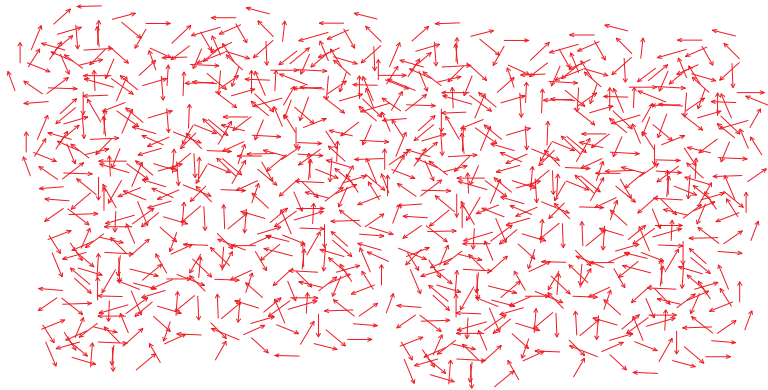


## QGD Cosmology

### The Initial or Isotropic State

Quantum-geometry dynamics predicts that the universe as we observe it is consistent with an initial state in which only free  $preons^{(+)}$  existed and were homogeneously distributed throughout space (we will refer to this state as the initial or isotropic state). The observable



The initial isotropic state of the Universe according to QGD. The red arrows represent the momentum vectors of  $preons^{(+)}$

universe is the result of condensation of  $preons^{(+)}$  into slow massive particles (dark matter particles), which fused to form visible particles, atoms, gases, the stars, galaxies and galaxy clusters. Therefore, the matter density of the Universe's initial state was homogeneous. That is

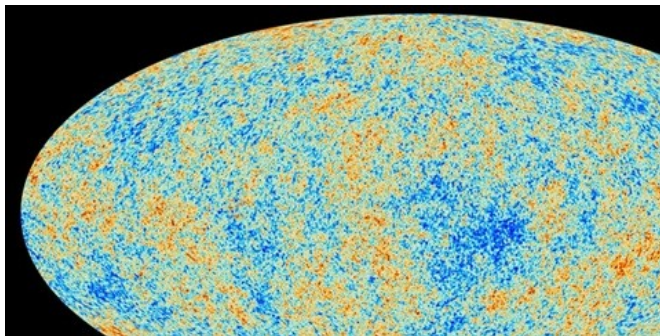
$$dens_U = \frac{m_U}{Vol_U}, \text{ where } m_U$$

is the number of  $preons^{(+)}$  in the Universe and  $Vol_U$ , its volume expressed in  $preons^{(-)}$ .

We find that the Universe evolved naturally from an initial isotropic state given that the same physical laws that rule the universe today prevailed throughout its entire existence.

### Cosmic Microwave Background Radiation (1st observable state)

We have seen how gravity at the microscopic scale is a hundred orders of magnitudes greater



Cosmic microwave background  
image Credit: European Space Agency

than that at the Newtonian scale due to the weakness of the n-gravity component of gravity. Gravity at very short distances between  $preons^{(+)}$  is such that they become gravitationally bounded and form progressively more massive particles and eventually, neutrinos and photons.

The simplest composite particles are

made from two  $preons^{(+)}$ . In order for two  $preons^{(+)}$   $a$  and  $b$  to become bounded, they must come at a distance such that  $\Delta \vec{G}(a;b) \geq \cos \theta * \vec{P}_{\vec{c}_i}$  where  $i \in \{a,b\}$ ,  $\vec{c}_i$  is the momentum of the  $preons^{(+)}$  and  $\theta$  is the angle between converging trajectories.

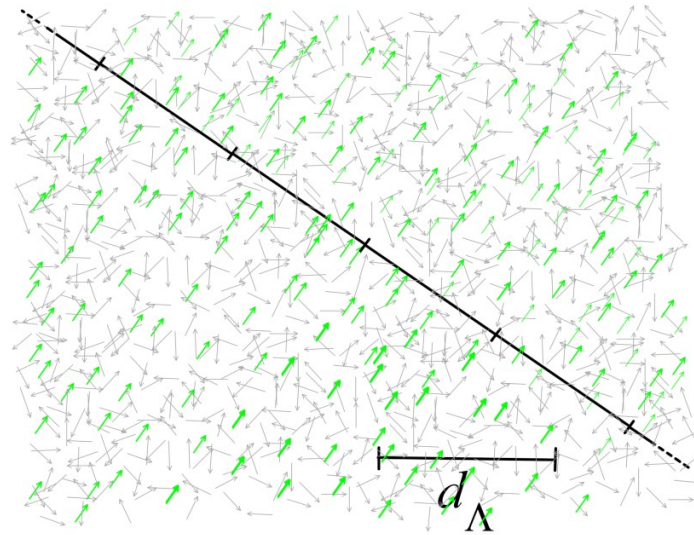
If  $\vec{c} \gg \Delta \vec{G}(a;b)$  then, following the initial isotropic state,  $preons^{(+)}$  became bound when  $\theta$  was very small. That is they became bounded when their trajectories are convergent and nearly parallel. **This binding of  $preons^{(+)}$  would only happen over large travelling distances exceeding galactic scales and would form photons.**

