Deriving Testable Predictions from QGD

The usefulness of quantum-geometry dynamics as a physics theory depends entirely on whether its predictions can be tested, hence measured. This means that the quantities used in its equations must be expressible in measurable units.

We have explained earlier the relationship between the intrinsic velocity of light $\vec{c}$, the metric velocity $\overset{\mapsto}{c}$ (which the displacement in quantum-geometrical space during that occurs during an interval t) and $\underset{\leftrightarrow}{\overset{\mapsto}{c}}$, the measured two-way velocity of light.

Most important are the relations $\overset{\mapsto}{c} \propto \vec{c}$ and $\underset{\leftrightarrow}{\overset{\mapsto}{c}} \propto \overset{\mapsto}{c}$ since they allow us to relate the intrinsic velocity of light to the two-way velocity of light, hence provide a bridge between the discrete fundamental units of QGD and a measurable quantity, the two-way velocity of light.

A two-way measurement of the velocity of light cancels the relative velocity of an inertial frame of reference which QGD predicts would be added to or subtracted from $\underset{\leftrightarrow}{\overset{\mapsto}{c}}$. QGD thus predict that one-way measurements of the velocity of light differs from two-way measurements and unlike two-way measurements are not constant.

In the next sections, we propose a way to measure the one-way velocity of light and show how this can be applied to derive the metric velocity of any object from its relative velocity. That is, we may find that the velocity of an object relative to space itself.

One-way Measurement of c

The measurement experiment we describe below assumes the consistency of two-way velocity of light which as we have shown here is direct consequence of QGD's axiom set.

The clocks *A* and *B* have similar mechanisms which include memory, capability to transmit and receive timestamp encoded of light signals. The clocks are kept at a constant distance relative to each other which can be tested using the time of flight in two-way measurement.

There is no prior requirement to synchronize the clocks before they are moved.

In step 1 of synchronization, clock *A* will send a light signal that will be reflected back from clock *B*. The delay between the transmission and reception of reflected signal will be used to calculate $\underset{A\leftrightarrow B}{\overset{\mapsto}{c}}$, the two-way velocity of light from *A* to *B* to *A*. Step 2 will give $\underset{B\leftrightarrow A}{\overset{\mapsto}{c}}$,

In step 3, clock *A* will transmit the value $\underset{A\leftrightarrow B}{\overset{\mapsto}{c}}$ and timestamp of time of transmission the signal in step 1 to clock *B*. Clock *B* will compare the two two-way measurements.

If $\underset{A\leftrightarrow B}{\overset{\mapsto}{c}} = \underset{B\leftrightarrow A}{\overset{\mapsto}{c}}$, the clock *B* will proceed to step 4 and using the difference between the timestamps of step 1 and step 2, will synchronize itself to clock *A*.

