_a} \vec{c}_i$. Thus the momentum of a , denoted P_a , is given by $P_a = \|\vec{P}_a\| = \left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$.
16. **Definition:** The energy of a particle or structure is the sum of the momentums of its component $preons^{(+)}$. That is:

$$E_a = \sum_{i=1}^{m_a} \|\vec{c}_i\| = m_a c \text{ or simply } E_a = m_a c$$

where \vec{c}_i is the momentum vector of the $preon^{(+)}$ of a_i .

17. **Definition:** The speed v_a of particle or structure a is the ratio of its momentum to its mass. That is:

$$v_a = \frac{\|\vec{P}_a\|}{m_a} = \frac{\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|}{m_a}.$$

3. The Structure of Space

The force between any two $preons^{(-)}$ is the fundamental unit of n-gravity force g^- . Unlike continuous geometrical space, points, lines, surfaces all have volumes According to QGD, spatial dimensions are emergent properties of $preons^{(-)}$; hence space is not fundamental.

It is important here to remind the reader that what exists between two $preons^{(-)}$ is the n-

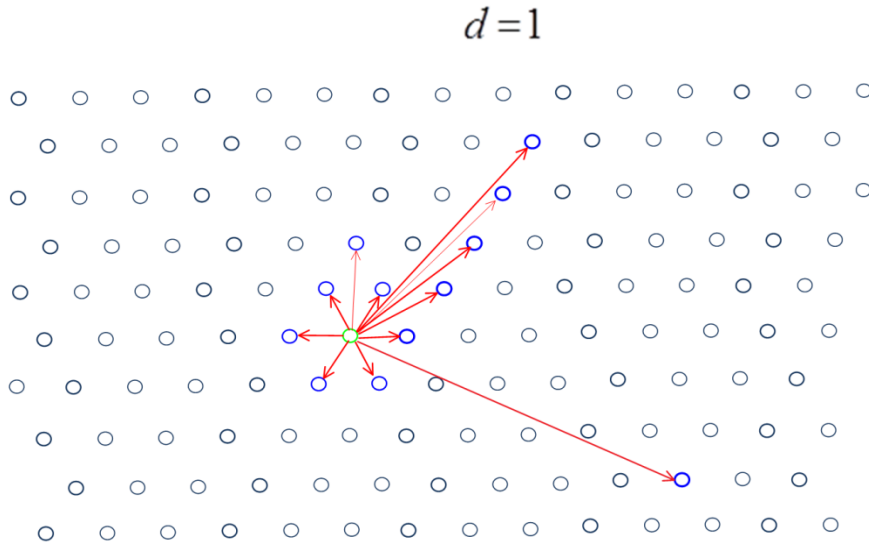


Figure 1

gravity field. There is no space in the geometrical sense between them. The force of the field between any two $preons^{(-)}$, anywhere in the Universe, is equal to g^- .

Figure 1 is a two dimensional representation of quantum-geometrical

space. The green circle represents a $preon^{(-)}$ arbitrarily chosen as origin and the blue circles represent $preons^{(-)}$ which are all at one unit of distance from it. Distance in quantum-geometrical space at the fundamental scale is very different from Euclidian distance (though we will show below that Euclidian geometry emerges from quantum-geometrical space at larger scales).

Quantum-geometric space is physical and not purely mathematical or geometrical. Because of that, in order to distinguish it from quantum-geometric space, we will refer to space in the classical sense of the term as *Euclidian space*.

Quantum-geometric space is very different from Euclidian space. A consequence of this is that the distance between any two $preons^{(-)}$ in quantum-geometric space is very different from the measure of the distance using Euclidian space; the distance between two points or $preons^{(-)}$ being equal to the number of leaps a $preon^{(+)}$ would need to make to move from one to the other.

In order to understand quantum-geometric space, one must put aside the notion of continuous and infinite space. Quantum-geometric space is created by the n-gravity interactions between

$preons^{(-)}$. $Preons^{(+)}$ do not propagate through space, they are space. Since $preons^{(-)}$ are fundamental and since QGD is founded on the principle of strict causality, then the n-gravity field between $preons^{(-)}$ has always existed and as such may be understood as instantaneous. N-gravity (or p-gravity for that matter) does no propagate. It just exists.

Figure 2 shows another example of how the distance between two $preons^{(-)}$ is calculated. So

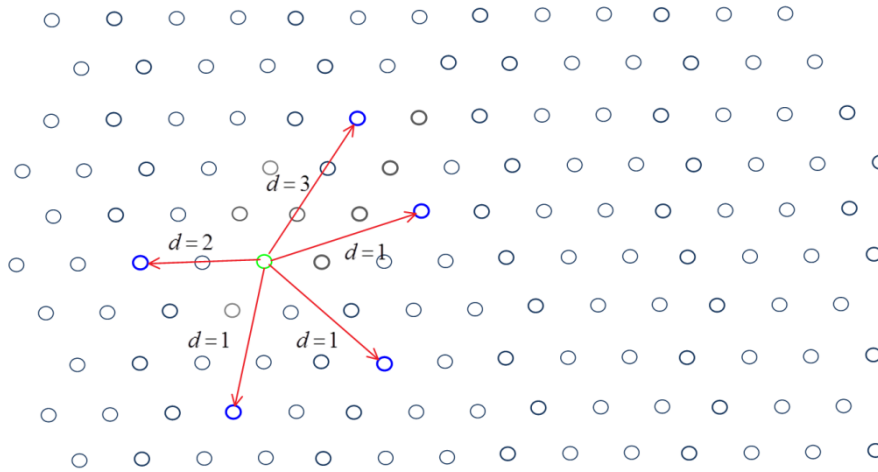


Figure 2

although the Euclidian distance between the green $preon^{(-)}$ and any one of the blue $preons^{(-)}$ are nearly equal, the quantum-geometrical distances between them varies greatly.

Since the quantum-geometrical distances do not correspond to the Euclidian

distances, the theorems of geometry do not hold. Applying Pythagoras's theorem to the triangle which in figure 3 is defined by the blue, the red and the orange lines, we see that $a^2 + b^2 \neq c^2$.

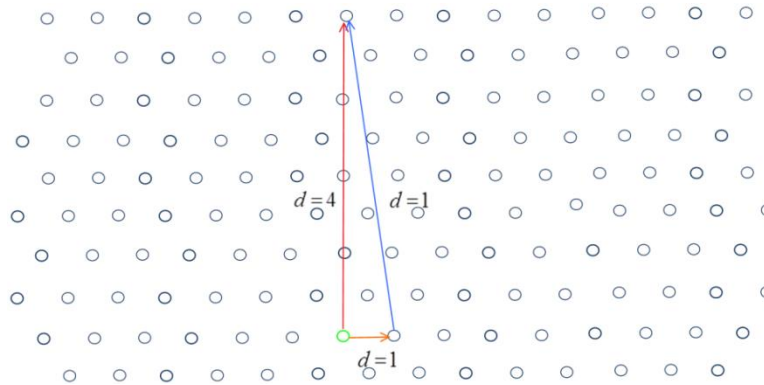


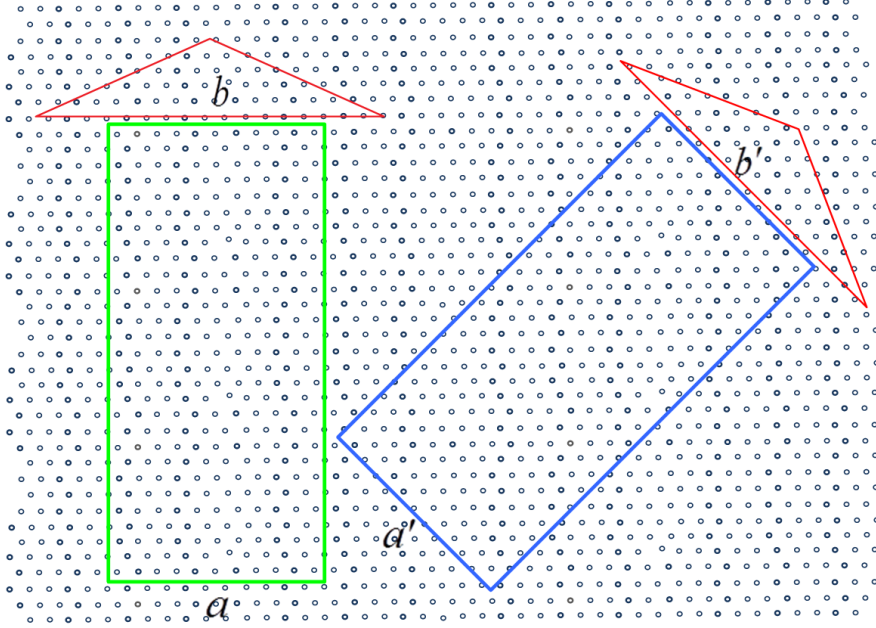
Figure 3

Also interesting the above figure is that if a is the orange side, b the red side and c the blue side (what would in Euclidian geometry be the hypotenuse, then $a + c < b$. That is, the shortest distance between two $preons^{(-)}$ is not necessarily the straight line.

But evidently, we live on a scale where Pythagoras's theorem holds, so how does Euclidian geometry emerge from quantum-geometrical space?

Figure 4 shows the $preons^{(-)}$ through which two objects of similar size pass through quantum-geometrical space but in different directions. If we consider that the area encompassed by the

Figure 4



blue rectangles is made of all the $preons^{(-)}$ through which the object passes, we see that as we move to larger scales, the number of $preons^{(-)}$ contained in the green rectangle approaches the number of $preons^{(-)}$ in the blue rectangle, so that if the distance from a to b or from a' to b' is defined by the number of $preons^{(-)}$ contained in the

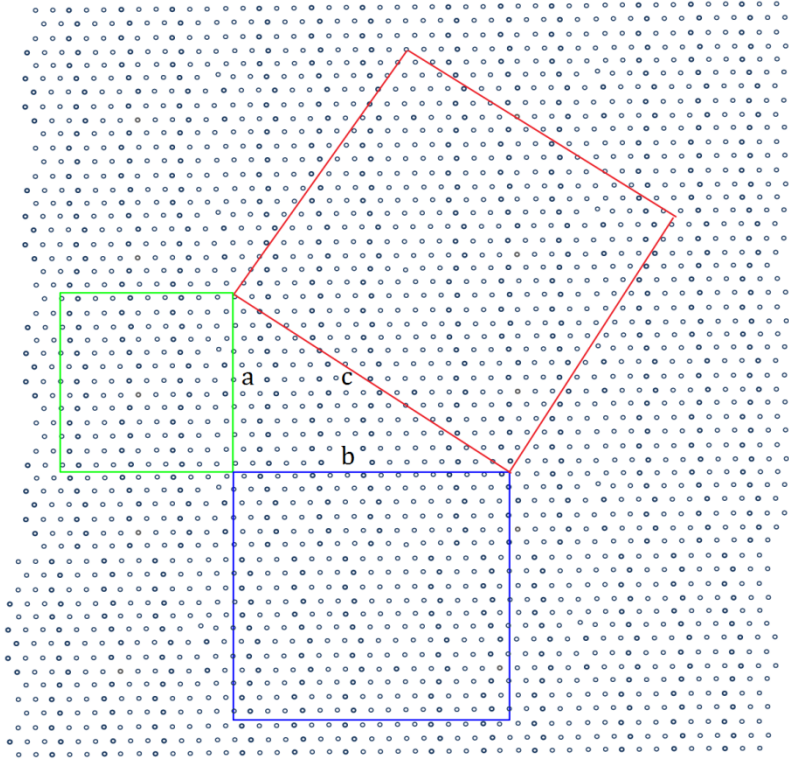
respective rectangles divided by the width of the path, we find that $a \rightarrow b \simeq a' \rightarrow b'$.

