Locality, Certainty and Simultaneity

Locality and Instantaneous Effects

Non-locality is based on the assumption that an event which affects a system cannot affect another system which is independent of it. Independent systems being defined as systems which are separated by a distance sufficiently large to prohibit one from influencing the other without violating the speed limit predicted by special relativity. But if gravity is instantaneous, then no systems is truly independent which means that all systems are local and can affect each other instantaneously regardless of distance.

Under instantaneous interactions, the entire universe is local.

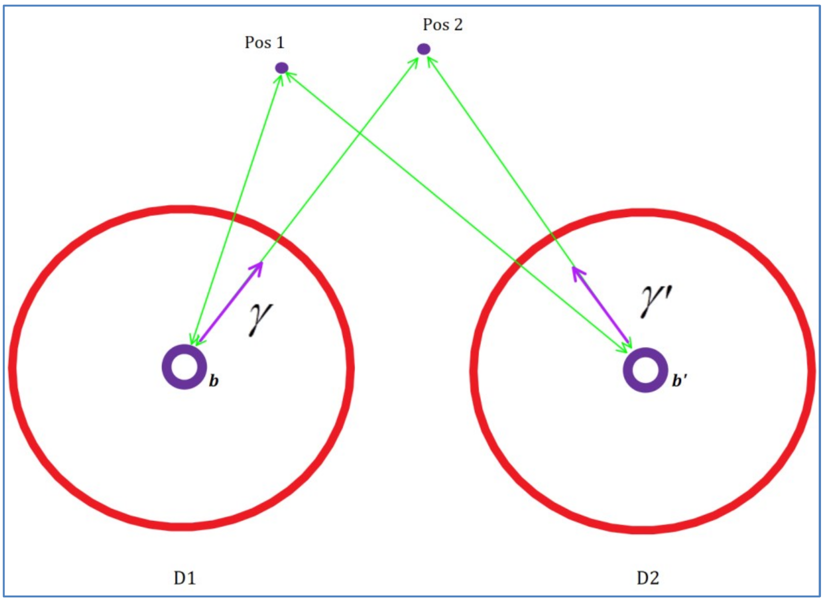
Currently, independent experiments which show correlations that cannot be accounted for by local hidden variables correlation are taken as evidence that reality is fundamentally non-local, hence are taken as evidence supporting quantum-entanglement. But if gravitational interactions and the electromagnetic effect of generation of magnetic fields are instantaneous, then any two experiments will influence each other instantaneously yet remain classical since they do so without violating locality since, as we have indicated earlier, the entire universe becomes local if these effects are instantaneous.

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 (quantum-geometrical as per QGD's axiom of discreteness of space), then the wave function provides only an approximation of the scattering of singularly corpuscular particles and the uncertainty principle is a consequence of quantum mechanics; one that does not correspond to a fundamental reality in which space is discrete rather than continuous.

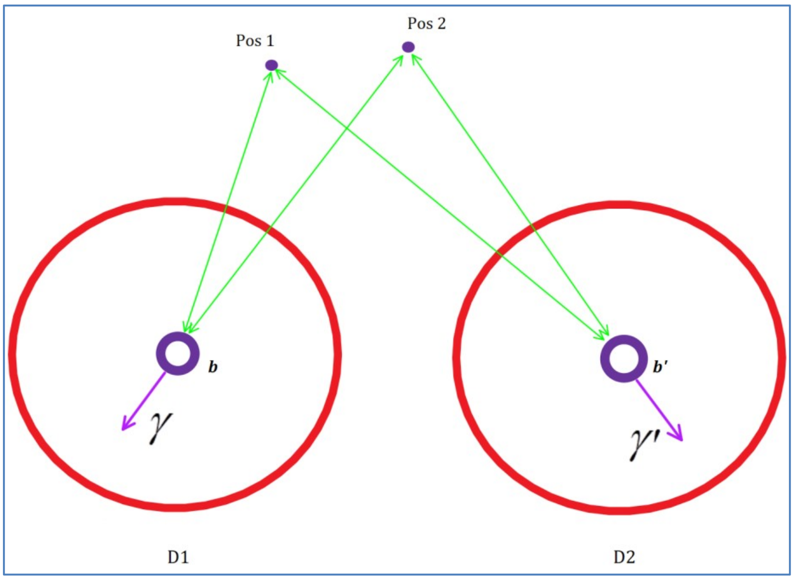
Position and Momentum of Particles (or Structures)

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.



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. [8] So, if $|\Delta G(a;b)| < m_b$ the change in the gravitational interaction is insufficient to impart momentum of b . In order to satisfy the gravitational interaction equation



$$G(a;b) = m_a m_b k - \sum_{\substack{i=1 \\ j=1}}^{\substack{m_j \\ m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2}$$

, b and b' must emit photons γ and γ' which momentum must exactly equal $\Delta G(a;b)$ and $\Delta G(a;b')$ units of momentum[9]. That is: $\|\vec{P}_\gamma\| = |\Delta G(a;b)|$ and $\|\vec{P}_{\gamma'}\| = |\Delta G(a;b')|$

[8] 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.