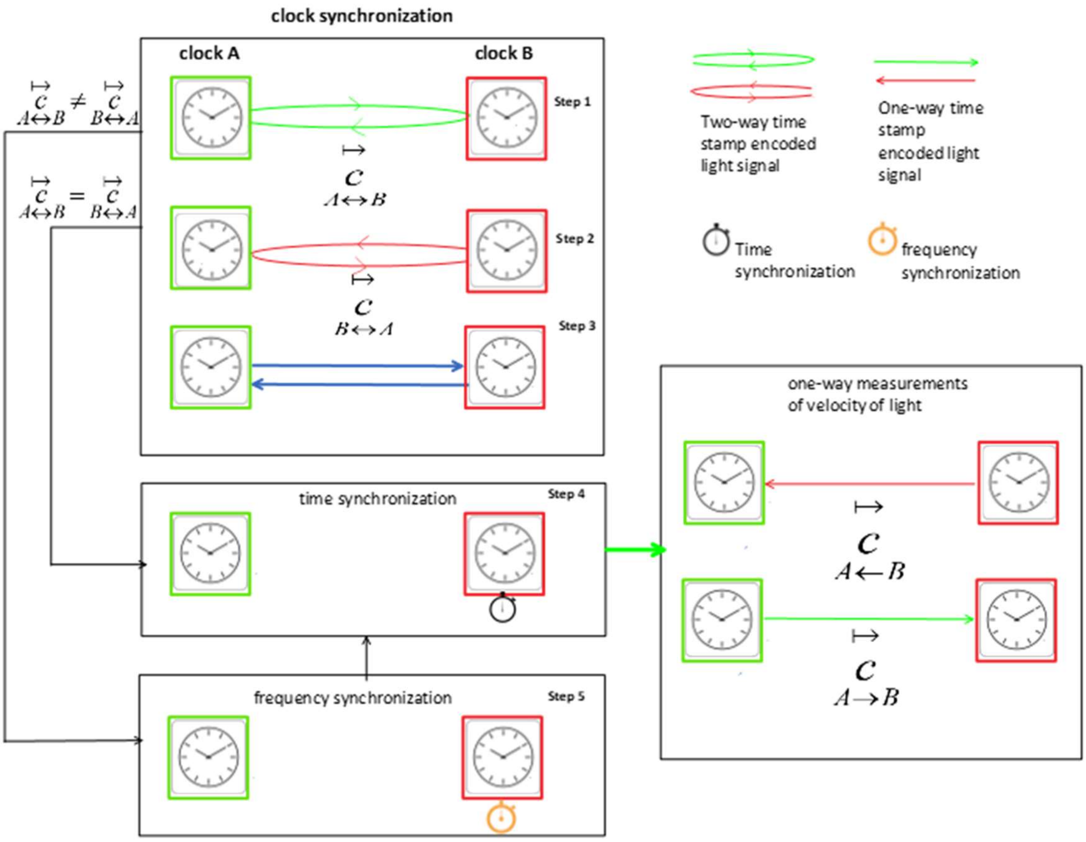
If $\underset{A\leftrightarrow B}{\overset{\mapsto}{c}} \neq \underset{B\leftrightarrow A}{\overset{\mapsto}{c}}$, then we will proceed to step 5. Clock *B* will adjust its frequency so that $\underset{B\leftrightarrow A}{t} = \underset{A\leftrightarrow B}{t}$ and $\underset{B\leftrightarrow A}{\overset{\mapsto}{c}} = \underset{A\leftrightarrow B}{\overset{\mapsto}{c}}$ then execute step 4 for time synchronization.

Synchronization of clock *A* and *B* can be checked by executing the synchronization steps again. Once synchronization is confirmed, we can proceed to one-way measurements of the velocity of light from *A* to *B*, $\underset{A\to B}{\overset{\mapsto}{c}}$ and from *B* to *A*, $\underset{B\to A}{\overset{\mapsto}{c}}$.

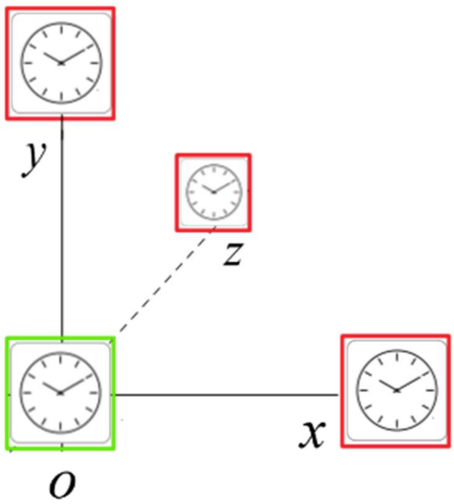
Clock *A* will send a timestamp signal to *B*. *B* will compare to timestamp of the signa from *A* to the time of detection of the signal to establish time of flight and calculate $\underset{A\to B}{\overset{\mapsto}{c}}$.

Clock *A* will similarly derive $\underset{B\to A}{\overset{\mapsto}{c}}$ from the timestamp signal from clock *B*.

The method of synchronization we described above compensates for effects on the rate of clocks predicted by relativity or QGD. A flowchart describing the synchronization procedure and measurements of one-way velocity of light is shown below.



If QGD's prediction that one-way velocity measurements are not constant, then the difference between the two-way velocity and one-way velocity is attributable to the <u>metric velocity component of the clocks along the axis between them</u>. That is $\overset{\mapsto}{v}_{A\to B} = \overset{\mapsto}{c}_{A\to B} - \overset{\mapsto}{c}_{\leftrightarrow}$. For the metric velocity of an object, we must first create a setup similar to that on the left synchronized as we described above.



