

On the Relations between Local and Non-Local Interactions

Locality is the notion that spatially separated systems are independent. That is, an event which affects one system cannot affect another. All such events, according to QGD, are [non-gravitational interactions](#). The terms “local” and “non-gravitational” are here interchangeable.

QGD predicts that gravitational effects are Instantaneous, and since local events always cause changes in momentum and mass, hence affects the gravitational interactions between the objects of the events and all other objects in the universe, then no system is independent. All local events have non-local effects, and all non-local events are local effects. Readers may reasonably object to the idea of instantaneous gravity which by all account has been proven to move at the speed of light.

After all, LIGO/Virgo observations support general relativity’s prediction that gravity moves at the speed of light; particularly the [GW170817](#) event where the LIGO and Virgo detectors received gravitational wave signals within two seconds of gamma ray and optical telescopes detections of electromagnetic signals from the same direction, which is strong evidence that gravitational waves move at the speed of light. But despite appearances, GW170817 does not contradict QGD’s description of gravity.

Let us be clear; We do not question the LIGO/Virgo observations. Quite the opposite since the detected signals are consistent with QGD predictions that predate the detections by several years and according to which the detected signals are not be gravitational but rather electromagnetic in nature. The signals would then be produced by the polarization of the preonic field by the binary system during merger event.

We also propose that means by which gravitational events may be detected instantly regardless of distance.

As we have seen earlier, quantum-geometry dynamics provides a non-perturbative description of the evolution of a system consisting of n gravitationally interacting bodies. The evolution of such a system of gravitationally is described completely using a *state matrix* such as the one below.

$$s+1 = \left\{ \begin{array}{c|c} \vec{P}_{a_{1|s+1}} = \vec{P}_{a_{1|s}} \vec{+} \Delta \vec{G}_{j=1}^n(a_{1|s}; a_{j|s+1}) & \varepsilon_{a_{1|s+1}} \\ \dots & \dots \\ \vec{P}_{a_{n|s+1}} = \vec{P}_{a_{n|s}} \vec{+} \Delta \vec{G}_{j=1}^n(a_{n|s}; a_{j|s+1}) & \varepsilon_{a_{n|s+1}} \end{array} \right\} \quad (1)$$

Where s is and $s+1$ are two successive states, $\vec{P}_{a_{i|s}}$ is the momentum of the i^{th} body out of a system consisting of n bodies, and a_j are bodies of the system, $j \neq i$ and

$$\Delta \vec{G}_{j=1}^n(a_{i|s+1}; a_{j|s+1}) = \Delta \vec{G}_{s+1}(a_{i|s+1}; a_{1|s+1}) + \dots + \Delta \vec{G}_{s+1}(a_{i|s+1}; a_{n|s+1}) \quad (2)$$

where $\Delta \vec{G}_{s+1}(a_{i|s+1}; a_{j|s+1})$ is the variation in gravity between two successive states s and $s+1$ of the system and $a_{i|s+x}$. The position itself is denoted $\mathcal{E}_{a_{i|s+x}}$.

A system can be a planetary system, a galaxy, group of galaxies or even the entire universe. All that changes is the scale of the objects which must be appropriately chosen.

Note however that the state matrix of systems smaller than the universe excludes forces external to the systems acting on them which, as we will show below, can have significant effects. A complete state matrix, one which includes all objects in the universe, is impossible to create but unnecessary to describe dynamic systems when scale simplification is possible.

For example, when describing the gravitational interaction between a local object¹¹ at a chosen scale¹² and a sufficiently distant system (which may be as large as a large scale structure), the distant system may be treated as single massive object with dynamics described by a single momentum vector.

Non-local Effects of Local Events

Local interactions are events involving momentum transfers between objects. Momentum transfers may result from collisions, partial or total absorption of photons or particles or absorption of *preons*⁽⁺⁾ from polarized preonic fields (aka magnetic fields) which impart their momentum.

Let a be a particle in state s of the universe that undergoes a local interaction. As we have seen, this implies a_{s+1} in the following state $s+1$ if the universe s that $m_{a_s} \neq m_{a_{s+1}}$ and

$$\vec{P}_{a_s} \neq \vec{P}_{a_{s+1}}.$$

¹¹ We define an object as a bound components that behave at a given scale and under a given interaction as a single indivisible object.

