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

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

$\dfrac{\Delta t}{d_{ref}} \propto \sqrt{c^2 - v_a^2}$. 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

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}}$$ which 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 $v_a = \dfrac{\left\| \vec{P}_a \right\|}{m_a}$ then $\dfrac{\Delta t}{d_{ref}} \propto \sqrt{c^2 - v_a^2} = \sqrt{c^2 - \left(\dfrac{\left\| \vec{P}_a \right\|}{m_a} \right)^2}$. We have also shown that

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

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

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

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

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 are 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 $\Delta t' = \Delta t \dfrac{\sqrt{c^2 - \left\| \vec{v}_a + \dfrac{\Delta \vec{G}(a;b)}{m_a} \right\|^2}}{\sqrt{c^2 - v_a^2}}$ 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. Since Newtonian gravity is instantaneous it is incompatible with time dependency and, as we will see now, is the cause of the discrepancies between the Newtonian predictions and observations.
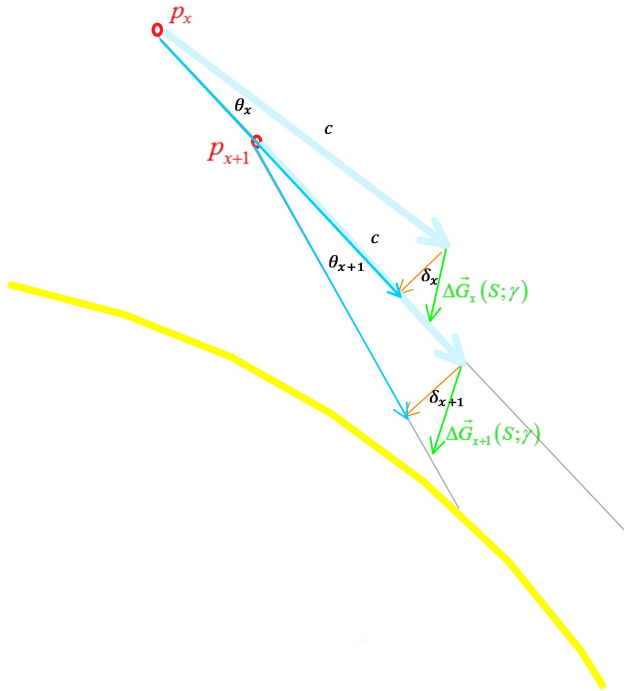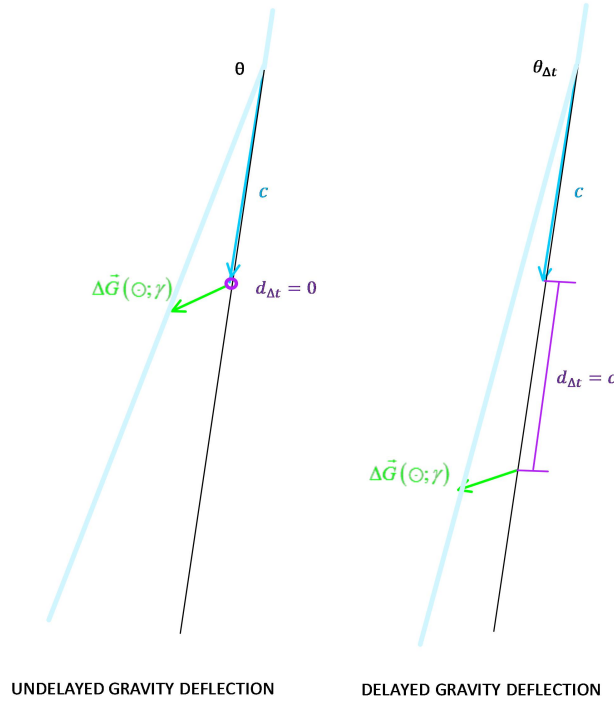

According to QGD, photons are composed of $preons^{(+)}$. It follows that photons interact gravitationally as do all other material structure. Applying the laws of motion to describe the effect of gravity on the trajectory of a photon coming into proximity to the sun $\odot$ we find that a photon γ changes direction at a position p_i by an angle θ_i given by

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

is the angle between the vector $\underset{p_{i-1} \to p_i}{\Delta} \vec{G}\left(S;\gamma\right)$ and the perpendicular to the vector $\vec{P}_\gamma$ (see figure on left).