$\overset{\mapsto}{v}_o = \overset{\mapsto}{v}_{o\to x} + \overset{\mapsto}{v}_{o\to y} + \overset{\mapsto}{v}_{o\to z}$ where $\overset{\mapsto}{v}_o$ is the metric velocity of clock o.

Metric Velocity of an Object

The metric velocity of any object is then

$\overset{\mapsto}{v}_a = \vec{v}_{a_{rel}} + \overset{\mapsto}{v}_o$, where $\overset{\mapsto}{v}_a$ is the metric velocity of object a, $\vec{v}_{a_{rel}}$ is its measured velocity relative to the to clock o and $\overset{\mapsto}{v}_o$ is the metric velocity of clock o.

Since quantum-geometrical space is finite and static, the derived metric velocity of any object is absolute thus observer independent.

According to QGD, all fundamental properties are associated with $preons^{(+)}$ and $preons^{(-)}$, and because they are intrinsic, they cannot be directly measured. However, the relations between physical quantities described by QGD remain valid when substituting metric properties for intrinsic properties. For example, the metric velocity of any object is proportional to its intrinsic, we can use substitute the former for the latter in a QGD equation if all other quantities in the equation are also metric.

Intrinsic Properties and their Metric Counterparts

Distance

$$\overset{\mapsto}{d} \propto d$$

Mass

$$\overset{\mapsto}{m}_a \propto m_a$$

The metric mass of a body may be obtained from the metric gravitational acceleration it imparts to reference body. However, one must remember that the metric gravitational acceleration is the rate of change of the metric velocity (not the rate of change of the velocity relative to the body) and must be derived as described above.

Velocity

$$\overset{\mapsto}{v}_a \propto \vec{v}_a$$

Momentum

Since $\dfrac{\vec{P}_a}{m_a} = \vec{v}_a$ and

$\overset{\mapsto}{P}_a = \overset{\mapsto}{m}_a \overset{\mapsto}{v}_a$ and

$\overset{\mapsto}{v}_a \propto \vec{v}_a$ then

$$\overset{\mapsto}{P}_a \propto \vec{P}_a$$

Constants

There are three constants in QGD:

$\vec{c}$, the fundamental momentum, which is also numerically equal to the velocity of $preons^{(+)}$ and consequently the velocity of photons.

k , the ratio between the magnitude of a unit of p-gravity over the magnitude of a unit of n-gravity.

d_Λ , the distance between two objects at which p-gravity and n-gravity cancel each other out.

Gravity

Since $\overset{\mapsto}{G}(a;b)=\overset{\mapsto}{m_a}\overset{\mapsto}{m_b}\left(k-\frac{\overset{\mapsto}{d}^2+\overset{\mapsto}{d}}{2}\right)$ then $\overset{\mapsto}{G}(a;b)\propto\vec{G}(a;b)$ and $\Delta\overset{\mapsto}{P_a}=\Delta\overset{\mapsto}{G}(a;b)=\Delta\overset{\mapsto}{P_b}$

where $\Delta\overset{\mapsto}{P_a}$ and $\Delta\overset{\mapsto}{P_b}$ are respectively the gravitationally induced change in momentum to objects a and b.

And since $\Delta\vec{v}_a=\frac{\Delta\vec{G}}{m_a}$ we have $\Delta\overset{\mapsto}{v_a}=\frac{\Delta\overset{\mapsto}{G}}{\overset{\mapsto}{m_a}}$. It is important to remember that in QGD, an increase in momentum is not a consequence of an increase in velocity. Increase in velocity is a consequence of an increase in of the intrinsic momentum as described in the chapter titled Forces, Interactions and the Laws of Momentum.

Note: When testing predictions against observations, metric value must be derived from measurements.

Assigning Value to k

QGD's equation for gravitational interactions is $G(a;b)=m_am_b\left(k-\frac{d^2+d}{2}\right)$ where m_a and m_b are the masses of objects of a and b . From the question we can predict that $G(a;b)=0$ when $k=\frac{d_\Lambda^2+d_\Lambda}{2}$ (d_Λ is the threshold distance beyond which gravity becomes repulsive[25]).