¹² We define the scale as that at which bounded components behave as one object under a given interaction.

Let b_s be a non-local particle in state s of the universe. Let us assume for the sake of simplicity that the quantum-geometrical distance between a and b does not change from states s and $s+1$.

Following the interaction a undergoes in state s , we know that $\vec{G}(a_s; b_s) \neq \vec{G}(a_{s+1}; b_{s+1})$. So the gravitationally change of the momentum of b is $\Delta \vec{P}_{b_{s+1}} = \Delta_{s \rightarrow s+1} \vec{G}(a; b)$ where $\Delta_{s \rightarrow s+1} \vec{G}(a; b)$ is the variation in the gravitational interaction between a and b between the states s and $s+1$.¹³

According to QGD, reality is strictly causal, so the evolution of any dynamic system is a sequence of causality linked states. The evolution of the gravitational interaction between a and b from an initial state s to a state $s+n$ is then:

$$\sum_{i=s}^n \Delta \vec{P}_{b_{i+1}} = \sum_{i=s}^n \Delta_{i \rightarrow i+1} \vec{G}(a; b) \quad (3)$$

If the interaction with a is a measurement at a local detector D1 in a Bell type experiment between states s and state $s+n$, and b a non-local particle simultaneously¹⁴ measured at detector D2, then equation (4) describes the non-local effect on particle b of measurement of particle a . This however is an incomplete description of the dynamics of b in the sequence $[s; s+n]$ since it does not account for its interactions with all other objects.¹⁵

Going back to the above Bell type experiment, if the sum of all other gravitational interactions is close to $\vec{0}$, then to predict the outcome of a measurement of b at D2 in the sequence of states $[s; s+n]$ one would first need to calculate $\sum_{i=s}^n \Delta_{i \rightarrow i+1} \vec{G}(a; b)$ based on the change in mass of a , itself proportional to the momentum it imparts to detector D1.

Effects at Non-Euclidean Scales

We have seen that at scales at which Euclidean geometry emerges, gravity is described by

$$\vec{G}(a; b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right) \vec{u} \quad \text{where } a \text{ and } b \text{ are spherical homogeneous objects}^{16}.$$

At Euclidean scales, $\Delta \vec{G}(a; b) = \Delta \vec{P}_a$ and $\Delta \vec{P}_a = x m_a$ and $\Delta \vec{P}_b = x' m_b$ where x and x' are positive

¹³ $\Delta \vec{G}_{s+1}(a; b) = \vec{G}(a_{s+1}; b_{s+1}) - \vec{G}(a_s; b_s)$

¹⁴ Events involving two objects are simultaneous if the state at which the objects interact gravitationally

¹⁵ A complete description requires a sequence of state matrixes which include all objects interacting with it.

¹⁶ This is the scale at which Newton gravity emerges (see derivation [here](#))

integers. Hence variations in the gravitational interactions are always equal to changes in momentum permitted by the laws of momentum, a direct consequence of which is [the equivalence principle](#). But $\vec{G}(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right) \vec{u}$ is what we may call and Euclidean approximation of QGD's exact equation for gravity:

$$\|\vec{G}(a;b)\| = m_a m_b k - \sum_{i=1}^{m_b} \frac{d_{i,j}^2 + d_{i,j}}{2} \quad (5)$$

where $d_{i,j}$ is the quantum-geometrical distance between a_i and b_j , respectively component *preons*⁽⁺⁾ of a and b . The exact equation must be used when describing gravitational dynamics at non-Euclidean scales (see explanation [here](#)).

An noteworthy implication of equation (6) is that, except for special cases, $\Delta\vec{G}(a;b) \neq x m_a$ and/or $\Delta\vec{G}(a;b) \neq x' m_b$. What that means is that at non-Euclidean scales (which includes quantum scales), variations in the gravitational interaction are no longer equal to permitted changes in momentum for a and b , thus [the equivalence principle](#) no longer holds. This means that the interaction cannot resolve itself through instant action on the momentums of the gravitationally interacting particles since the changes in momentum induced by the variations in gravity are forbidden by the laws of momentum. Instantaneous action being fundamental in QGD, the interaction must resolve itself through the mechanism described below.