[9] *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.*

where the directions of the momentum vectors $\vec{P}_\lambda$ 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 $\vec{P}_\gamma$ points towards a, then a is moving towards b;

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

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

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

The momentums (which for photons is equal to their energy) $\|\vec{P}_\gamma\|$ and $\|\vec{P}_{\gamma'}\|$ provides an exact measure of $\Delta G(a;b)$ and $\Delta G(a;b')$. 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.

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

Position and Momentum of Charged Particles

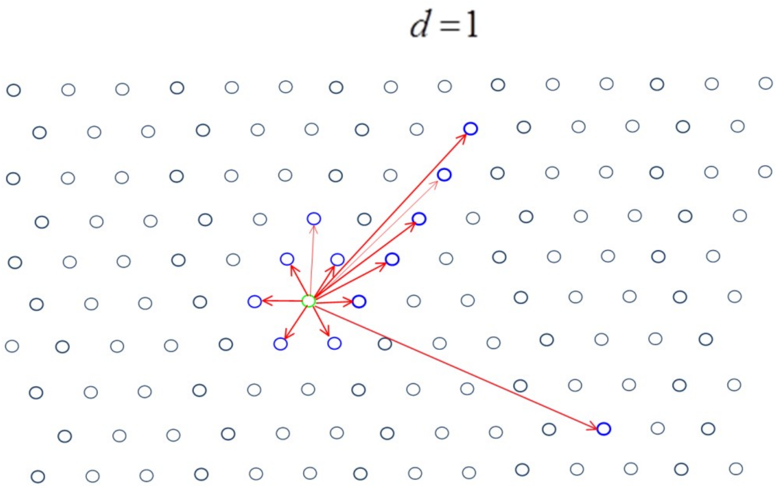
In the above description, we assumed that the particle was electrically neutral. If the particle is not neutral, then QGD predicts the generation of a magnetic field is instantaneous and the same reasoning applies with the difference that in addition to changes in gravitational interactions, we have changes in the intensity of the magnetic field and the momentum they can impart to b and b' .

Here again, when $\left\|\Delta\vec{P}_{H_{b'}}\right\| < m_{b'}$, the structures b and b' must emit photons λ and λ' where $\left\|\vec{P}_{\lambda}\right\| = \left\|\Delta\vec{P}_{H_b}\right\|$ and $\left\|\vec{P}_{\lambda'}\right\| = \left\|\Delta\vec{P}_{H_{b'}}\right\|$. In the case of charged particles, the change momentum imparted by a magnetic being orders of magnitude greater than the change in momentum imparted by gravity, the photons λ and λ' will have momentums orders of magnitude greater than that of photons produced from variations in the gravitational interactions alone.

Two measurements using the apparatus in Figure 1 for a charged particle will simultaneously provide its instant position and momentum with certainty.

Interactions between Distant Experiments

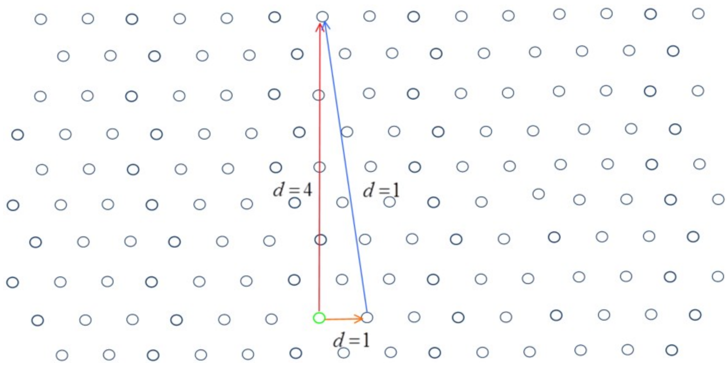
If space is discrete as per QGD's axiom, then we know that there can be significant differences between the geometrical distance and the physical distance between any two positions in space. The physical distance between two particles, even when large, may be significantly reduced even by a small shift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

In the figure below, 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 vertex (green circle). If a moves one position to the right to the bottom right vertex,