Photons (or any other particle for that matter) become observable when their momentum is sufficient to affect an electron, that is when  $\|\vec{P}_\gamma\| \geq m_{e^-}$ . A number of particles of the photon and neutrino types formed following the initial preonic state, but the first photons to be observable collectively composed what we know as the cosmic microwave background radiation (CMBR). As we have discussed earlier, the observed isotropy of the cosmic microwave background is a direct and natural consequence of the initial isotropic state.

Note that though the momentum of photons that formed during this stage of the evolution of the Universe possessed the minimum momentum necessary to be absorbed or emitted by electrons, electrons formed at a much later stage of the evolution of the Universe. This suggests that the luminosity of the CMBR was at some point much greater than what is now observed.

## Particle Formation and Large Scale Structures

According to QGD, photons gained mass over long distances by binding with other photons and



Particles moving in same direction in the early Universe interact over long distances and allowing to become bound.

$preons^{(+)}$ . During the formation of the CMBR, the particles momentum and energy were equal and their speed is equal to  $c$  or as we have seen

$$\|\vec{P}_\gamma\| = \left\| \sum_{i=1}^{m_\gamma} \vec{c}_i \right\| = \sum_{i=1}^{m_\gamma} \|\vec{c}_i\| = E_\gamma \text{ and}$$

$$v_\gamma = \frac{\left\| \sum_{i=1}^{m_\gamma} \vec{c}_i \right\|}{m_\gamma} = \frac{m_\gamma c}{m_\gamma} = c.$$

After travelling over very large distances, some photons became sufficiently massive from the absorption of  $preons^{(+)}$  or from

merging with other photons for them to bind with other massive photons when their trajectory

intersected at larger angles. That is when  $\Delta\vec{G}(\gamma;\gamma') \geq \frac{\cos\theta^* \vec{P}_\gamma}{\cos\theta^* \vec{P}_{\gamma'}}$ . The momentum of the

resulting particles would be much smaller than their combined individual momenta or energies. Hence the velocity of the new particles formed in that way would be orders of magnitude slower than  $c$ .

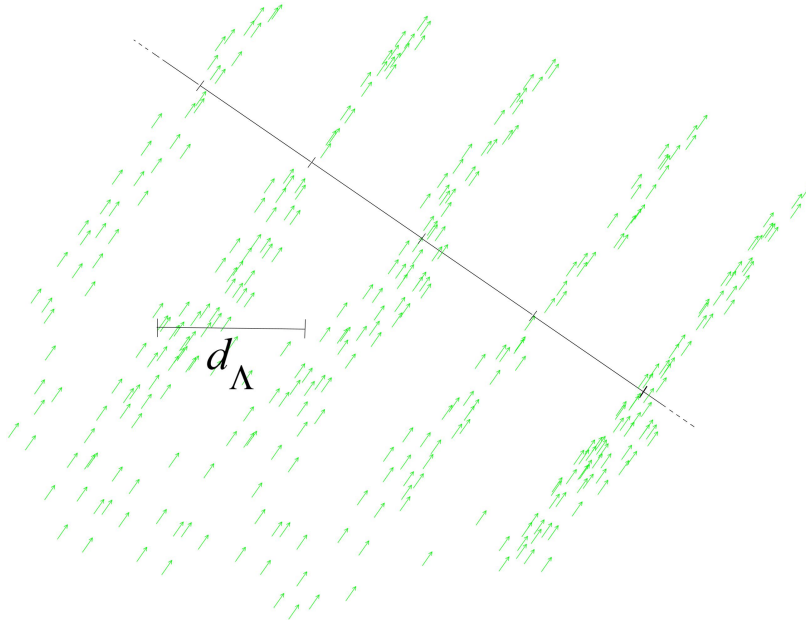
$$\|\vec{P}_{\gamma''}\| = \left\| \sum_{i=1}^{m_\gamma} \vec{c}_i \right\| + \left\| \sum_{i=1}^{m_{\gamma'}} \vec{c}_i \right\| = \left\| \sum_{i=1}^{m_\gamma} \vec{c}_i + \sum_{i=1}^{m_{\gamma'}} \vec{c}_i \right\| < \sum_{i=1}^{m_\gamma} \|\vec{c}_i\| + \sum_{i=1}^{m_{\gamma'}} \|\vec{c}_i\| \text{ and } v_{\gamma''} = \frac{\|\vec{P}_{\gamma''}\|}{m_{\gamma''}} \text{ and since}$$