If $x m_b = \Delta_{s \rightarrow s+1} \vec{G}(a;b) < (x+1) m_b$ then the interaction is resolved by b emitting a particle b' such that $\vec{P}_{b'} = \Delta_{s \rightarrow s+1} \vec{G}(a;b) - x m_{b_{s+1}}$ and $\Delta \vec{P}_b = x m_{b_{s+1}}$ where $m_{b_{s+1}} + m_{b'} = m_{b_s}$.

Similarly, if $x m_a = \Delta \vec{G}(a;b) < (x+1) m_a$ then a emits a particle a' such that $\vec{P}_{a'} = \Delta_{s \rightarrow s+1} \vec{G}(a;b) - x m_{a_{s+1}}$ and $\Delta \vec{P}_a = x m_{a_{s+1}}$.

Example of Nuclear Scale Effect from Distant Event

Let us consider an atomic nucleus a_s and a massive binary system B_s at a distance $d \gg d_\Lambda$ from a_s where s is the universe¹⁷ and d_Λ is the distance beyond which gravity becomes repulsive (see [here](#)). The dynamics of the binary system causes discrete variations in the gravitational interaction between B and a (and simultaneously between B and all other particles and structures in the universe, but for simplicity we will focus on the interaction between a and B).

¹⁷ Two particles or structures coexist only when they are in the same s state, that is, they interact gravitationally. A particle in state s cannot interact gravitationally with a particle in state other than s .

As we have seen earlier, the equivalence principle breaks down at the nuclear scale when $xm_a < \Delta\vec{G}(a;B) < (x+1)m_a$ and as a consequence gravitational acceleration of a which normally would be equal to $\Delta\vec{G}(a;B)$ is forbidden by the laws of momentum (see [Transfer and Conservation of Momentum](#)).

As we have seen earlier, the change of state must resolve itself by a emitting one or more particles a'_i such that $\sum_{i=1}^n \Delta\vec{P}_{a'_i} = \Delta\vec{G}(a;B) - xm_{a_{s+1}}$ where n is the number of particles emitted and $\Delta\vec{P}_a = xm_{a_{s+1}}$.

For a given dynamic system S , the type and momentums of the radiated particles will depend on m_a and d . The larger m_a , the wider the range $]xm_a, (x+1)m_a[$ and the wider the range of possible radiated particles. So, all other factors being equal, the more massive an atomic nucleus and larger $\Delta\vec{G}(a;S) - xm_a$, the wider the momentum range of gravitationally triggered particle radiation. Also, this equation for gravity implies that repulsive gravity increases with distance, so beyond $d \gg d_\Lambda$ the most distant systems exert the largest gravitational effect.

We must remind the reader here that equation describes a universe which would contain only a and S . To account for all objects in the universe interacting with a significantly, we must use the appropriate state matrixes and scales. There is much work to be done to develop experiments that would test the effects we have described here but should such test support QGD's predictions of nuclear decay triggered by distant events, then they may be used to inform us in "real time" of evolution of distant systems and possibly help map out distant systems in their actual present states.

Local Effect on Molecules and Bound Molecules from Distant Events

Molecules behave as one object under gravitational interaction with distant objects. Take a molecule composed of x number of atoms. In such a case, it is the gravitational interaction between the molecule and the distant structure that must be used to predict gravitationally induced decay of nuclei.

As one can easily infer, only a small number of nuclei need to radiate to maintain equilibrium. The ratio of radiating nuclei will depend on the mass of the nuclei, the number of atoms in the molecules, and on whether the molecules are bound into a larger structure in which case, we must consider the interaction with the larger structure. It will also depend on difference between the amplitude of the gravitational variations and the permitted changes in momentum of the molecule. All these may be factors in the radioactivity of isotopes and their [half-life](#).

Theorem

All local interactions have non-local effects. Conversely, all non-local events have local effects.

It follows that although both QGD and quantum mechanics agree on the existence of a non-local effect, QGD differs in that it predicts that though instantaneous, the non-local effect of the measurement of a local particle will vary with distance, quantum-geometrical distance to be specific, as well as the scale of the objects that are measured.