The total angle of deflection θ of a photon is then $\theta = \sum_{-i}^{i} \frac{\left\| \underset{p_{i-1} \to p_i}{\Delta} \vec{G}\left(\odot;\gamma\right) \cos\delta_i \right\|}{2\pi c}$. 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 $\underset{p_{i-1} \to p_i}{\Delta} \vec{G}\left(\odot;\gamma\right)$ equal to the distance travelled by a photon in one second or c units of distance (figure on the next page). Since

θ

θ_Δt

c

c

$\Delta \vec{G}(\odot;\gamma)$ $d_{\Delta t}=0$

$d_{\Delta t}=c$

$\Delta \vec{G}(\odot;\gamma)$

$\Delta \vec{G}(\odot;\gamma)$

UNDELAYED GRAVITY DEFLECTION   DELAYED GRAVITY DEFLECTION

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

non-delayed gravity and

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

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

$$\theta = \sum_{-i}^{i} \frac{\left\|\underset{p_{i\,N}}{\vec{G}}(\odot;\gamma)\right\|\cos\delta}{2\pi c} = 2\,\theta_{\Delta t}.$$

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

the angle of non-delayed gravitational deflection of Mercury from its momentum vector at a given position is $\theta = \sum\limits_{-i}^{i}\dfrac{\left\|\underset{p_{i-1}\to p_i}{\Delta}\vec{G}(\odot;b)\right\|\cos\delta_i}{2\pi\left\|\vec{P}_b\right\|}$. The angle for delayed gravity corresponds is

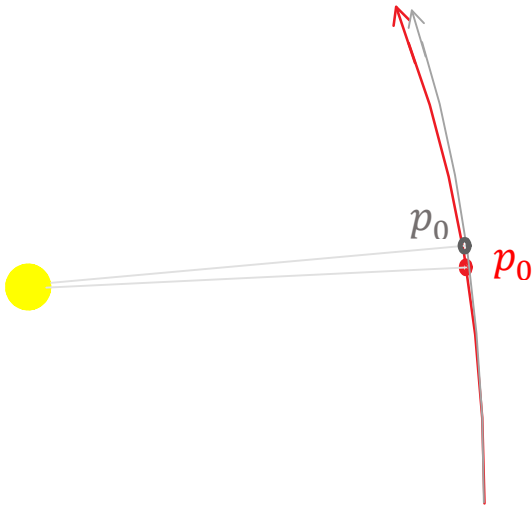obtained after a displacement of the gravity vector equal to $\left\|\vec{v}_b\right\|\Delta t$ that is:

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

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

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

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

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


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).

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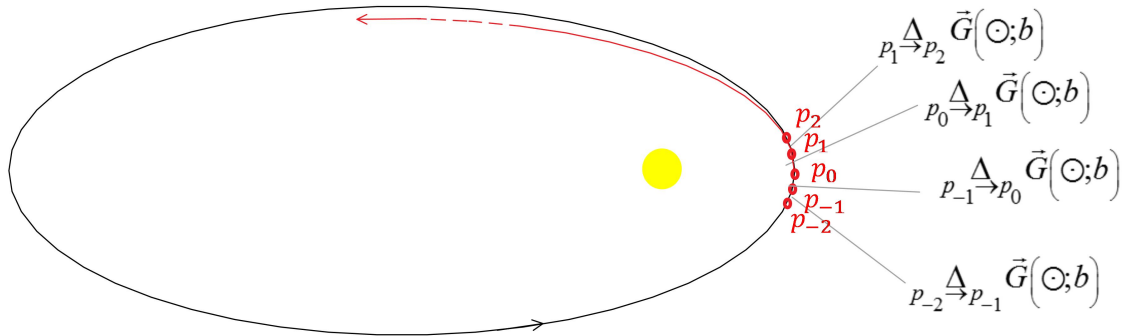
Orbital Decay of Binary Systems

The mechanisms using which we described and explained the precession of the perihelion of Mercury in the preceding section also predicts the precession 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
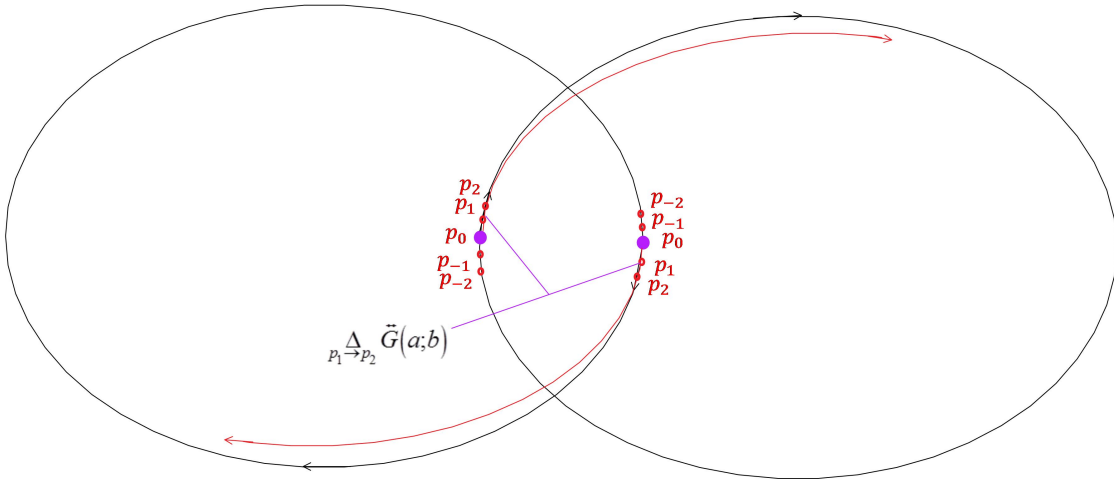
explains that the observed orbital decay such as that of the Hulse-Taylor system is not due to loss of energy emitted as gravitational waves, but increase in the momentum towards of each body towards the other due to gravitational acceleration. As we have explained earlier, gravitational acceleration results from the reorientation of the trajectories of the component vectors of the bodies and such an increase in momentum does not change the number of component $preons^{(+)}$, hence has no effect on the mass or energy of the bodies. As massive bodies such as black holes spiral approach, they speed approach that of the speed of light so