Theorem on the Emergence of Euclidian Space from Quantum-Geometrical Space

There exist a minimum quantum-geometrical distance d_{\min} such that if d , the quantum-geometrical distance between two $preons^{(-)}$, if $d > d_{\min}$ then $d = d_E$, where d_E is the Euclidean distance between the two $preons^{(-)}$.

Beyond a certain scale, the Euclidian distance between two points provides a good approximation of the quantum-geometrical distance, but below that scale, the closer we move towards the fundamental scale, the greater the discrepancies between Euclidian and quantum-geometrical measurements of distance.

Figure 5



of a the length of the side of the third. Also, the greater the values of n_1 , n_2 and n_3 , the closer the approximation will be to the actual unknown length. That is $\lim_{\substack{n_1 \rightarrow \infty \\ n_2 \rightarrow \infty \\ n_3 \rightarrow \infty}} (\bar{a}^2 + \bar{b}^2) = \bar{c}^2$.

In figure 5, if n_1 , n_2 and n_3

are respectively the number of parallel trajectories that sweep the squares a , b and c , for $n_{1-3} > M$, then

$$\bar{a} \approx \frac{\sum_{i=1}^{n_1} d_i}{n_1}, \bar{b} \approx \frac{\sum_{i=1}^{n_2} d_i}{n_2} \text{ and}$$

$$\bar{c} \approx \frac{\sum_{i=1}^{n_3} d_i}{n_3} \text{ so that}$$

$\bar{a}^2 + \bar{b}^2 \approx \bar{c}^2$. Hence, given the quantum-geometrical length of the sides of any two of the three squares above, Pythagoras's theorem can be used to calculate an approximation

4. Propagation

Simply put, propagation implies motion; the displacement of matter ($preons^{(+)}$) through quantum-geometric space. A $preon^{(+)}$, which is the fundamental particle of matter, moves by leaps from $preon^{(-)}$ to $preon^{(-)}$. Therefore, the displacement of a $preon^{(+)}$ is equal to the number of leaps it makes.

The speed of $preons^{(+)}$ is limited by the structure of quantum-geometrical space. That is, a $preon^{(+)}$ must move by a succession of single leaps between adjacent $preons^{(-)}$ along a trajectory determined by its momentum vector. So the preonic leap, or leap, must be the smallest unit of motion.

5. Interactions

Interactions do not require the displacement of matter. So unlike propagations, interactions are not mediated by quantum-geometrical space ($preons^{(-)}$).

We have explained that quantum-geometrical space is generated by the interaction between $preons^{(-)}$; by the n-gravity field between them. N-gravity does not propagate through quantum-geometrical space, it generates it. Therefore n-gravity is instantaneous. Also, p-gravity, the force acting between $preons^{(+)}$, is similarly instantaneous.

It follows that gravity, which will be described in the next section as the combined effects of n-gravity and p-gravity, must also be instantaneous.

6. Forces, Interactions and Laws of Motion

The dynamics of a particle or structure is entirely described by its momentum vector. The momentum vector can be affected by forces, which imply no exchange of particles. The momentum vector of a particle or structure can also be affected by interactions during which two or more particle of structures will exchange lower order particles or structures. These are non-gravitational interactions which result in momentum transfer or momentum exchanges.

We will show how all effects in nature result from one or a combination of these two types of interactions.

Gravitational Interactions and Momentum

According to QGD, there exist only two fundamental forces: n-gravity which is a repulsive forces acting between $preons^{(-)}$ and p-gravity, an attractive force which acts between $preons^{(+)}$ and gravity as we know it is the resultant effect of n-gravity and p-gravity.

$Preons^{(+)}$ exist in quantum-geometrical space which is composed of $preons^{(-)}$. $Preons^{(-)}$ are also strictly kinetic so they must move by leaping from $preons^{(-)}$ to $preons^{(-)}$ and, between leaps, transitorily pair with $preons^{(-)}$ to form $preon^{(-)} | preon^{(+)}$ pairs (which we will represent by $preon^{(+/-)}$) which because of conservation of fundamental properties interact with other $preon^{(-)} | preon^{(+)}$ pairs through both n-gravity and p-gravity. It follows that since all particles or structures are made of $preon^{(-)} | preon^{(+)}$ pairs, they must interact through both n-gravity and p-gravity.

The combined effect of the n-gravity and p-gravity is what we call gravity. Hence gravity, according to QGD, is not a fundamental force but an effect of the only two fundamental forces it predicts must exist.

$G(a;b)$, the gravitational interaction between two material structures ace a and b , is the combined effect of the n-gravity and p-gravity interactions. So, to find $G(a;b)$ we simply need to count the number of n-gravity and p-gravity interactions and vector sum them. We do this as follows:

Since a and b respectively contain m_a and m_b $preons^{(+)}$ and since every $preon^{(+)}$ of a interacts with each and every $preon^{(+)}$ of b , the number of p-gravity interactions is given by the product $m_a m_b$ or the product of their masses in $preons^{(+)}$.

The n-gravity effect between a $preon^{(+)}$ of a and a $preon^{(+)}$ of b , the force that space exerts on a and on b , is the sum of n-gravity interactions between them. Given a quantum-geometrical distance d , which is the number $preons^{(-)}$ from a $preon^{(+/-)}$ of a and a $preon^{(+/-)}$ of b (including a and b) and given that all $preons^{(-)}$ between a and b interact with each other,

the number of n-gravity interactions is given by $\frac{d_{i,j}^2 + d_{i,j}}{2}$, where i and j respectively

correspond to the i^{th} $preon^{(+/-)}$ of a and the j^{th} $preon^{(+/-)}$ of b . And since a and b respectively contain m_a and m_b $preons^{(+/-)}$, then the total number of n-gravity interactions

between them is $\sum_{i=1}^{m_i} \sum_{j=1}^{m_j} \frac{d_{i,j}^2 + d_{i,j}}{2}$.

Using the relation $g^+ = k |g^-|$ we can express p-gravity in units equivalent to the magnitude of an n-gravity interaction which allows us to find the resulting effect from n-gravity and p-gravity interactions between a and b . Thus the gravitational interaction between a and b is given by

$G(a;b) = m_a m_b k - \sum_{i=1}^{m_i} \sum_{j=1}^{m_j} \frac{d_{i,j}^2 + d_{i,j}}{2}$ where the first component, $m_a m_b k$, is the magnitude of the p-

gravity force acting between a and b and $\sum_{i=1}^{m_i} \sum_{j=1}^{m_j} \frac{d_{i,j}^2 + d_{i,j}}{2}$ is the magnitude of the n-gravity force

between them. It is interesting to note here that $\sum_{i=1}^{m_i} \sum_{j=1}^{m_j} \frac{d_{i,j}^2 + d_{i,j}}{2}$ is the force exerted by quantum-

geometrical space itself on two particles or structures.

At larger scales, for homogeneous spherical structures, we find that

$\sum_{i=1}^{m_i} \sum_{j=1}^{m_j} \frac{d_{i,j}^2 + d_{i,j}}{2} \approx m_a m_b \frac{d^2 + d}{2}$ where d is the distance between the centers of gravity of a and

b . This allows us to derive the simplified gravitational interaction equation

$$G(a;b) = m_a m_b k - m_a m_b \frac{d^2 + d}{2} \text{ or } G(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right) .$$

The reader should note that according to the QGD equation for gravity, the p-gravitational interaction is independent of distance. It is the number of n-gravitational interactions between two bodies, which is proportional to the square of the number of *preons*⁽⁻⁾ between them (the physical distance), that causes variations in the magnitude of the gravity. As we will now see, the effect of gravity on momentum (and speed) results from variations in distance. It space's repulsive force determine the dynamics of systems.

The Fundamental Momentum and Gravity

That the momentum of the *preon*⁽⁺⁾ is fundamental is a postulate of QGD. It is equal to $\|\vec{P}_{p^{(+)}}\| = \|\vec{c}\| = c$. In fact, of all properties of the *preon*⁽⁺⁾, only its direction is variable. And the only thing that affects it is gravity.

The direction of a *preon*⁽⁺⁾ is determined by the resultant of the gravitational interactions acting on it, which interactions are with free *preons*⁽⁺⁾, particles or structures and if the *preon*⁽⁺⁾ is bound, with the *preons*⁽⁺⁾ that it is bound to.

A change in direction of a *preon*⁽⁺⁾ is proportional to the change in the resultant of the forces acting on it. That is:

$$\vec{P}_{p^{(+)}}_{s_2} = \vec{P}_{p^{(+)}}_{s_1} \vec{+}_{s_1 \rightarrow s_2} \Delta \vec{G}_{s_1 \rightarrow s_2} \text{ where } \Delta \vec{G}_{s_1 \rightarrow s_2} = \left(\sum_{j=1}^{m_a} \Delta \vec{G}(p_i^{(+)}; p_j^{(+)}) + \sum_{k=1}^n \Delta \vec{G}(p_i^{(+)}; a_k) \right) \text{ is the}$$

resultant of the forces acting on the *preon*⁽⁺⁾ and $\vec{+}$ is the directional vector sum which we

$$\text{define as } \vec{P}_{p^{(+)}}_{s_1} \vec{+}_{s_1 \rightarrow s_2} \Delta \vec{G}_{s_1 \rightarrow s_2} = \frac{\vec{P}_{p^{(+)}}_{s_1} + \Delta \vec{G}_{s_1 \rightarrow s_2}}{\left\| \vec{P}_{p^{(+)}}_{s_1} + \Delta \vec{G}_{s_1 \rightarrow s_2} \right\|} c = \vec{c}_{s_2} .$$

The directional vector sum describes the conservation of the momentum of the *preons*⁽⁺⁾ . The result of the directional is the normalized vector sum of the momentum vector of the *preon*⁽⁺⁾ and the variations in gravity vector $\Delta \vec{G}_{s_1 \rightarrow s_2}$ between states s_1 and s_2 .