[25] for $d>d_\Lambda$ gravity becomes negative and is, as we explained, is responsible for the effect we call dark energy

Recent observations[26] suggest that $d_\Lambda \approx 10Mpc$ in which case $k \approx 4.5*10^{34}$ when using the meter as unit of distance in the gravity equation.

Rest Mass and Relativistic Mass

Unless an object absorbs particle (which it does only when non-gravitational forces are applied to a body) the mass of an object does not change as a function of its velocity.

The mass remains equal to the number of $preons^{(+)}$ it contains. What changes under the influence of gravity is the net orientation of their components $preons^{(+)}$, what we call its momentum given by the equation $\left\|\vec{P}_a\right\| = \left\|\sum_{i=1}^{m_a} \vec{c}_i\right\|$. The magnitude of $\vec{P}_a$ increases in towards b when $G(a;b) > 0$ and increases away from b when $G(a;b) < 0$ but as we explained it mass m_a or its energy $\sum_{i=1}^{m_a}\left\|\vec{c}_i\right\|$ remain constant.[27]

The relation between mass and energy expressed by $E_a = \sum_{i=1}^{m_a}\left\|\vec{c}_i\right\| = m_a c$ where, if we may remind the reader, the "=" sign symbolizes is a proportionality relation and not and equivalence as interpreted by special relativity. Here again, the relativistic and QGD mass are one and the same.

Application to States of Gravitationally Interacting Bodies

The two bodies systems described by the simplified gravitational interaction equation is the basis of the state matrix used to describe the behaviour of a system composed of n gravitationally interacting bodies.

The change in momentum due to gravitational interaction is given by

$$\Delta\vec{P}_a = \Delta G_{1\to 2}(a;b) = \frac{\left\|\vec{G}_2(a;b)\right\| - \left\|\vec{G}_1(a;b)\right\|\cos(\theta)}{\left\|\vec{G}_2(a;b)\right\|}\vec{G}_2(a;b) \qquad (1)$$

where θ is the angle between $\vec{G}_1(a;b)$ and $\vec{G}_2(a;b)$ which are respectively the gravitational vectors between a and b in states 1 and 2 and $\Delta G_{1\to 2}(a;b)$ is understood to be the

[26] Dark energy and key physical parameters of clusters of galaxies http://arxiv.org/abs/1206.1433

[27] A body is at rest if its momentum is equal to zero. This implies that a body is at rest if $\vec{P}_a = \vec{0}$ which implies that its metric momentum and metric velocity are null vectors.

difference in the magnitude of the gravitational interaction between a and b from state 1 to state 2 (or $1 \to 2$)

For a system consisting of n gravitationally interacting bodies,

$$\Delta\vec{P}_{a_{i_{s+1}}} = \mathop{\Delta\vec{G}}_{j=1}^{n}\left(a_{i_s};a_{j_{s+1}}\right) = \sum_{j=1}^{n} \frac{\left\|\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)\right\| - \left\|\vec{G}_{s}\left(a_{i_s};a_{j_{s+1}}\right)\right\|\cos(\theta)}{\left\|\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)\right\|}\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right) \qquad (2)$$

where a_i and a_j are gravitationally interacting astrophysical bodies of the system, $j \neq i$ and s and $s+1$ are successive states of the system (a state being understood as the momentum vectors of the bodies of a system at given co-existing positions of the bodies) and $a_{i|s+x}$ is the body a_i and its position when at the state $s+x$. The position itself is denoted $\varepsilon_{a_i|s+x}$.

In order to plot the evolution in space of such a system, we must choose one of the bodies as a reference so that the motions of the others will be calculated relative to it. A reference distance travelled by our reference body is chosen, d_{ref} , which can be as small as the fundamental unit of distance (the leap between two $preons^{(-)}$ or *preonic leap*) but minimally small enough as to accurately follow the changes in the momentum vectors resulting from changes in position and gravitational interactions between the bodies.