that their momentum approach their energy, that is $\left\|\sum_{i=1}^{m_a} \vec{c}_i\right\| \to \sum_{i=1}^{m_a} \|\vec{c}_i\|$. Momentum is not

conserved during gravitational acceleration but energy is. Therefore, there is no loss of energy in the process of coalescence of massive bodies. The mass and energy of resulting from the

coalescence will be $m_{a+b} = m_a + m_b$, $E_{a+b} = E_a + E_b$ and $\vec{P}_{a+b} = \sum_{i=1}^{m_a} \vec{c}_i + \sum_{i=1}^{m_b} \vec{c}_i$. The resulting

black hole (in the case of black hole merger) will spin at a speed equal to the speed of light.

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.
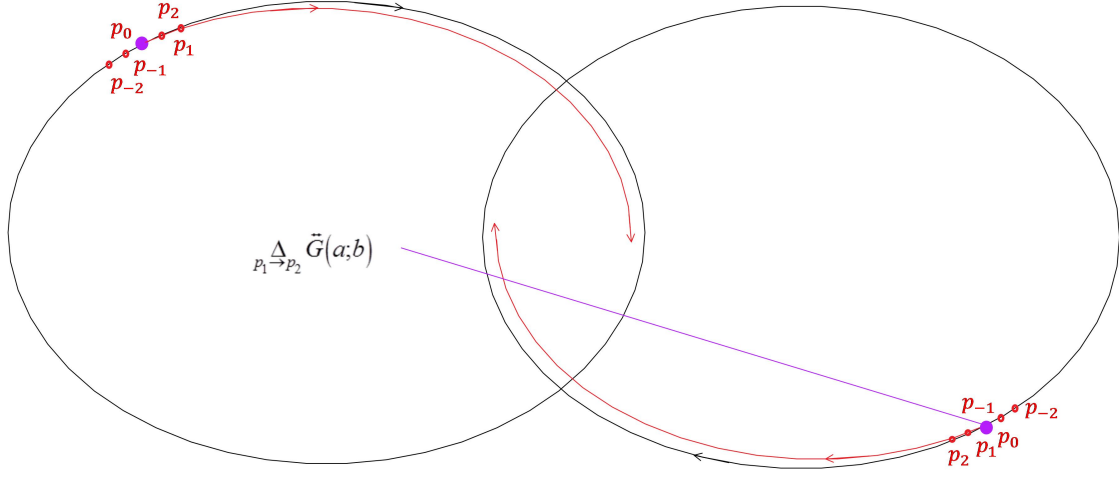
About the Relation Between Mass and Energy

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 $\left\|\vec{P}_a\right\| = \left\|\sum_{i=1}^{m_a} \vec{c}_i\right\|$, 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:

$m = \sum\limits_{i=1}^{n} m_{\gamma_i}$ and $E = \sum\limits_{i=1}^{n} m_{\gamma_i} c$ 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 $\left\| \sum\limits_{i=1}^{m_\gamma} \vec{c}_i \right\| = \sum\limits_{i=1}^{m_\gamma} \left\| \vec{c}_i \right\|$, 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 $heat_{S_1} = \sum\limits_{i=1}^{n_1} \left\| \vec{P}_i \right\|$ and

$$heat_{S_2} = \sum\limits_{j=1}^{n_2} \left\| \vec{P}_j \right\| < \sum\limits_{j=1}^{n} m_{\gamma_j} c \,.$$

The temperatures of S_1 and S_2, immediately after the reaction, before the volume S_2 expands are respectively $temp_{S_1} = \dfrac{\sum\limits_{i=1}^{n_1} \left\| \vec{P}_i \right\|}{Vol_{S_1}}$ and $temp_{S_2} = \dfrac{\sum\limits_{j=1}^{n_2} \left\| \vec{P}_i \right\|}{Vol_{S_1}}$ 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.