Newton's first law of motion is implied here since for $\Delta \vec{G} = 0$ we have $\vec{P}_{p^{(+)}_{s+1}} = \vec{P}_{p^{(+)}_s}$.

We will see how Newtonian gravity emerges from gravitational interactions at the fundamental scale.

Gravity between Particles and Structures

Astrophysical observations which we shall discuss later suggest that $k \gg 10^{100}$, so that at short distances, the number of n-gravitational interactions being very low and the magnitude of the force being over a hundred orders of magnitude weaker than p-gravity.

$$\vec{G}(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right)$$

The n-gravitational component of QGD equation for gravity is insignificant compared to the p-gravitational component. Gravity at short scales being over a hundred orders of magnitude stronger than at that at large scales, it is strong enough to bind *preons*⁽⁺⁾ into composite particles and composite particles into larger structures.

Bound *preons*⁽⁺⁾ form particles and structures which then behave as one body which dynamic property is described by the momentum vector $\vec{P}_a = \sum_{i=1}^{m_a} \vec{c}_i$ which magnitude is its momentum.

That is $P_a = \|\vec{P}_a\| = \left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$. Because of that, the dynamics of particles and structures can be

described simply as the evolution of their momentum vector \vec{P}_a from state to state.

Particles and structures are in constant gravitational interactions with all particles and structures in the entire universe. The direction of the momentum vector of a particle or structure at any position is the resultant of its intrinsic momentum and extrinsic interactions. Hence, if the structure of a particle or structure and its interactions remain constant, so will its momentum vector. Changes in momentum are due to variations in the magnitude and direction of the gravitational interaction, hence due to variations in their positions.

For simplicity, we will start by describing the dynamics of a system consisting of two gravitationally interacting bodies.

Consider bodies *a* and *b* in state s_1 which interact gravitationally in accordance to the equation $\vec{G}_{s_1}(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right)$. Change in the momentum vector of the bodies from

s_1 to the next causally related state s_2 is $\Delta_{s_1 \rightarrow s_2} \vec{P}_a = \Delta_{s_1 \rightarrow s_2} \vec{G} = \vec{G}_{s_2}(a;b) - \vec{G}_{s_1}(a;b)$ so that

$$\vec{P}_{a,s+1} = \vec{P}_{a,s} + \Delta_{s \rightarrow s+1} \vec{G}(a;b) \phi_a$$
 and

$$\Delta_{s_1 \rightarrow s_2} \vec{P}_b = \Delta_{s_1 \rightarrow s_2} \vec{G} = \vec{G}_{s_2}(a;b) - \vec{G}_{s_1}(a;b)$$
 so that

$$\vec{P}_{b,s+1} = \vec{P}_{b,s} + \Delta_{s \rightarrow s+1} \vec{G}(a;b) \phi_b$$
 where s_2 is a successive state of our two body system.

Here $\phi_x = \left\lceil \frac{c - v_x}{c} \right\rceil$ preserves the fundamental limit of the momentum of a particle or structure

which we have shown cannot exceed its energy; that is: $\left\| \sum_{i=1}^{m_x} \vec{c}_i \right\| \leq \sum_{i=1}^{m_x} \|\vec{c}_i\|$. The bracket is the

ceiling function so that for $c < v_x$ we have $\left\lceil \frac{c - v_x}{c} \right\rceil = 1$ and $\Delta_{s_1 \rightarrow s_2} \vec{P}_x = \Delta_{s_1 \rightarrow s_2} \vec{G}(a;b)$ but for

$v_x = c$ we have $\left\lceil \frac{c - v_x}{c} \right\rceil = 0$ and $\Delta_{s_1 \rightarrow s_2} \vec{P}_x = 0$. And since the momentum of a particle or

structure cannot exceed its energy, its maximum speed is $\max v_x = \frac{\sum_{i=1}^{m_x} \|\vec{c}_i\|}{m_x} = \frac{m_x c}{m_x} = c$.

Note that for descriptions of dynamics system at speed below the speed of light, will simply write $\vec{P}_{a,s+1} = \vec{P}_{a,s} + \Delta_{s \rightarrow s+1} \vec{G}(a;b)$ and $\vec{P}_{b,s+1} = \vec{P}_{b,s} + \Delta_{s \rightarrow s+1} \vec{G}(a;b)$ with the understanding that ϕ_x is implicit and equal to 1.

Derivation of the Weak Equivalence Principle

The weak equivalence principle is easily derived from QGD's equation for gravity $G(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right)$ where m_a and m_b are respectively the masses of a and b and d the distance, all in natural fundamental units.

According to QGD, the change in momentum due to gravity following the change in positions between two successive states s_1 and s_2 is equal to the gravity differential between the two positions $\Delta G(a;b)$. That is: $\left\| \Delta_{s_1 \rightarrow s_2} \vec{P}_a \right\| = \left\| \Delta_{s_1 \rightarrow s_2} \vec{G}(a;b) \right\|$.

QGD defines speed of a body as $v_a = \frac{\|\vec{P}_a\|}{m_a}$ and the acceleration of a body is $\Delta v_a = \frac{\|\Delta \vec{P}_a\|}{m_a}$.

Since $\|\Delta \vec{P}_b\| = \Delta G(a;b)$, the acceleration of an object a due to the gravitational interacting

between a and b and $\Delta v_a = \frac{\|\Delta \vec{P}_a\|}{m_a} = \frac{\|\Delta G(a;b)\|}{m_a}$. Then

$$\Delta G(a;b) = m_a m_b \left(k - \frac{d_1^2 + d_1}{2} \right) - m_a m_b \left(k - \frac{d_2^2 + d_2}{2} \right) = m_a m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right)$$

$$\text{then } \Delta v_b = \frac{1}{m_a} m_a m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right) = m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right)$$

.

Therefore, gravitational acceleration of a body a relative a second body b is independent of the mass of the first and dependent on the mass of the second. Conversely, the gravitational acceleration of an object b relative to a is given by

$$\Delta v_b = m_a \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right) \text{ is independent of } m_b. \text{ So, regardless of their mass}$$

m_a , all bodies a will be accelerated relative to a given body b at the same rate.

Note: The equation $\Delta G(a;b) = m_a m_b \left(k - \frac{d_1^2 + d_1}{2} \right) - m_a m_b \left(k - \frac{d_2^2 + d_2}{2} \right)$ may not be algebraically

simplified to $\Delta G(a;b) = m_a m_b \left(\left(\frac{d_1^2 + d_1}{2} \right) - \left(\frac{d_2^2 + d_2}{2} \right) \right)$ since the information as to whether $d_i < d_\Lambda$,

$d_i = d_\Lambda$ or $d_i > d_\Lambda$ would be lost and there would be no way to know whether the gravitational interaction at d_1 or d_2 is attractive or repulsive (or one of each), thus no way to know if a body b is gravitationally accelerated or decelerated relative to a . For instance, if $d_2 > d_1$, b would accelerate away from a when $d_1 > d_\Lambda$ and $d_2 > d_\Lambda$ but would accelerate towards a when $d_1 < d_\Lambda$ and $d_2 < d_\Lambda$. Therefore, the gravitational interaction at each the initial and following positions must be calculated first, which gives the proper sign to each (negative meaning repulsive and positive meaning attractive) and only then should $\Delta G(a;b)$ be calculated. Finally, $\Delta G(a;b)$ has a different physical interpretation depending on whether $d_i < d_\Lambda$, $d_i = d_\Lambda$ or $d_i > d_\Lambda$.

So a body b moving away from a body a will be gravitationally decelerated until it reaches a distance d_Λ from which distance it will be accelerated. It follows that a particle that moves at a less than the speed of light will be accelerated if the distance it travels is greater than d_Λ (approximately 10MPS). The greater the distance from the source beyond d_Λ , the greater its speed will be when it reaches the Earth. Particles moving at the speed of light are unaffected (see [Why Nothing Moves Faster than the Speed of Light](#)).

The repulsive gravitational effect predicted by QGD between structures over large distances is supported by the recent discovery known as [the dipole repeller](#).

We have shown that the weak equivalence principle is a direct consequence of QGD's equation for gravity which itself is derived from QGD's axiom set.

However, it is essential to keep in mind that the acceleration of a first body relative to a second body is independent of the mass of the first body does not mean that the effect of gravity on an object, the change in momentum it produces, is independent of its mass.

But unlike gravitational acceleration, the resultant change in momentum is dependent on the mass of the accelerated body. A body a' that is n times as massive as a body a will experience a change in momentum n times greater. The measurement of acceleration alone does not provide a measurement of the effect gravity has on distinct bodies.

A major problem with classical mechanics description of gravity is how it relates force to acceleration and considers the change in momentum to be a consequence of the effect of a force on speed and not, as it should, the reverse. Classical momentum is also defined as the product of the speed of a body and its mass. Speed is function of time, which is a pure relational concept, and mass is a conventional definition and not a fundamental property of matter.

According to QGD, the momentum vector of object is an intrinsic property given by $\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$

where the mass, m_a , is the number of bounded $preons^{(+)}$ of a and each \vec{c}_i correspond to the

momentum vector of a bound $preon^{(+)}$. The speed of object is given by $\frac{\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|}{m_a}$.

Gravity affects the resultant trajectories of the component $preons^{(+)}$, which changes the momentum. The change in speed is a consequence of the change in momentum and not the reverse.

Given two object a and b both at the same distance from a massive structure, it is impossible to distinguish between them based on their respective acceleration, which makes acceleration the wrong property to measure if one wants to compare the effect of gravity on particles or structures.

Variations in the gravitational interaction affect directly and instantaneously the momentum of the interacting bodies. It is the variations in momentum that determine the variations in speed and not the reverse.

Comparison between the Newtonian and QGD Gravitational Accelerations

From $\Delta v_b = m_a \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right)$ we have

$$m_b \Delta v_b = m_a m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right) = \Delta G(a; b) \text{ which is equivalent to Newton's}$$

second law of motion relating force, mass and acceleration $F = m \Delta v_a$ where $F = \Delta G(a; b)$.