$$\|\vec{P}_{\gamma''}\| < E_{\gamma''} \text{ then } v_{\gamma''} < c.$$

That is how particles with larger masses and subluminal velocity were produced, some many orders of magnitude slower than  $c$ .

Slow massive particles with momentum less than the minimum allowable change in momentum for an electron are as a consequence not detectable (dark) but they can be indirectly detected

through their gravitational interactions with visible matter and light.

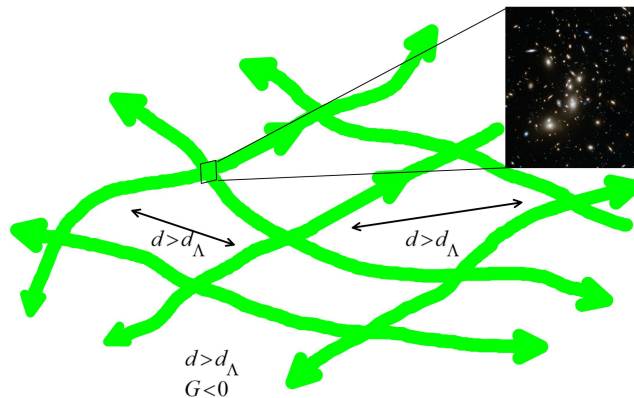


Under the effect of gravitational interaction (attractive for  $d < d_\Lambda$  and repulsive for  $d > d_\Lambda$ , where the threshold distance  $d_\Lambda \approx 10 \text{ Mpc}$ ) condensed into streams of dark matter which at their intersection formed halos. It is from and within these halos that progressively more massive particles formed, which eventually created the galaxies and galaxies clusters.

**Under the influence of attractive and repulsive gravity, particles over very large distances form streams of particles. The more massive the particles, the shorter the distance over which the streams are formed and the denser they are.**

The above figure illustrates streams of dark particles (dark matter), shaped by attractive and repulsive gravity create the filaments of the observed large scale structure of the Universe. Galaxy clusters are formed at the intersections of two or more streams.

Since the distance between intersections of filaments within which clusters are formed is greater than  $d_\Lambda$ , galaxies belonging to different clusters gravitationally repel each other and causing the expansion of the material Universe. The rate at which galaxies recess from one

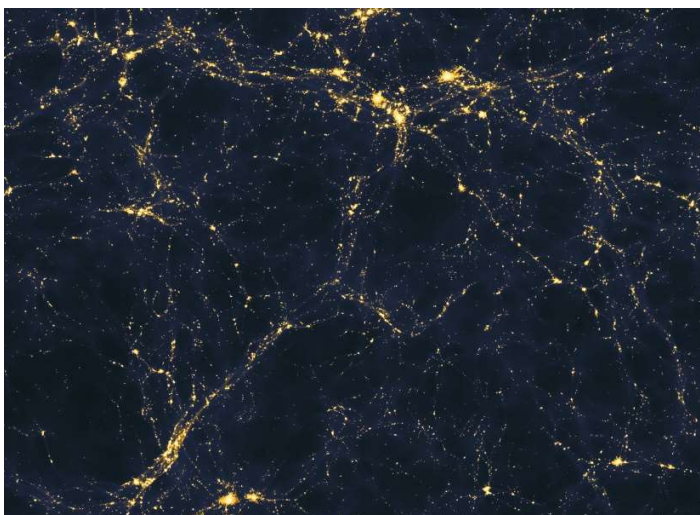


another is described by the [QGD's equation for gravity](#); hence it increases with distance between them and with their mass and most significantly as a function of their distance from the center of the Universe. Current theories assume that the universe is infinite, but if space is discrete (an axiom of QGD), then the fundamental elements of space, the *preons*<sup>(-)</sup>, must obey the

law of conservation, hence there must be a finite number of them, hence the universe must be spatially finite with a finite number of dimension (three) and a finite amount of matter.