So given an initial state s , the state $s+1$ corresponds to the state described by the positions and momentum vectors of the bodies of the system after the reference body travels a distance of d_{ref} . For simplicity, we will assign a_1 to the reference body.

$$s+1 = \begin{Bmatrix} \vec{P}_{a_{1|s+1}} = \vec{P}_{a_{1|s}} \mp \Delta \mathop{\vec{G}}_{j=1}^{n}\left(a_{1|s};a_{j|s+1}\right) & | & \varepsilon_{a_1|s+1} \\ \ldots & | & \ldots \\ \vec{P}_{a_{n|s+1}} = \vec{P}_{a_{n|s}} \mp \Delta \mathop{\vec{G}}_{j=1}^{n}\left(a_{n|s};a_{j|s+1}\right) & | & \varepsilon_{a_n|s+1} \end{Bmatrix}$$

Using the above state matrix, the evolution of a system from one state to the next is obtained by simultaneously calculating the change in the momentum vectors from the variation in the gravitational interaction between bodies resulting from their change in position. Changes in the momentum vectors have are as explained earlier. Changes in position are given by $\varepsilon_{a_i|s+1} = \varepsilon_{a_i|s} + \frac{v_{a_i}}{v_{a_1}}\frac{d_{ref}}{\left\|\vec{P}_{a_i}\right\|}\vec{P}_{a_i}$. The distance travelled by a_i from s to $s+1$ is $\frac{v_{a_i}}{v_{a_1}}d_{ref}$ (for $j=1$, the distance becomes simply d_{ref}) and distance between two bodies of the system at state $s+x$ is $d_{a_i;a_j|s+x} = \varepsilon_{a_i|s+x} - \varepsilon_{a_j|s+x}$.

Of course, we find that for $i=j$, then $d_{a_i;a_j|s+x}=0$, so that

$$\begin{aligned}
\left\|\Delta\vec{G}_{s+1}\left(a_{i|s+1};a_{j|s+1}\right)\right\| &= \left\|\vec{G}\left(a_{i|s+1};a_{i|s+1}\right)\right\| - \left\|\vec{G}\left(a_{i|s};a_{i|s}\right)\right\| \\
&= m_a m_a\left(k - \frac{d^2{}_{a_i;a_i|s+1} - d_{a_i;a_j|s+1}}{2}\right) - m_a m_a\left(k - \frac{d^2{}_{a_i;a_i|s} - d_{a_i;a_i|s}}{2}\right), \\
&= m_a m_a k - m_a m_a k \\
&= 0
\end{aligned}$$

the variation in the gravitational interaction between a body with itself is equal to zero, which implies that its momentum vector will remain unchanged unless $n>1$ and $\overset{n}{\underset{j=1}{\Delta\vec{G}}}\left(a_{n|s};a_{j|s+1}\right)\neq 0$. This is the QGD explanation of the first law of motion.

Note also that for an object a_j freefalling towards an object a_i , $\theta = 0$ so equation (2) becomes

$$\Delta\vec{P}_{a_{i_{s+1}}} = \overset{n}{\underset{j=1}{\Delta\vec{G}}}\left(a_{i_s};a_{j_{s+1}}\right) = \frac{\left\|\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)\right\| - \left\|\vec{G}_s\left(a_{i_s};a_{j_{s+1}}\right)\right\|}{\left\|\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)\right\|}\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)$$ and

$$\left\|\overset{n}{\underset{j=1}{\Delta\vec{G}}}\left(a_{i_s};a_{j_{s+1}}\right)\right\| = \left\|\frac{\left\|\vec{G}_{s+1}\left(a_{i_s};a_{j_{s+1}}\right)\right\| - \left\|\vec{G}_s\left(a_{i_s};a_{j_{s+1}}\right)\right\|}{\left\|\vec{G}_{s+1}\left(a_{i_{s+1}};a_{j_{s+1}}\right)\right\|}\vec{G}_{s+1}\left(a_{i_{s+1}};a_{j_{s+1}}\right)\right\| = \left\|\vec{G}_{s+1}\left(a_{i_{s+1}};a_{j_{s+1}}\right)\right\| - \left\|\vec{G}_s\left(a_{i_s};a_{j_{s+1}}\right)\right\|$$

Measurements of the Intrinsic Speed of a Distant Light Source

Once the metric velocity of the earth is known, their effects on the light received from a distant source can be factored out. Then, using the QGD's description of the redshift effect, we may calculate the metric velocity of the distant light source at the time the light was emitted.

However, a much better option (when such option becomes technically feasible) would be the measurement of variations in gravitational interactions with distant objects we discussed here and which would provide current instantaneous position and velocity.