The equations are very similar and it would be tempting to equate Newton's second law and its QGD equation, but this cannot be done directly.

Newtonian gravity varies with distance and is time independent. However Newton's second law of motion when applied to gravity ignores the distance dependency but treats the force as if it were constant. And most importantly, despite the fact that Newtonian gravity is instantaneous (as must be its effects) Newtonian mechanics introduces a time dependency on the effect of gravitational acceleration. The introduction of the time dependency of the gravitational acceleration is not in agreement with Newton's law of gravity. And while the time dependency approximates its dependency on distance (since $\Delta d \propto \Delta t$ and $\vec{v}_b \propto \vec{v}_b$ where \vec{v}_b is the classically defined speed) it introduces delays on the action which according to Newton's law of gravity does not exist.

Newton's second law of motion applied to gravity gives $\Delta \vec{v}_b = \frac{\vec{G}(a; b) \Delta t}{m_b}$ where $\vec{G}(a; b)$

represents the Newtonian force of gravity. Since the QGD equation is $\Delta \vec{v}_b = \frac{\Delta \vec{G}(a; b)}{m_b}$, it

follows that $\vec{G}(a; b) \Delta t \approx \Delta \vec{G}(a; b)$. But the assumed time dependency of the effect introduces a delay in the effect of gravity on the momentum of a body while it should be instantaneous. So

for Newtonian mechanics we have $\frac{\Delta \vec{v}_b}{\Delta t} = \frac{\vec{G}(a; b)}{m_b}$ while in QGD $\Delta \vec{v}_b = \frac{\Delta \vec{P}_b}{m_b} = \frac{\Delta \vec{G}(a; b)}{m_b}$. So

the Newton's law of motion introduces a delay of $\Delta t = \frac{m_b \Delta \vec{v}_b}{\vec{G}(a; b)}$.

Such delays of the effect of gravitational acceleration are very small since the distance between two positions in quantum-geometrical space is fundamental, and it would be difficult if not impossible to detect over short variations in distance, especially if there are no changes in direction of the gravitationally accelerated body. But over an astronomical number of changes in direction, such as experienced by a planet orbiting the sun, the predicted delays would add up to observable differences with the observed motion of the planet. As we will discuss in detail

[later in this book](#) by removing the time dependency in accordance to QGD, Newtonian gravity can predict the precession of the perihelion of Mercury.

If correct, the discrepancy between Newtonian mechanics' prediction of the motion of Mercury and observation is due to the time dependency introduced when using Newton's second law of motion; incorrectly making the effect of an instantaneous force dependent on time.

It is also interesting to note that the application of general relativity to the motion of Mercury (or other bodies) does the exact opposite since the effect of a change in position of a body in a gravitational field instantly changes its direction because it instantly follows the predicted geodesics. This may explain why general relativity correctly predicts the precession of the perihelion of Mercury.

Non-Gravitational Interactions and Momentum

The momentum of a particle or structure may also change as the result of absorption of particles.

For example, if a absorbs a photon λ then $\vec{P}_a = \vec{P}_a + \vec{P}_\lambda$. Similarly, if it emits a photon then

$\vec{P}_a = \vec{P}_a - \vec{P}_\lambda$. Note that depending of the relative direction of a and the absorbed photon, \vec{P}_a

may be greater or smaller than \vec{P}_a .

The mass of particle or structure increases or is reduced by an amount that is equal to the mass of the absorbed or emitted photon (or other particle).

Since $v_a = \frac{\vec{P}_a + \vec{P}_\lambda}{m_a}$ and $\Delta v_a \approx \frac{\vec{P}_\lambda}{m_a}$ the acceleration is inversely proportional to the mass of the

object that is accelerated. Gravitational acceleration being independent of its mass, there is no equivalence between gravity and non-gravitational acceleration as suggested by Einstein's famous thought experiment. We will show that it is possible to distinguish the effect of gravity from constant acceleration because their effect on mass, momentum and energy are different for different bodies.

7. Transfer and Conservation of Momentum

Also, a consequence of the discreteness of space is that the momentum of an object a can only change by a multiple of its mass (each component $preon^{(+)}$ must overcome the effect of n-gravity which are discrete units). All changes in momentum obeys must obey the law $\Delta \|\vec{P}_a\| = xm_a$.

Changes in momentum due to variation in gravity are proportional to the mass of the body subjected to it so that $\|\Delta \vec{G}(a;b)\| = xm_a$ $\|\Delta \vec{P}_a\| = xm_a$ law since.

Gravity and variation in gravity between two objects are multiples of their masses of the object, but this is not the case for non-gravitational interactions.

For instance, the momentum of a photon will only in special cases be a multiple of the mass of the object it interacts with.

For instance, for an electron e^- and a photon γ . Then we have the three possibilities:

1. $\|\vec{P}_\gamma\| < xm_{e^-}$ or
2. $\|\vec{P}_\gamma\| = xm_{e^-}$ or
3. $\|\vec{P}_\gamma\| \geq xm_{e^-}$ where $x \in N^+$

In case 1, the momentum of the photon is below the minimum allowed change in momentum of the electron. The photon cannot be absorbed (become bounded) and so will be reflected or refracted depending on its trajectory relative to the electron.

In case 2, the photon will be absorbed and $\|\Delta \vec{P}_\gamma\| = xm_{e^-}$. In this case, all its $preons^{(+)}$ will become part of the electron's structure, the electron's mass will increase by m_γ its momentum by $\|\vec{P}_\lambda\|$.

In case 3, though the photon's momentum is greater than the minimum allowed change in momentum for a , absorption is not possible as it would imply a fractional change in the momentum of e^- and thus is forbidden (a fractional change in momentum would imply that material structure could move between $preons^{(-)}$ which is not possible since there is no space which can hold them).

The electron can absorb the higher momentum (or energy since for photons $\|\vec{P}_\gamma\| = E_\gamma$) but to respect the $\Delta\|\vec{P}_a\| = \chi m_a$ law it must simultaneously emit a photon γ' that will carry the excess momentum.

The emitted photon γ' is such that $\|\vec{P}_{\gamma'}\| = \|\vec{P}_\gamma\| - \left\lfloor \frac{\|\vec{P}_\gamma\|}{m_{e^-}} \right\rfloor m_{e^-}$.

This, we shall see later, describes why atomic electrons can only absorb photons have specific momentum and thus explain the emission and adsorption lines of elements.

Momentum Conservation and Impact Dynamics

A postulate of quantum-geometry dynamics is that space is fundamentally discrete (quantum-geometrical, in QGD terms). If as QGD suggests the discreteness of space exists at a scale that is orders of magnitude smaller than the [Planck scale](#) then the fundamental structure of space (and matter) lies way beyond the limits of the observable.

That said, the discreteness of space and matter, as described by QGD, carries unique consequences at observable scales. In fact, the laws that govern the dynamics of large systems can be derived from the laws governing space and matter at its most fundamental.

We will now re-examine observations which, when interpreted by QGD, supports its prediction of the quantum-geometrical structure of space, more specifically, we will show the law of conservation of momentum at the fundamental scale explain the conservation of momentum at larger scales.

The Physics of Collision and Conservation of Momentum

Three laws govern the physics of collision:

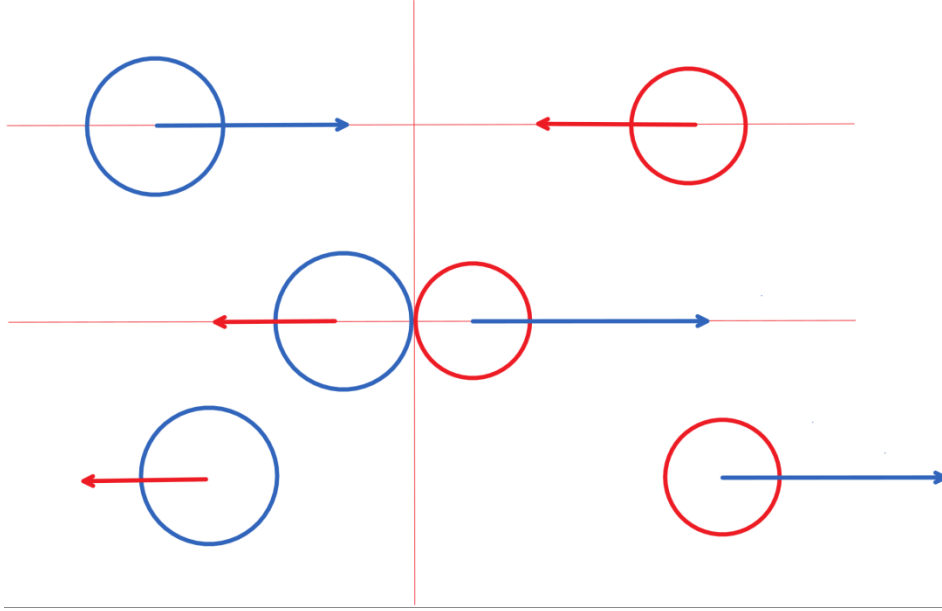
1. So, two objects cannot occupy the same space at the same time (a consequence of the preonic exclusion principle).
2. The momentum of particles is conserved in non-gravitational interactions.
3. Changes in the momentum of an object is a multiple of its mass or $\|\Delta\vec{P}_a\| = \chi m_a$.

For simplicity, let a and b be two rigid spheres of same volume with momentum \vec{P}_a and \vec{P}_b , which are set on a direct collision course as in the figure below.

When the spheres reach the position of impact, the first law applies. Neither sphere can occupy that position. So the spheres cannot move beyond the point of impact or, to be precise, the intersection of the volumes of the spheres along the line of impact, which is the line that passes through the centers of the spheres at impact.

To satisfy the second law, the spheres a and b in the simple example below must each emit photons whose momentums will be exactly those of a and b respectively. That is:

$$\sum_{i=1}^{n_a} m_{\gamma_i} c = \|\vec{P}_a\| \text{ and } \sum_{j=1}^{n_b} m_{\gamma_j} c = \|\vec{P}_b\| \text{ where } n_a \text{ and } n_b \text{ are respectively the numbers of photons}$$



emitted at impact by a and b .

The photons emitted by a will be absorbed by b , imparting it their momentum and the photons emitted by b will impart their momentum to a so that after impact $\vec{P}'_a = \sum_{i=1}^{n_b} m_{\gamma_i} c = \vec{P}_b$

and $\vec{P}'_b = \sum_{i=1}^{n_a} m_{\gamma_i} c = \vec{P}_a$ where \vec{P}'_a and \vec{P}'_b are respectively the momentums of a and b after impact.