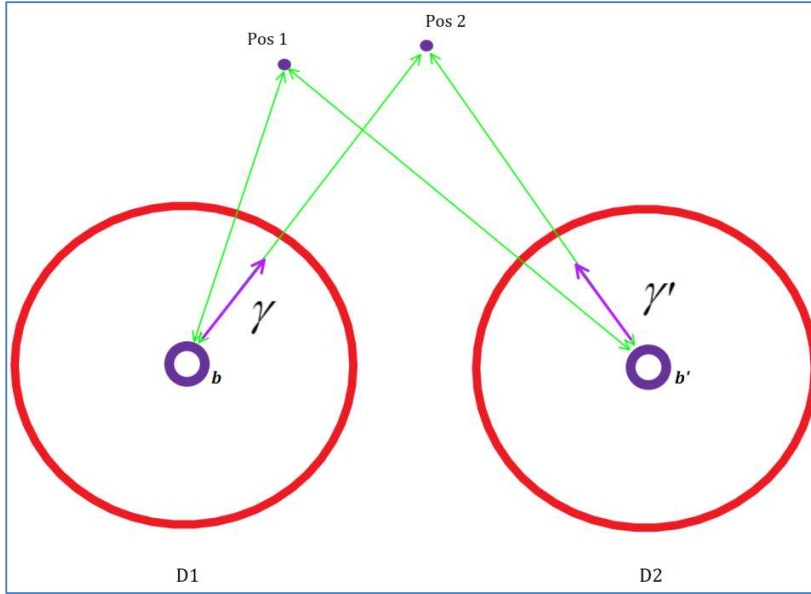
If QGD's equation for gravity holds, then the amplitude of the effect is not only inversely proportional to the square of the distance as Newtonian gravity predicts but repulsive gravity is proportionally the quantum-geometrical distance for $d > d_{\Lambda}$, where d_{Λ} is the threshold distance beyond which gravity becomes repulsive.

Instantaneity and the Uncertainty Principle

The uncertainty principle states that two conjugate properties cannot be known with certainty. The most common example being that of the properties of momentum and position. According to the Heisenberg's uncertainty principle, as the certainty of the measurement of momentum increases, the uncertainty of the position increases as well. This is described by the famous equation $\sigma_x \sigma_p \geq \frac{\hbar}{2}$ and thought to be inherent to wave-like systems. But if space is discrete (specifically quantum-geometrical as per QGD's axiom of discreteness of space), then the wave function provides only a probabilistic approximation of the state of singularly corpuscular particles and the uncertainty principle is a consequence of quantum mechanics; not of a fundamental aspect of reality in which space is discrete rather than continuous.

Position and Momentum of Particles (or Structures)

Consider a particle which momentum and position are unknown and two gravitational detectors as shown in figure 1. The red circles in the figure represent arrays of photon detectors which will detect and measure the photons energy and direction. At the core of the detectors are variable mass spherical structures b and b' (the mechanism by which the mass of the cores vary may be by laser pulses or a form a induce decay of its structure).



According to QGD, when the position of a particle a (purple dots) changes position, $G(a;b)$ and $G(a;b')$, respectively the gravitational interactions between it and the cores b and b' at the center of the detectors $D1$ and $D2$ instantly change.

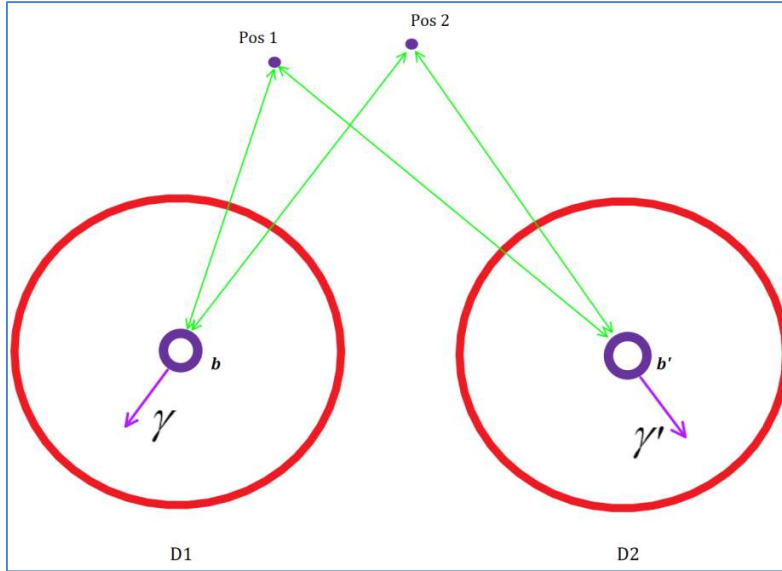
A consequence of space being discrete is that only changes in momentum which are