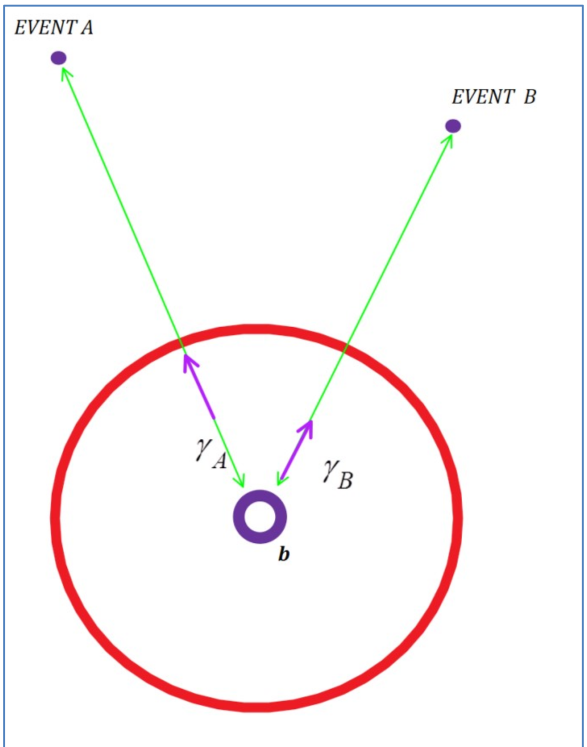
the physical distance between a and b becomes four times smaller even though the geometrical distance increased. Such changes in physical distance will cause significant instantaneous changes in the gravitational interaction between the particles and additionally, if the particles are not electrically 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

As we have explained, if gravity is instantaneous then all objects in the universe are local. 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.

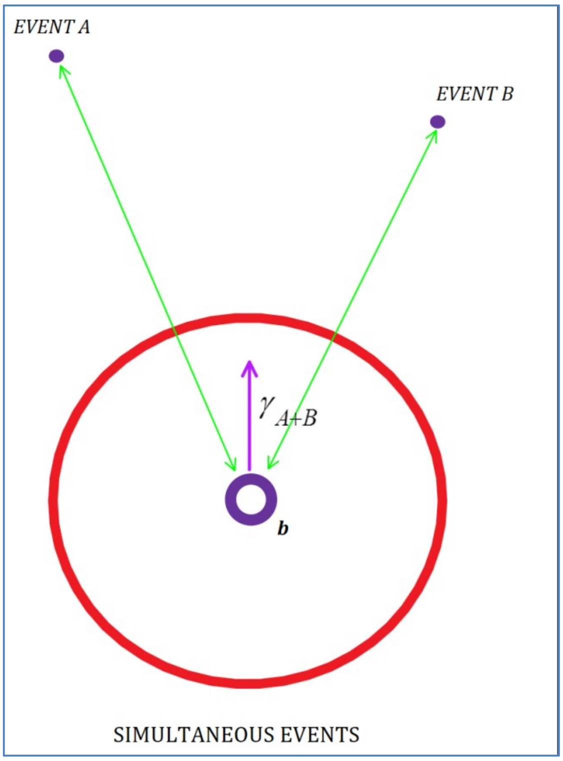


NON-SIMULTANEOUS EVENTS

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 others 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 $\vec{P}_{\gamma_{A+B}} = \Delta\vec{G}_A + \Delta\vec{G}_B$ (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, as a consequence 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 speed cannot exceed the speed of light, gravitational interactions which is instantaneous and without mediating particles[10] and non-gravitation interactions which implies absorption and/or emission of particles and transfer of their momentum. It follows that 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?

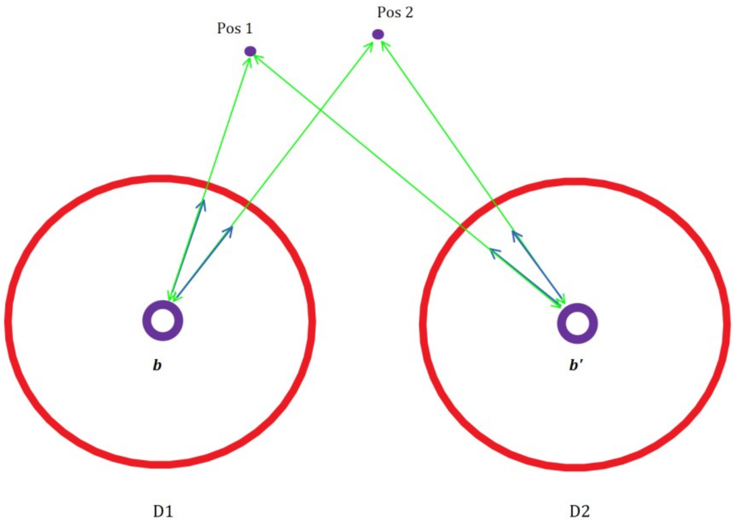
If any observed violation of Bell's inequality could attributed to instantaneous classical effects Bell-type experiments would no longer allows us to distinguish between the two.

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 $\left\|\vec{P}_x\right\| = \Delta G(a;b)$ and $\left\|\vec{P}_{x'}\right\| = \Delta G(a;b')$ 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

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



gravitational telescope that exploits the effect we described requires that this probability be significantly increased.

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.