As a result of the impact, the spheres will move in opposite direction at speed

$$v_a = \frac{\|\vec{P}_b\|}{m_a} \text{ and } v_b = \frac{\|\vec{P}_a\|}{m_b}.$$

Case 2

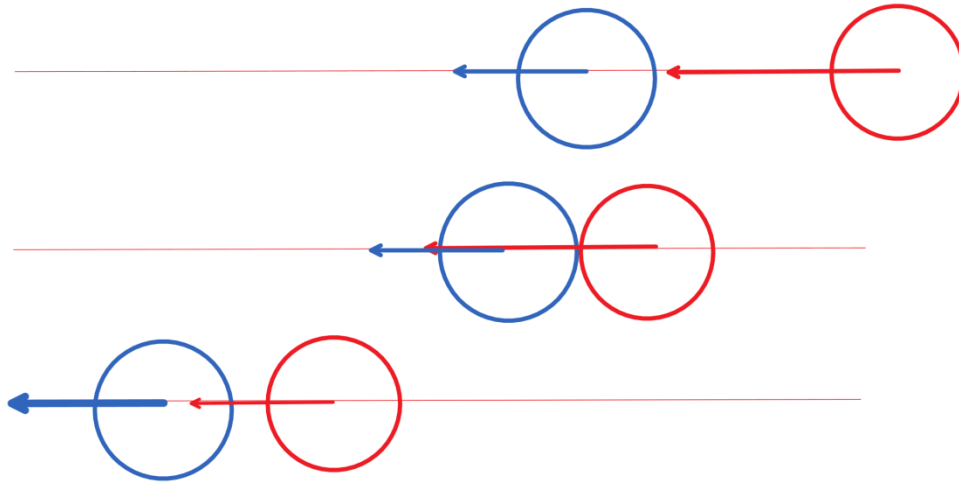
Consider two spheres of equal mass moving in the same direction as in the figure below.

Here, at the point of impact, the forbidden component of the momentum of a in direction of b is given by $(v_a - v_b)m_a$, but the component momentum of b in direction of a is equal to zero.

² Note that for simplicity, we ignored here the changes in the masses of the spheres due to emission and absorption of photons. These variations in mass will be taken into account when significant.

That is $\sum_{i=1}^{n_a} m_{\gamma_i} c = (v_a - v_b) m_a$ and $\sum_{j=1}^{n_b} m_{\gamma_j} c = 0$, hence after impact the momentums of a and b will be

$$\begin{aligned} \|\vec{P}'_a\| &= \|\vec{P}_a\| - (v_a - v_b) m_a \\ &= \|\vec{P}_a\| - \left(\frac{\|\vec{P}_a\|}{m_a} - v_b \right) m_a \\ &= m_a v_b \end{aligned}$$

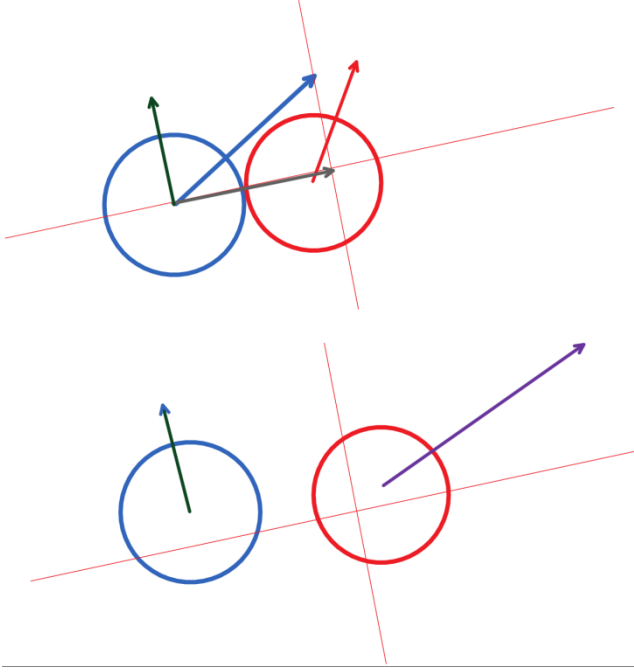


We can see that Newton's third law of motion is a direct consequence of the three laws governing collision physics but that it is not due, as Newton's third law implies, to the second body exerting a force equal magnitude and opposite direction, but to the loss of momentum of the first through the mechanism we have describe and which is equal to the momentum is imparts to the second body. Newton's third law of motion is special case of the laws of conservation of momentum of QGD.

Consider the same setup as above. The third law says that $\|\Delta\vec{P}_b\| = x m_b$. Now, if $\vec{P}_a < x m_b$, the momentum of a , which is the maximum momentum that it can impart, is smaller than the minimum allowable change in momentum of b . Hence b must emit back photons in opposite direction whose momentum is equal to the momentum of the photons emitted by a . Hence the Newton's third law of motion.

Case 3

So far we have discussed the special cases of the physics of collision for spheres of similar volume which trajectories coincide. The same laws apply for all cases and when we take into account different angles and directions we find that:



$$\sum_{i=1}^{n_a} m_{\gamma_i} c = (v_a - v_b) m_a \quad \text{and}$$

$\sum_{j=1}^{n_b} m_{\gamma_j} c = (v_b - v_a) m_b$ where v_a is the speed component of a towards b at the point of impact and v_b is the speed component of b towards a at the point of impact.

Now since $\|\Delta \vec{P}_a\| = x m_a$ and $\|\Delta \vec{P}_b\| = x' m_b$

and since $x m_a \leq \sum_{j=1}^{n_b} m_{\gamma_j} c < (x+1) m_a$

and $x' m_b \leq \sum_{i=1}^{n_a} m_{\gamma_i} c < (x'+1) m_b$, the

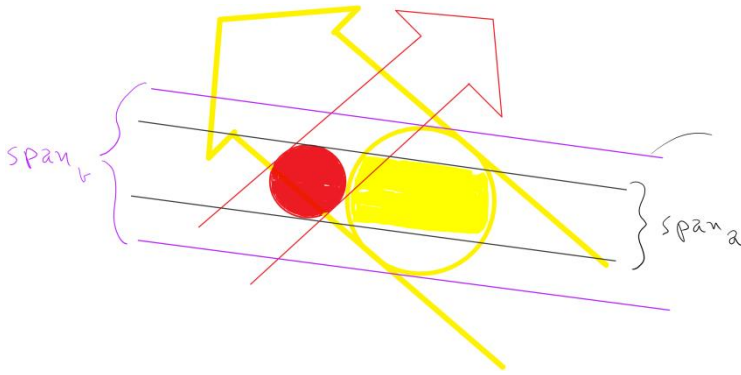
momentum carried by photons emitted by a that exceed the allowed change in momentum of b will be emitted, reflected or refracted (generally as heat) as will the momentum carried by photons emitted by b which exceed the allowed change in momentum of a .

We will now see how the laws that govern gravitational and non-gravitational change in momentum can be used to describe the dynamics of any system at larger scales.

Generalization of Momentum Transfer

Objects that collide are generally not spheres and even when they are, they are generally not of similar dimensions, mass, composition, etc.

If R_a and R_b are the regions occupied by a and b respectively prior to impact. If span_a is the regions of space spanned by a in direction of b and span_b that of b in direction of a then for bodies then:



$$\|\vec{P}_{a \rightarrow b}\| = (v_b - v_a) m_a \frac{R_a \cap S_a \cap S_b}{R_a}$$

and

$$\|\vec{P}_{b \rightarrow a}\| = (v_b - v_a) m_b \frac{R_b \cap S_a \cap S_b}{R_b}.$$

In the figure above, a is

represented by the sphere on the left and $R_a \cap S_a \cap S_b$ is shown in red. Similarly, $R_b \cap S_a \cap S_b$ is in yellow. In this special illustrated here, $R_a = R_a \cap S_a \cap S_b$ so that $\|\vec{P}_{a \rightarrow b}\| = (v_b - v_a)m_a$.

8. Axiomatic Derivations of Special and General Relativity

Though the axiom sets of QGD and those of the special and the general relativity are mutually exclusive, our theory is not exempt from having to explain observations and experiments; particularly those which confirm the predictions of the relativity theories.

We will now derive some of the key predictions of special relativity and general relativity and since a new theory must do more than explain what is satisfactorily explain current theories, we will also derive new predictions that will allow experiments to distinguish QGD from the relativity theories.

Constancy of the Speed of Light

Light is composed photons, themselves composites of *preons*⁽⁺⁾ which move in parallel directions.

The speed of a photon is thus

$$v_\gamma = \frac{\left\| \sum_{i=1}^{m_\gamma} \vec{c}_i \right\|}{m_\gamma} = \frac{\sum_{i=1}^{m_\gamma} \|\vec{c}_i\|}{m_\gamma} = \frac{m_\gamma c}{m_\gamma} = c$$
 which is the fundamental speed of *preons*⁽⁺⁾ and by definition constant.

Why nothing can move faster than the speed of light

We know that $v_a = \frac{\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|}{m_a}$ and that $\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\| \leq \sum_{i=1}^{m_a} \|\vec{c}_i\|$ then since $\frac{\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|}{m_a} \leq \frac{\sum_{i=1}^{m_a} \|\vec{c}_i\|}{m_a}$ and

$$\frac{\sum_{i=1}^{m_a} \|\vec{c}_i\|}{m_a} = \frac{m_a c}{m_a} = c$$
 it follows that $v_a \leq c$.

The Relation between Speed and the Rates of Clocks

QGD considers time to be a purely a relational concept. In other words, it proposes that time is not an aspect of physical reality. But if time does not exist, how then does QGD explain the different experimental results that support time dilation; the phenomenon predicted by special relativity and general relativity by which time for an object slows down as its speed increases or is submitted to increased gravitation interactions?

To explain the time dilation experiments we must remember that clocks do not measure time; they count the recurrences of a particular state of a periodic system. The most generic definition

possible of a clock is a system which periodically resumes an identifiable state coupled to a counting mechanism that counts the recurrences of that state.

Clocks are physical devices and thus, according to QGD, are made of molecules, which are made of atoms which are composed of particles; all of which are ultimately made of bounded *preons*⁽⁺⁾.

From the axiom of QGD, we find that the magnitude of the momentum vector of a *preon*⁽⁺⁾ is fundamental and invariable. The momentum vector is denoted by \vec{c} the momentum is $\|\vec{c}\| = c$.