multiple of m_b units of momentum are allowed.¹⁸ So, if $|\Delta G(a;b)| < m_b$ the change in the gravitational interaction is insufficient to impart momentum to b . In order to satisfy the gravitational interaction equation $\|\vec{G}(a;b)\| = m_a m_b k - \sum_{i=1}^{m_a} \sum_{j=1}^{m_b} \frac{d_{i,j}^2 + d_{i,j}}{2}$, b and b' must emit photons γ and γ' which momentum must exactly equal $\Delta \vec{G}(a;b)$ and $\Delta \vec{G}(a;b')$ units of

¹⁸ This explains why atomic electrons can only absorb photons of specific energy. QGD attributes the different absorption energies to minute variations in the masses of orbital electrons.

momentum¹⁹. That is: $\vec{P}_\gamma = \Delta\vec{G}(a;b)$ and $\vec{P}_{\gamma'} = \Delta\vec{G}(a;b')$ where the directions of the momentum vectors \vec{P}_γ and $\vec{P}_{\gamma'}$ (purple arrows) coincide with $\vec{G}(a;b)$ and $\vec{G}(a;b')$.

By triangulation, the instantaneous position and distance of a can be found and depending on the distance and direction we can make the following interpretation:



1. If distance is such that $k > \frac{d^2 + d}{2}$ and \vec{P}_γ points towards a , then a is receding from b ;

2. If $k > \frac{d^2 + d}{2}$ and \vec{P}_γ (or $\vec{P}_{\gamma'}$) points away from a then a is moving towards b ;

3. If $k < \frac{d^2 + d}{2}$ and \vec{P}_γ points towards a , then a is moving towards b ;

4. If $k < \frac{d^2 + d}{2}$ and \vec{P}_γ points away from a , then a is receding from b .

The momentums (which for photons is equal to their energy) $\|\vec{P}_\gamma\|$ and $\|\vec{P}_{\gamma'}\|$ provides an exact measure of $\Delta\vec{G}(a;b)$ and $\Delta\vec{G}(a;b')$. Since m_b and $m_{b'}$ are known, we can resolve the gravitational interaction equation for m_a , hence obtain an exact value of its mass.

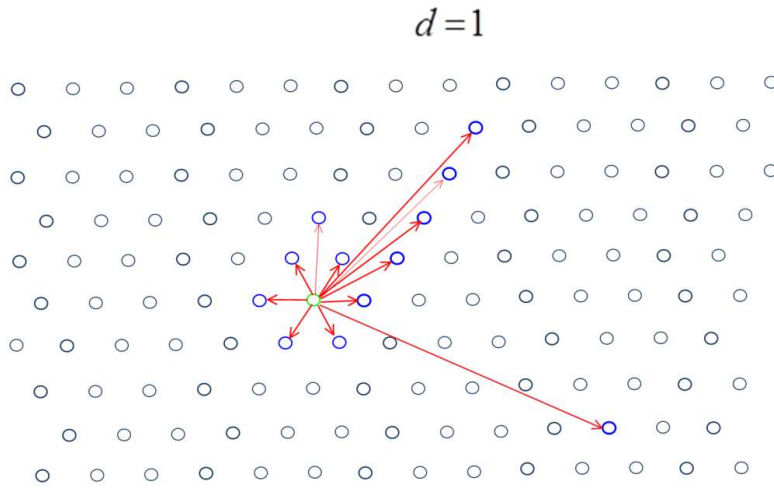
Thus, a first measurement gives us the instantaneous position and mass of a .

