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 $preon^{(-)} \mid preon^{(+)}$ pairs (which we will represent by $preon^{(+\!/\!-)}$) which because of conservation of fundamental properties interact with other $preon^{(-)} \mid preon^{(+)}$ pairs through both n-gravity and p-gravity. It follows that since all particles or structures are made of $preon^{(-)} \mid preon^{(+)}$ 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 $preon^{(+)}$ 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 $\sum_{\substack{i=1\\j=1}}^{\substack{m_j\\m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2}$.

Using the relation $g^+ = k\left|g^-\right|$ 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

$G(a;b) = m_a m_b k - \sum_{\substack{i=1\\j=1}}^{\substack{m_j\\m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2}$ where the first component, $m_a m_b k$,is the magnitude of the p-gravity force acting between a and b and $\sum_{\substack{i=1\\j=1}}^{\substack{m_j\\m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2}$ is the magnitude of the n-gravity force between them. It is interesting to note here that $\sum_{\substack{i=1\\j=1}}^{\substack{m_j\\m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2}$ is the force exerted by quantum-geometrical space itself on two particles or structures.

At larger scales, for homogeneous spherical structures, we find that $\sum_{\substack{i=1\\j=1}}^{\substack{m_j\\m_i}} \frac{d_{i,j}^2 + d_{i,j}}{2} \approx m_a m_b \frac{d^2 + d}{2}$ where d is the distance between the centers of gravity of a and b. This allows us to derive the simplified gravitational interaction equation $G(a;b) = m_a m_b k - m_a m_b \frac{d^2 + d}{2}$ or $G(a;b) = m_a m_b \left(k - \frac{d^2 + d}{2} \right)$.

The difference between the magnitude of the gravitational interaction obtained from the detailed equation and that obtained from the simplified equation becomes less significant as we move from microscopic to macroscopic scales. Therefore, the simplified equation is a sufficiently good approximation of the magnitude of gravity for calculations of the gravitationally interacting systems at scales to which Newtonian gravity or general relativity is applied.

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 $\left\| \vec{P}_{p^{(+)}} \right\| = \left\| \vec{c} \right\| = c$. 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 is it 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:

$\vec{P}_{\substack{p^{(+)}\\s_2}} = \vec{P}_{\substack{p^{(+)}\\s_1}} \mp \underset{s_1 \to s_2}{\Delta} \boxed{\vec{G}}$ where $\underset{s_1 \to s_2}{\Delta} \boxed{\vec{G}} = \left(\sum_{j=1}^{m_a} \underset{s_1 \to s_2}{\Delta} \vec{G}\left(p_i^{(+)}; p_j^{(+)}\right) + \sum_{k=1}^{n} \underset{s_1 \to s_2}{\Delta} \vec{G}\left(p_i^{(+)}; a_k\right) \right)$ is the resultant of the forces acting on the $preon^{(+)}$ and $\vec{\mp}$ is the directional vector sum which we define as $\vec{P}_{\substack{p^{(+)}\\s_1}} \mp \Delta \boxed{\vec{G}}_{s_1 \to s_2} = \dfrac{\vec{P}_{\substack{p^{(+)}\\s_1}} + \Delta \boxed{\vec{G}}_{s_1 \to s_2}}{\left\| \vec{P}_{\substack{p^{(+)}\\s_1}} + \boxed{\Delta \vec{G}}_{s_1 \to s_2} \right\|} c = \vec{c}_{s_2}$.

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 $\Delta \boxed{\vec{G}}$ between states s_1 and s_2.

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

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 $P_a = \left\| \vec{P}_a \right\| = \left\| \sum_{i=1}^{m_a} \vec{c}_i \right\|$. 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 $\underset{s_1}{\vec{G}}(a;b) = m_a m_b \left(k - \frac{d^2+d}{2}\right)$. Change in the momentum vector of the bodies from s_1 to the next causally related state s_2 is $\underset{s_1 \to s_2}{\Delta} \vec{P}_a = \underset{s_1 \to s_2}{\Delta} \vec{G} = \underset{s_2}{\vec{G}}(a;b) - \underset{s_1}{\vec{G}}(a;b)$ so that $\underset{s+1}{\vec{P}_a} = \underset{s}{\vec{P}_a} + \underset{s+1}{\Delta} \vec{G}(a;b)\phi_a$ and $\underset{s_1 \to s_2}{\Delta} \vec{P}_b = \underset{s_1 \to s_2}{\Delta} \overleftarrow{G} = \underset{s_2}{\overleftarrow{G}}(a;b) - \underset{s_1}{\overleftarrow{G}}(a;b)$ so that $\underset{s+1}{\vec{P}_b} = \underset{s}{\vec{P}_b} + \underset{s+1}{\Delta} \overleftarrow{G}(a;b)\phi_b$ 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 $\underset{s_1 \to s_2}{\Delta} \vec{P}_x = \underset{s_1 \to s_2}{\Delta} \vec{G}(a;b)$ but for $v_x = c$ we have $\left\lceil \frac{c - v_x}{c} \right\rceil = 0$ and $\underset{s_1 \to s_2}{\Delta} \vec{P}_x = 0$. 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 $\vec{P}_{\underset{s+1}{a}} = \vec{P}_{\underset{s}{a}} + \underset{s+1}{\Delta}\vec{G}(a;b)$ and $\vec{P}_{\underset{s+1}{b}} = \vec{P}_{\underset{s}{b}} + \underset{s+1}{\Delta}\vec{G}(a;b)$ with the understanding that ϕ_x is implicit and equal to 1.

Derivation of the 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: $\left\| \underset{s_1 \to s_2}{\Delta} \vec{P}_a \right\| = \left\| \underset{s_1 \to s_2}{\Delta} \vec{G}(a;b) \right\|$.

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

Since

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

then $\Delta v_b = \frac{1}{m_a} m_a m_b\left(\left(\frac{d_1^2+d_1}{2}\right) - \left(\frac{d_2^2+d_2}{2}\right)\right) = m_b\left(\left(\frac{d_1^2+d_1}{2}\right) - \left(\frac{d_2^2+d_2}{2}\right)\right)$. Therefore, gravitational acceleration of a body a towards 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 towards a is given by $\Delta v_b = m_a\left(\left(\frac{d_1^2+d_1}{2}\right) - \left(\frac{d_2^2+d_2}{2}\right)\right)$ is independent of m_b. So, regardless of their mass m_a, all bodies a will be accelerated towards a given body b at the same rate, hence proving the weak equivalence principle.

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.