We have shown that the momentum vector of a structure is given by $\vec{P}_a = \left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$ and its speed

by $v_a = \frac{\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|}{m_a}$. From these equations, it follows that the maximum possible speed of an

object a corresponds to the state at which all of its component *preons*⁽⁺⁾ move in the same direction. In such case we have $\left\| \sum_{i=1}^{m_a} \vec{c}_i \right\| = \sum_{i=1}^{m_a} \|\vec{c}_i\| = m_a c$ and $v_a = \frac{m_a c}{m_a} = c$. Note here that

$\sum_{i=1}^{m_a} \|\vec{c}_i\|$ corresponds to the energy of a so the maximum speed of an object can also be defined as the state at which its momentum is equal to its energy.

From the above we see that the speed of an object must be between 0 and c while all its component *preons*⁽⁺⁾ move at the fundamental speed of c .

Now whatever speed a clock may travel, the speed of its *preons*⁽⁺⁾ components is always equal to c . And since a clock's inner mechanisms which produce changes in states depends fundamentally on the interactions and motion of its component *preons*⁽⁺⁾, the rate at which any mechanism causing a given periodic state must be limited by the clock's slowest inner motion; the transversal speed of its component *preons*⁽⁺⁾.

Simple vector calculus shows that the transversal speed of bound *preons*⁽⁺⁾ is given by $\sqrt{c^2 - v_a^2}$ where v_a is the speed at which a clock a travels. It follows that the number of recurrences of a state, denoted t for ticks of a clock, produced over a given reference distance d_{ref} is proportional to the transversal speed of component *preons*⁽⁺⁾, that is

$\frac{\Delta t}{d_{ref}} \propto \sqrt{c^2 - v_a^2}$. As the speed at which a clock travels is increased, the rate at which it produces ticks slows down and becomes 0 when its speed reaches c .

We have thus explained the observed slowing down of periodic systems without using the concepts of time or time dilation.

The predictions of special relativity in regards to the slowing down of clocks (or any physical system whether periodic or not, or biological in the case of the twin paradox) are in agreement with QGD however, the QGD explanation is based on fundamental physical aspects of reality. Also, since according to QGD, mass, momentum, energy and speed are intrinsic properties of matter, their values are independent of any frame of reference, avoiding the paradoxes, contradictions and complications associated with frames of reference.

However, though both QGD and special relativity predict the speed dependency of the rates of clocks, there are important differences in their explanation of the phenomenon and the quantitative changes in rate. While for special relativity the effect is caused by a slowing down of time, QGD explains that it is a slowing down of the mechanisms clocks themselves.

If Δt and $\Delta t'$ are the number of ticks counted by two identical clocks counted travelling respectively at speeds v_a and v'_a over the same distance d_{ref} then QGD predicts that

$$\Delta t' = \Delta t \frac{\sqrt{c^2 - v_a'^2}}{\sqrt{c^2 - v_a^2}} = \Delta t \frac{\sqrt{1 - \frac{v_a'^2}{c^2}}}{\sqrt{1 - \frac{v_a^2}{c^2}}}.$$

The speeds in the above equation are absolute so cannot be directly compared to special relativity's equation for time dilation which is dependent on the speed of the one clock relative to that of the other. However, the special relativity equation can be derived by substituting for v_a the speed of the second clock relative to the first clock v , then v'_a must be the speed of the second clock relative to itself, that is $v'_a = 0$, substituting in the equation above we get

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} \text{ which is the special relativity equation describing time dilation.}$$

Then using the derivations $\Delta x' = v \Delta t' = \frac{v \Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{x_2 - x_1}{\sqrt{1 - \frac{v^2}{c^2}}}$, $y' = y$ and $z' = z$, we can easily

derive the relation between two inertial frames of reference.

The Relation between Gravity and the Rates of Clocks

We know that $v_a = \frac{\|\vec{P}_a\|}{m_a}$ then $\frac{\Delta t}{d_{ref}} \propto \sqrt{c^2 - v_a^2} = \sqrt{c^2 - \left(\frac{\|\vec{P}_a\|}{m_a}\right)^2}$. We have also shown that

gravity affects the orientation of the component $preons^{(+)}$ of structure so that

$\Delta \vec{P}_a = \Delta \vec{G}(a;b)$ and $\Delta \vec{v}_a = \frac{\Delta \vec{G}(a;b)}{m_a}$ and since $v'_a = \left\| \vec{v}_a + \frac{\Delta \vec{G}(a;b)}{m_a} \right\|$ in order to predict the

effect of gravity on the rates of clocks, all we need to do is substitute the appropriate value in

$$\Delta t' = \Delta t \frac{\sqrt{c^2 - v_a'^2}}{\sqrt{c^2 - v_a^2}} \text{ and we get } \Delta t' = \Delta t \frac{\sqrt{c^2 - \left\| \vec{v}_a + \frac{\Delta \vec{G}(a;b)}{m_a} \right\|^2}}{\sqrt{c^2 - v_a^2}} = \Delta t \frac{\sqrt{1 - \frac{\left\| \vec{v}_a + \frac{\Delta \vec{G}(a;b)}{m_a} \right\|^2}{c^2}}}{\sqrt{1 - \frac{v_a^2}{c^2}}}$$

And if $\Delta \vec{G}(a;b) = \vec{0}$ then the equation is reduced to $\Delta t' = \Delta t$.

As we can see, the greater the gravitational interaction between a clock and a body, the slower will be its rate of recurrence of a given periodic state. This prediction is also in agreement with general relativity's prediction of the slowing down of clocks by gravity.

Predictions

QGD is in agreement with special relativity and general relativity's predictions of the slowing down of clocks but it differs in its understanding of time. Time for the QGD being a relational concept is necessary to relate the states of dynamical systems to the states of reference dynamical systems that are clocks. Clocks are shown not to be measuring devices but counting devices which mark the recurrences of a particular state of a periodic system chosen as reference. So if clocks are understood to measure time, then time is simply the number of times a given change in state occurs over a distance. It is not physical quantity.

We have shown that the slowing down of clocks resulting from increases in speed or the effect gravity is explained not as a slowing down of time, but as a slowing down of their intrinsic mechanisms.

The effects of time dilation predicted by special relativity and general relativity are both

described by $\Delta t' = \Delta t \frac{\sqrt{c^2 - \left\| \vec{v}_a + \frac{\Delta \vec{G}(a;b)}{m_a} \right\|^2}}{\sqrt{c^2 - v_a^2}}$ since this equation takes into account both the

effect of the speed and gravity on a clock. Thus, if QGD is correct, the predictions of SR and GR are approximations of particular solutions of the QGD equation.

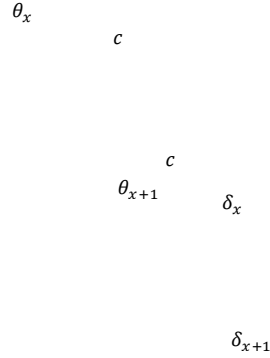
Although both general relativity and QGD's predict changes in the speed of clocks subjected to variations in the magnitude of the gravity effect, their predictions quantitatively differ. There is hope that, in the next few years, experiments such as [Atacama Large Millimeter/submillimeter Array](#) in Chile will discover pulsars moving in proximity to the supermassive black hole predicted to exist at the center of our galaxy (SGR A). The predictions of general relativity would then be tested against variations of the rate at which pulsars emit pulses as they are subjected to the intense gravity of the black hole. QGD makes distinct predictions which could also be tested against the same measurements.

Bending of light

The reader will recall that using the second law of motion for gravitational acceleration introduces time delays on the effect of gravity which is incompatible Newtonian gravity which is

instantaneous and, as we will see

now, is the cause of the discrepancies between the Newtonian predictions and observations.



According to QGD, photons are composed of *preons*⁽⁺⁾. It follows that photons interact gravitationally as do all other material structure.

Applying the [laws of motion](#) to describe the effect of gravity on the trajectory of a photon coming into proximity to the sun \odot we find that a photon γ changes direction at a position p_i by an angle θ_i given by

$$\theta_i = \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; \gamma) \right\| \cos \delta_i}{2\pi c}$$

where δ_i is the angle between the vector $\frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(S; \gamma)$ and the perpendicular to the vector

\vec{P}_γ (see top figure). The total angle of deflection θ of a photon is then

$$\theta = \sum_{-i}^i \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; \gamma) \cos \delta_i \right\|}{2\pi c}.$$

The acceleration towards the sun expressed as units of distance per units of time. At the speed c this corresponds to a displacement of the vector $\frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; \gamma)$ equal to the distance travelled by a photon in one second or c units of distance (figure on the right). Since

$$\theta_i = \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; \gamma) \cos \delta_i \right\|}{2\pi c} \text{ for}$$

non-delayed gravity and

$$\theta_{\Delta t} = \frac{\left\| \Delta \vec{G}(\odot; \gamma) \cos \delta \right\|}{2\pi * 2c} \text{ for delayed}$$

gravity then $\theta_{\Delta t} = \frac{\theta_i}{2}$ and

$$\theta = \sum_{-i}^i \frac{\left\| \vec{G}(\odot; \gamma) \cos \delta \right\|}{2\pi c} = 2\theta_{\Delta t}. \text{ QGD and non-delayed Newtonian gravity (which is a special}$$

case of QGD gravity) predicted angle of deflection θ is exactly twice the angle $\theta_{\Delta t}$ predicted by Newtonian mechanics, hence in agreement with general relativity and observations. That is for $\theta_{\Delta t} = .875''$ we get $\theta = 1.75''$. So Newtonian gravity, if correctly applied, gives the correct prediction.

As a side note, it is interesting that there has never been an explanation as to why the angle of deflection predicted by Newtonian mechanics is exactly half that of the observed deflection. Not one third, one quarter, seven sixteenth, but exactly half.