¹⁹ A principle of conservation of momentum (induced momentum for gravity) comes into play here. If a change in the magnitude of the interaction between a and b is smaller than that which is required to achieve the minimum change in momentum in one or both particles, then one or both must emit photons that will carry the would be change in momentum.

A second measurement will give us a second position, hence the distance travelled between position 1 and position 2. This allows us to calculate speed $v_a = \frac{d_x}{d_{ref}} c$ where d_{ref} is the distance light would have travelled during the same interval. From QGD's definition of speed we know that $\vec{v}_a = \frac{\vec{P}_a}{m_a}$ where \vec{P}_a is the momentum vector of a so that $\vec{P}_a = m_a \vec{v}_a$. Therefore, a second measurement allows us to find simultaneously the position and momentum of a with certainty.

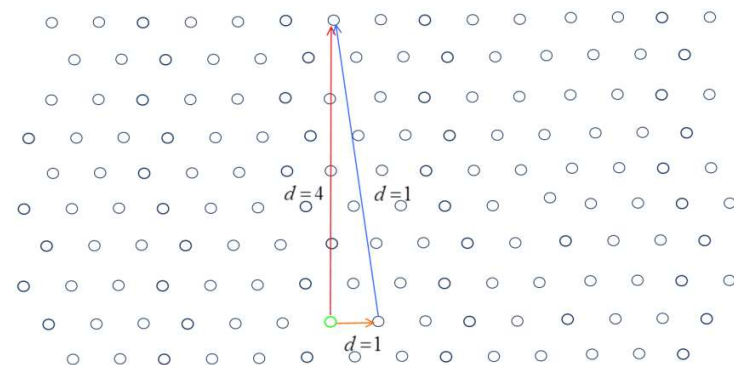
Non-location interactions

If space is discrete as per QGD's axiom, then we know that there can be significant differences between the geometrical distance and the physical distance between any two positions in space. The physical distance between two particles, even when large, may be significantly reduced even by a small shift in their positions.



In the figure on the left, the geometrical distance may be associated with the lengths of the red arrows, while the physical distance, corresponds to the number of the number of leaps necessary to move from an initial position (green circle) to a second position (blue circles).

As we can see, though the geometrical distances between the green position and the blue positions may vary greatly, the physical distance between them is the same and equal to one unit.



If a moves one position to the right to the bottom right vertex, the physical distance between a and b becomes four times smaller even though the geometrical distance

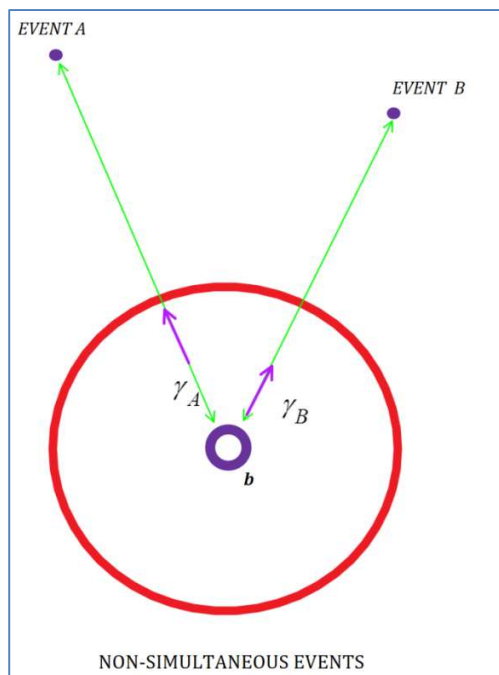
In the figure on the left, we see that at the fundamental scale, Pythagoras's theorem does not hold. How Euclidean space emerges at larger scales is explained in [here](#). If we assume the existence of a particle b positioned at the top vertex and particle a at the bottom left

increased. Such changes in physical distance will cause significant instantaneous changes in the gravitational interaction between the particles and additionally, if the particles are not electrically neutral, significant changes the magnetic field they generate.

Since experiments use electronic components, they contain particles or structures a and b which are not electrically neutral. In such case, the change in the momentum of the magnetic field they generate can impart will be orders of magnitude greater than that of purely gravitational changes and photons emitted by b will have significantly greater energy.