Precession of the Perihelion of Mercury

The time dependency introduced when Newton's second law of motion also causes errors in Newtonian mechanics predictions of the motion of planets which causes the discrepancy between the predicted position of the perihelion of Mercury and its observed precession. The

$$\text{general equation for the angle of deviation due to gravity is } \theta = \sum_{-i}^i \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(a; b) \cos \delta_i \right\|}{2\pi \left\| \vec{P}_b \right\|} \text{ so}$$

the angle of non-delayed gravitational deflection of Mercury from its momentum vector at a

given position is $\theta = \sum_{-i}^i \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \right\| \cos \delta_i}{2\pi \left\| \vec{P}_b \right\|}$. The angle for delayed gravity corresponds is

obtained after a displacement of the gravity vector equal to $\left\| \vec{v}_b \right\| \Delta t$ that is:

$$\theta_{\Delta t} = \sum_{-i}^i \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \right\| \cos \delta_i}{2\pi \left(\left\| \vec{P}_b \right\| + \left\| \vec{v}_b \right\| \Delta t \right)}.$$

Therefore, the angle of gravitational deflection for non-delayed gravity is greater from a given position p_x than for delayed gravity. The difference between θ and $\theta_{\Delta t}$ is the cause of the

discrepancy between observations of the position the perihelion and that predicted by Newtonian mechanics. So in order to correctly prediction the precession of the perihelion of Mercury, we need to reduce the effect of the time delays as much as possible. We can do so by making the interval Δt as small as possible. For a given position we have

$$\lim_{\Delta t_i \rightarrow 0} \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \right\| \cos \delta_i}{2\pi \left(\left\| \vec{P}_b \right\| + \left\| \vec{v}_b \right\| \Delta t_i \right)} = \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \right\| \cos \delta_i}{2\pi \left\| \vec{P}_b \right\|}.$$

And using the relation $\frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \approx \vec{G}(\odot; b)$ where $\vec{G}(\odot; b) \Delta t$ is the Newtonian gravity at a position p_i allows us to work in conventional units since

$$\lim_{\Delta t_i \rightarrow 0} \frac{\left\| \vec{G}(\odot; b) \right\| \Delta t_{i-1} \cos \delta_i}{2\pi \left(\left\| \vec{P}_b \right\| + \left\| \vec{v}_b \right\| \Delta t_i \right)} = \frac{\left\| \frac{\Delta}{p_{i-1} \rightarrow p_i} \vec{G}(\odot; b) \right\| \cos \delta_i}{2\pi \left\| \vec{P}_b \right\|}.$$

The angle of precession of the perihelion may then be obtained from initial position p_0 (in grey in the figure on the left) at a perihelion by calculating the position of the next perihelion (in red).

p_0
 p_0

The next figure compares the non-delayed gravity prediction for a single orbit of Mercury (in red) in red to the prediction from Newtonian mechanics delayed gravity.

o

$$\begin{matrix} p_2 \\ p_1 \\ p_0 \\ p_{-1} \\ p_{-2} \end{matrix}$$

Orbital Decay of Binary Systems

The mechanisms using which we described and explained the precession of the perihelion of Mercury in the preceding section also predicts the orbital decay of binary systems. Therefore we will not repeat the explanation here. Suffice to say all systems of gravitationally interacting systems are governed by the same laws and described by the same equations. QGD thus

o

$$\begin{matrix} p_2 \\ p_1 \\ p_0 \\ p_{-1} \\ p_{-2} \end{matrix} \quad \begin{matrix} p_{-2} \\ p_{-1} \\ p_0 \\ p_1 \\ p_2 \end{matrix}$$

explains that the observed orbital decay such as that of the Hulse-Taylor system is not due to loss of energy emitted as gravitational waves. The two figures illustrate how the QGD predictions (in red) diverge from that of Newtonian mechanics (in black).

The figure below extrapolates the orbital decay over the large number of orbits. As we see, the orbital decay will eventually leads to a collision of the two stars.



About the Relation Between Mass and Energy

As we have seen, the energy of a particle or structure is given by $E_a = \sum_{i=1}^{m_a} \|\vec{c}_i\| = m_a c$. Though similar in form to Einstein's equivalence equation, QGD's does not represent an equivalence but a proportionality relation between energy, mass and c which though numerically equal to c , the speed of light, here represents the intrinsic momentum of *preons*⁽⁺⁾. This description of energy explains and provides the fundamental grounds for the principle of conservation of energy.

According to QGD's interpretation, when a body is accelerated by gravity, its mass and energy are both conserved. What changes is the net orientation of its *preons*⁽⁺⁾ components. Hence,

the object's momentum, given as we have seen by $\|\vec{P}_a\| = \left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$, changes.

Applied to nuclear reactions, for example, we find that no mass is actually lost from its conversion to pure energy (there is no such thing as pure energy according to QGD). If the QGD prediction that photons have mass, a prediction that may be confirmed by deflection of light from the self-lensing binary systems, then the amount of mass that appears to have been converted to energy is exactly equal to the total mass of photons emitted as a result of the reaction. The so-called pure energy is actually the total momentum of the emitted photons. That is:

$m = \sum_{i=1}^n m_{\gamma_i}$ and $E = \sum_{i=1}^n m_{\gamma_i} c$ where m is the mass of the photons resulting from the reaction and E , the momentum carried by the photons. The reader will note that since the momentum vectors of the *preons*⁽⁺⁾ of photons are parallel to each other then $\left\| \sum_{i=1}^{m_\gamma} \vec{c}_i \right\| = \sum_{i=1}^{m_\gamma} \|\vec{c}_i\|$, that is momentum and the energy of a photon are numerically equal. However, it is important to keep in mind that though they can be numerically equivalent, momentum and energy are two distinct intrinsic properties.

The production of photons alone does not account for the total production of heat. Consider the nuclear reaction within a system S_1 containing n_1 particles resulting in S_2 , which contains n_2 particles (including the n photons produced by the reaction). Following QGD's axioms, we find that the heat of S_1 and S_2 are respectively given by $heat_{S_1} = \sum_{i=1}^{n_1} \|\vec{P}_i\|$ and

$$heat_{S_2} = \sum_{j=1}^{n_2} \|\vec{P}_j\| < \sum_{j=1}^n m_{\gamma_j} c.$$

The temperatures of S_1 and S_2 , immediately after the reaction, before the volume S_2

expands are respectively $temp_{S_1} = \frac{\sum_{i=1}^{n_1} \|\vec{P}_i\|}{Vol_{S_1}}$ and $temp_{S_2} = \frac{\sum_{j=1}^{n_2} \|\vec{P}_j\|}{Vol_{S_2}}$ where Vol_{S_1} is the volume of S_1 .

Implications

In its applications, the QGD equation relating energy, mass and the speed of light is similar to Einstein's equation. However, the two equations differ in some essential ways. The most obvious is in their interpretation of the physical meaning of the equal sign relating the left and right expressions of the equation. For QGD, the equal sign expresses a proportionality relation between energy and mass while Einstein's equation represents an equivalence relation.

Also, the equivalence interpretation of Einstein's equation implies the existence of pure energy and pure mass. QGD's axioms imply that mass and energy are distinct intrinsic properties of *preons*⁽⁺⁾ hence inseparable.

QGD's fundamental definitions of mass, energy, momentum and speed that can be applied to all systems regardless of scale.

9. Other Consequences of QGD's Gravitational Interaction Equation

Effects Attributed to Dark Matter

Another implication of the axiom set of QGD which will be discussed in detail in the cosmology section of this book follows what the initial state of the universe it predicts. In its initial state, the only matter was in the form of free *preons*⁽⁺⁾ which were isotropically distributed throughout quantum-geometrical space.

During the isotropic state, *preons*⁽⁺⁾, as a consequence of the attractive force acting between them, started to form the simplest of all particles; low mass photons and neutrinos. And because *preons*⁽⁺⁾ were distributed isotropically, so was the distribution of these newly formed photons. If QGD's description of the early stages of the universe is correct, then these isotropically distributed photons have been first observed in 1964 by Arno Penzias and Robert Wilson and correspond to the cosmic microwave background radiation.

If, as QGD predicts, most *preons*⁽⁺⁾ in the universe are still free, their gravitational effect on particles and structure may account for the dark matter effect.

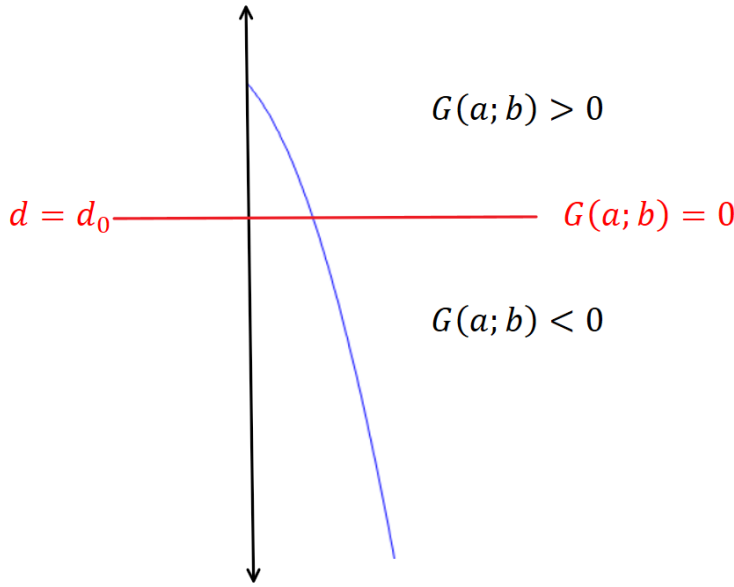
That *preons*⁽⁺⁾ interact too weakly with matter, hence with instrumentation, to be directly observed may explain why dark matter hasn't been detected directly. Individually, their mass is too small to have an effect on structures (or instruments) and their momentum insufficient to impart any measurable change in the momentum of larger particles or structures. But collectively, over a large enough regions of space, their cumulative mass will strongly interact with large structures or systems.

Effects Attributed to Dark Energy

QGD's equation for gravity allows for either attractive gravitational interaction, $G(a;b) > 0$ when $k > \frac{d^2 + d}{2}$, and repulsive gravitational interaction, $G(a;b) < 0$ when $k < \frac{d^2 + d}{2}$. For

distances shorter than the threshold distance d_Λ where $k = \frac{d^2 + d}{2}$, where $G(a;b) = 0$ regardless of m_a and m_b , p-gravity overcomes n-gravity, but at distances beyond d_Λ , gravity is repulsive and increases proportionally to the square of the distance. And acceleration being proportional to the derivative of gravity, QGD predicts a linear increase in acceleration as a function of distance.

QGD equation for gravity's prediction of repulsive gravity beyond the threshold distance may explain the acceleration we attribute to dark energy.



To resume, we have shown that the same equation 1., describes at very short distances the number of p-gravity interactions, hence the attractive gravity, is over a hundred orders of magnitude greater than gravity at large scale, 2., describes gravity at scales at which we apply Newtonian gravity, and 3., that at very large scale the equation accounts for the

effect we attribute to dark energy.

It follows that for distances between material structures greater than the threshold distance d_Λ , and assuming there is no matter in the space that separates them, the gravitational interaction will be repulsive and proportional to the square of the distance beyond d_Λ , resulting in a gravitational acceleration proportional the distance.

We have also shown that the effect we attribute to dark matter can be the gravitational effect of free *preons*⁽⁺⁾ over large regions of space.