When in one experiment a particle is measured, it causes changes in the momentum of some of its component particles (changes in electrons within the electrical current which powers its detectors for example), these changes are compounded and will cause components of a second experiment to emits photons instantly. Some of the photons produced within the second experiment will have energies in the range of the sensitivity of detectors.

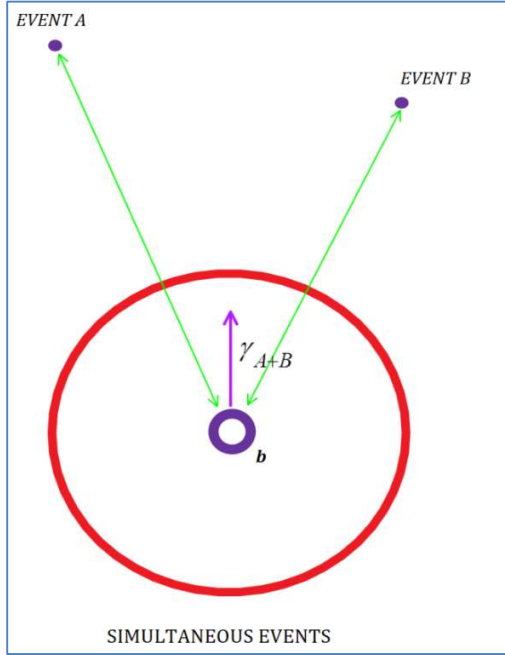
The Notion of Simultaneity



If gravity is instantaneous then all objects in the universe are interaction. That means that if an event affects an object anywhere in the universe, the gravitational interactions between that object and all other objects in the universe regardless the distances that separate them will be affected instantly.

An event can be defined as a change in mass, density, direction, speed, momentum, or position, all of which affect either the magnitude and/or direction of the gravitational interaction between the object of the event and all other objects in the universe.

If A and B are events anywhere in the universe then if the events are non-simultaneous b will emit two photons γ_A and γ_B and the order in which they are emitted correspond to order in which the events took place (figure on the left). But if the events are simultaneous, the changes in gravitational interactions will be additive and b will emit a single photon γ_{A+B} such that



$$\vec{P}_{\gamma_{A+B}} = \Delta\vec{G}_A + \Delta\vec{G}_B \text{ (figure on the right).}$$

Note: since a single photon is emitted, it will be necessary to distinguish the emission of a photon resulting from simultaneous events from the emission of a photon resulting from a single event.

It follows that two events are simultaneous if the variations in the gravitational interactions resulting from the events are additive. And since, because of gravity being instantaneous, any event must be simultaneously detected by all observers in the universe regardless of their chosen frame of reference and distance. If gravity is instantaneous, then simultaneity must be frame independent and absolute.

Furthermore, position, speed and momentum which can be derived from γ_{D_1} and γ_{D_2} will also be frame independent, determined with certainty and instantaneously.

Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?

If a refutation of Bell's refutation of the EPR paper of the same title were possible, chances are it would have been found a long time ago. Generations of some of the best minds of mathematics and physics have put it to the test.

That said, if we remain rigorous, we must remember that a refutation of the arguments presented in the EPR is exactly what Bell's paper offers and nothing more. The proof of Bell's theorem confirms without doubt that aspects of nature are fundamentally non-local as opposed local when we take the EPR definition of locality. But locality in the EPR paper is kept in agreement with special relativity's prediction that no classical interactions can propagate faster than the speed of light.

It follows that Bell's paper may also be taken as a refutation of locality as derived from special relativity or even as a refutation of special relativity's prediction precluding faster than light interactions.

As we have seen, QGD distinguishes between propagation which is the motion of particles or structures which velocity cannot exceed the speed of light, gravitational interactions which is instantaneous and without mediating particles²⁰ and non-gravitation interactions which implies absorption and/or emission of particles and transfer of their momentum. It follows that only non-gravitational interactions are limited to the speed of light.

Implications for Bell Type Experiments

If classical forces and quantum entanglement both violate locality as it is described in the EPR paper and which description assumes that no classical force can propagate faster than c , then how can we know whether a violation of Bell's inequalities is due to a classical or to a quantum mechanical effect? Would this render the proof of Bell's theorem via the violation of Bell's inequality irrelevant? Or should it be taken as taken not as a refutation of the EPR locality, but of the understanding and description of locality it assumes?

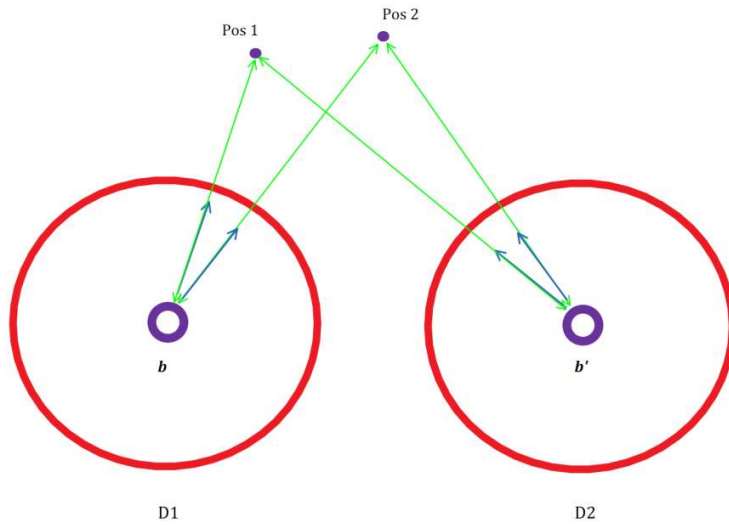
If any observed violation of Bell's inequality could be attributed to instantaneous classical effects Bell-type experiments would no longer allows us to distinguish between the two.

It would however be possible to determine if such violation is caused by classical instantaneous interactions since realism would be preserved and, as we have shown above, we could simultaneously and with certainty measure conjugate properties such as momentum and position; something that would not be possible if reality was quantum mechanical.

On the Effect of Gravitational Interactions on Particle Decay and how it Can be Used for Gravitational Telescopes

In figure 1, if b and b' are massive nuclei such that $\Delta G(a; b) < m_b$ and $\Delta G(a; b') < m_{b'}$, then b and b' will emit particles x and x' for which $\|\vec{P}_x\| = \Delta G(a; b)$ and $\|\vec{P}_{x'}\| = \Delta G(a; b')$ respectively. So if x and x' are simultaneously emitted (and detected by the array) and their directions converge, then there is a probability that their emissions result from the a change their gravitational interactions between b and b' and a . But when considering that all matter in the universe interacts, the convergence of the directions of the particles emitted by b and b' only means that the objects they interact with are somewhere along the directions of their emitted particles and that the changes in gravitational interactions are simultaneous. For a gravitational telescope that exploits the effect we described requires that this probability be significantly increased.

²⁰ According to QGD, particles do not mediate forces. They can, as in magnetic fields, impart momentum to particles or structures.



This could be done by augmenting the number of massive nuclei of the apparatus. If n is the number of massive nuclei so that $\Delta G(a; b_i) < m_{b_i}$ where $i \leq n$, then we can predict n simultaneously emitted particles x_i which have the predicted momentum and which directions converge onto a sufficiently small region of space, then for a

certain value of n the probability that the simultaneous emission of particles result from the nuclei's gravitational interactions with a approaches certainty. That is, the number of possible objects which would cause the observation is reduced to 1.

A gravitational telescope exploiting the effect can thus discriminate precisely between the objects it observes and provide their position, momentum, and mass with certainty.

Note: The type of particles emitted by nuclei will depend on the strength of the bonds between the particles when they were components of the nuclei, their masses as well as the magnitude of the variation in the gravitational interactions. Since, as shown earlier, even small changes in position can cause disproportionately large changes in the physical distance between objects, they induce emissions of particles with significantly greater momentum than would be possible if space were continuous.

Note: The effect described in this section may already have been observed. See [Evidence for Correlations Between Nuclear Decay Rates and Earth-Sun Distance](#) by Jere H. Jenkins, Ephraim Fischbach, John B. Buncher, John T. Gruenwald, Dennis E. Krause, Joshua J. Mattes.