The Weak Equivalence Principle

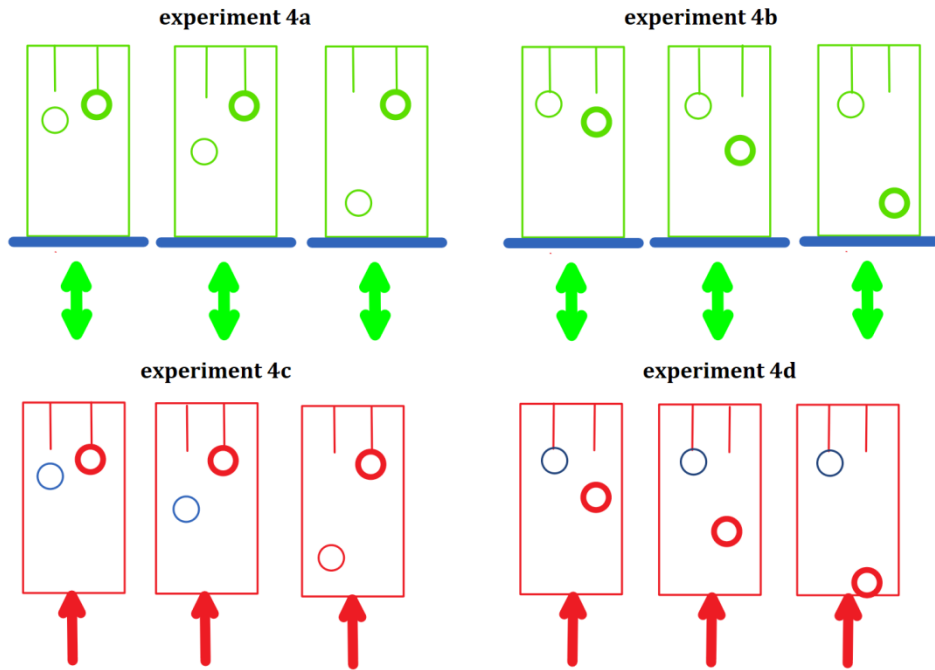
According to QGD, there is only one definition of mass: the intrinsic mass of an object being simply the number of *preons*⁽⁺⁾ it contains. The intrinsic mass determines not only the effect of gravity but all non-gravitational effect.

The gravitational mass is that property which determines the magnitude of gravitational acceleration while the inertial mass determines the magnitude of non-gravitational acceleration. It is important in describing a dynamic system that we understand that the distinction made between the gravitational and inertial masses are actually distinctions between gravitational and non-gravitational effects. Doing so, we will show that the intrinsic mass determines both gravitational and non-gravitational effects and that these effects are very distinct, thus distinguishable.

The acceleration of an object is given by $\Delta v_a = \frac{\|\Delta \vec{P}_a\|}{m_a}$ where $\|\Delta \vec{P}_a\| = \|\Delta \vec{G}\|$ for gravitational acceleration and $\|\Delta \vec{P}_a\| = \|\vec{F}\|$ for non-gravitational force \vec{F} imparting momentum to a . From $\Delta v_a = \frac{\|\Delta \vec{G}\|}{m_a} = \frac{1}{m_a} m_a m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right) = m_b \left(\left(k - \frac{d_1^2 + d_1}{2} \right) - \left(k - \frac{d_2^2 + d_2}{2} \right) \right)$ we know that gravitational acceleration is independent of the mass of the accelerated body, while $\Delta v_a = \frac{\|\vec{F}\|}{m_a}$ tells us that non-gravitational acceleration is inversely proportional to the mass of the accelerated body.

Let us consider the experiments represented in the figure below which based on Einstein's famous thought experiment.

The green rectangles represent a room at rest relative to Earth's gravitational field.



The Earth and green room dynamics is described by the equation $\vec{v}_{\boxed{g}} = \frac{\vec{P}_{\boxed{g}}}{m_{\boxed{g}}} = \frac{\vec{P}_{\boxed{E}}}{m_{\boxed{E}}} = \vec{v}_{\boxed{E}}$

where \boxed{g} represents the green room and \boxed{E} the Earth. Applying the laws of momentum [discussed earlier](#), we know that green room and the Earth are moving at the same speed hence, since $(v_{\boxed{g}} - v_{\boxed{E}})m_{\boxed{g}} = 0$ and $(v_{\boxed{E}} - v_{\boxed{g}})m_{\boxed{E}} = 0$ there is no momentum transfer between the

Earth and the green room, consequently no non-gravitational acceleration. And since there is no change in distance between \boxed{g} and $\boxed{\mathcal{E}}$, there is no variation in the gravity, so no gravitational acceleration either.

The red room is in region of space where the effect of gravity is negligible. A non-gravitational force imparts momentum \vec{F} to the red room from the floor up.

Einstein's thought experiment assumes that it is possible to apply a force which will accelerate the red room so that, to an observer within the room, the acceleration will be indistinguishable from that of gravity. That is, He assumes that $\vec{F} = \Delta\vec{G}$.

Before going into a full description of the experiment, we need to keep in mind the distinctions between gravitational acceleration and non-gravitational acceleration. For one, gravitational acceleration of body is independent of its mass while non-gravitational acceleration of a body is

inversely proportional to its mass. That is: $\Delta\vec{v}_a = \frac{(\vec{v}_F - \vec{v}_a)m_{\vec{F}}}{m_a}$ where \vec{v}_F is the speed of the

particles carrying the momentum \vec{F} (in the case of a rocket engine, this is the speed of the molecules of gas produced by the engine which interact with the room) and v_a the speed of the

room. It follows that we can set $\vec{F} = \Delta\vec{G}$ for a given m_a but for an object of mass $m_b \neq m_a$, we

can have $\vec{F} = \Delta\vec{G}$ but $\vec{F} \neq \vec{F}'$ and $\Delta\vec{v}_a = \frac{(\vec{v}_F - \vec{v}_a)m_{\vec{F}}}{m_a} \neq \frac{(\vec{v}_F - \vec{v}_b)m_{\vec{F}}}{m_b} = \Delta\vec{v}_b$. Which means

that, to maintain an acceleration equivalent to gravitational acceleration, \vec{F} must be adjusted to take into account the mass of the accelerated to compensate for its speed since the imparted momentum of a rocket engine (or any other form of propulsion) decreases as the speed increases.

Returning to experiment 4, the green and red rooms will have the same mass and composition. In each room, there will be a set of two spheres of mass m_a and m_b where $m_a < m_b$. In the rooms initial state the spheres are suspended from rods fixed to the ceilings. The spheres can be released on command. In each of the room is an observer that is cut off from the outside world. They have no clue as to which of the two rooms they are in. The observers however, being experiment physicists, are trusted to measure the accelerations of the spheres in the two experiments and see if they can determine whether the room each is in is at rest in a gravitational field or uniformly accelerated.

In the first experiment, the spheres with mass m_a will be dropped in each room. In the second experiment, from the same initial state, spheres with mass m_b will be dropped. The observers will compare the results.

The green room observer finds that both spheres have the same rate of acceleration relative to the room despite having different masses. He finds this to be consistent with gravitational acceleration, but cannot exclude on these two experiments alone that he may be in a uniformly accelerated room.

The red room observer however finds that rate of acceleration of the a sphere is lower than the rate of acceleration of the more massive b sphere. His observations of the accelerations of the spheres being inconsistent with gravitational acceleration he must conclude that the room is accelerated by an external non-gravitational force \vec{F} .

Furthermore, being a physicist, the red room observer knows that at the moment a sphere is released, the momentum imparted by \vec{F} is no longer transferred to the sphere. The sphere stops accelerating instantly and will move at the speed it had at the moment of its. Therefore, it is the room that is accelerated and not the sphere. The acceleration of the red room in its

initial state is $\Delta v_{[r]} = \frac{\|\Delta \vec{F}\|}{m_{[r]} + m_a + m_b}$. At the moment the a sphere is released, there is a

sudden change in the rate of acceleration of the room given by

$\Delta \Delta v'_{[r]} = \frac{\|\vec{F}\|}{m_{[r]} + m_b} - \frac{\|\vec{F}\|}{m_{[r]} + m_a + m_b}$. The change the rate of acceleration after the release of

sphere b is $\Delta \Delta v'_{[r]} = \frac{\|\vec{F}\|}{m_{[r]} + m_a} - \frac{\|\vec{F}\|}{m_{[r]} + m_a + m_b}$. The higher variation the in the rate of

acceleration after the release of b is seen from within the room as a larger acceleration of b relative to the room.

So, it appears that observers can easily distinguish between being in a room at rest in a gravitational field from being in a uniformly accelerated room away from any significant gravitational field. This appears to invalidate the weak equivalence principle. Being an experimental physicist, the observer in the red room requires confirmation of his observation. He decides to repeat the experiment. After all, one experiment is not enough and one has to be able to reproduce the results before doing something so drastic as to refute the weak equivalence principle.

Again the more massive sphere accelerates faster than the lighter sphere, but something is different. The acceleration rates of sphere a and sphere b in the second set of experiments are slower than the accelerations of the same spheres in the first set of experiments. After conducting a few more experiments he finds the observations to be consistent with

$\Delta \vec{P}_{[r]} = (v_{\vec{F}} - v_{[r]}) m_{\vec{F}}$ and concludes that the momentum imparted by the non-gravitational force decreases as speed of the room increases which allows him to predict that the maximum

possible speed the red room can achieve is $\vec{v}_{\square} = \vec{v}_{\tilde{F}}$ at which speed $\Delta\vec{P}_{\square} = (v_{\tilde{F}} - v_{\square})m_{\tilde{F}} = 0$

and $\Delta v_{\square} = \frac{\Delta\vec{P}_{\square}}{m_{\square}} = 0$.

If experiments confirm QGD predictions that:

- Gravitational acceleration and non-gravitational acceleration are not equivalent then
 - The weak equivalence principle is falsified
- The outcome of an experiment may be affected by the speed of the laboratory then
 - The strong equivalence principle is falsified

10. Conclusion

We have shown that from a simple consistent axiom set, a theory can be derived that can describe dynamic systems at different scales in a manner that is consistent with observational and experimental data. However, we understand any number of theories can explain observations *a posteriori* and that the only valid test of a theory is the experimental or observational confirmation of predictions that are original to it.

Testing some predictions quantum-geometry dynamics require new observations while others may need nothing more than reanalysing data already accumulated from the observations from the different telescopes and experiments. It is our hope that physicists and astrophysicists find the arguments of this paper sufficiently compelling to put QGD's predictions to the test.

Further reading:

For a more detailed discussion or applications of QGD to other areas of physics, see [Introduction to Quantum-Geometry Dynamics](#).