It is important here to emphasize the difference between the expansion of the Universe as it is currently understood, which implies the expansion of space itself, and the material expansion of the large scale structure due to repulsive gravity which requires [space](#) to remain fixed.

## Galaxy Formation, Motion, Shape and Evolution



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Once particles started to condense to form the large scale structures, the distribution of matter became anisotropic and as a consequence, the non-homogeneous distribution of matter resulted in heterogeneous gravitational interactions between structures.

As more matter condensed, the magnitude of both attractive gravity from within proto-galaxies and net repulsive gravity from matter at distances beyond the  $d_\Lambda$  threshold increased and

became determinant in shaping galaxies.

A galaxy will be shaped by the gravitational interactions with other galaxies within their clusters, but even more so between galaxies belonging to different clusters at very large distances.

For example, when the net gravity acting on a galaxy is along one axis, the galaxy will be flattened. Similarly, when the distribution of structures a galaxy interacts with is irregular, then its shape will be irregular. The more homogeneous the distribution of matter interacting with a galaxy, the more spherical it will be. Therefore from the shape of galaxies, we can deduce the



gravitational interactions it is subjected to and from it, the distribution of the structures gravitationally acting on them.

## Galaxy Dynamics

In order to correctly describe the dynamics of galaxies we need to take into account all gravitational interactions.

An object  $b$  becomes locked into orbiting a more massive object  $a$  when the magnitude of the component momentum vector of  $b$  in

direction of  $a$  is cancelled out by gravity. That is:  $\vec{P}_b \cos \theta = - \Delta \vec{G}_{p_1 \rightarrow p_2}(a; b)$  where

$$\Delta \vec{G}_{p_1 \rightarrow p_2}(a; b) = \vec{G}_{p_2}(a; b) - \vec{G}_{p_1}(a; b) \cos \theta \text{ and } \theta \text{ is the angle between } \vec{G}_{p_1}(a; b) \text{ and } \vec{G}_{p_2}(a; b).$$

$\vec{P}_b$  is itself resultant the momenta of the components from which it was formed (see [laws of momentum](#)) and the gravitational interactions it is subjected to. For example, a star  $x$  belonging to a galaxy  $a$  within a given cluster,  $\vec{P}_x$  will be the resultant momenta of the converging streams of particles within which its cluster was formed and the gravitational interactions it is subjected to.

In the simplest case, the speed of an object  $b$  in orbit at a radial distance  $r$  from the center of a

massive structure  $a$  is  $\vec{v}_b = \frac{\vec{P}_b}{m_b} = \frac{\Delta \vec{G}_{p_1 \rightarrow p_2}(a; b)}{m_b \cos \theta}$ , but this simplest case is only to serve as a basis

describe gravitational interactions which in reality are always much more complex.

For one, we must take into account gravitational effects attributed to dark matter.

## Dark Matter Halo Density Distribution

In order to correctly describe the motion of stars within a galaxy, we must first understand the distribution of [dark matter](#) in the region containing the galaxy. Unlike other models which treat



dark matter as an exotic type of matter, QGD predicts that all matter is fundamentally composed of *preons*<sup>(+)</sup>, themselves dark, which become bounded to form progressively more massive particles which as we have explained earlier become visible matter when photons they absorb or emit have at least the minimum momentum necessary to be absorbed by an electron.

This implies that  $\Delta m_{vm}$ , the rate at which visible matter is created from dark matter, must be proportional to the dark halo density  $\Omega_{dm}$  but also that there is a critical density  $\Omega_{min}$  below which visible matter cannot form. As a consequence, the density of the dark matter is not expected to increase as we get closer to the center of a galaxy as dominant dark matter models predict. Under the influence of gravity, dark matter would concentrate towards the center, but the higher rate of production of visible matter would tend towards keeping  $\Omega_{dm}$  below  $\Omega_{min}$ .

QGD predicts that  $\Omega_{dm} \approx \Omega_{min}$  within a radius  $r < d_{\Omega_{min}}$  where  $d_{\Omega_{min}}$  is the distance beyond which  $\Omega_{dm} < \Omega_{min}$ . This dynamics which limits the increase of dark matter density towards the center of a galaxy is consistent with the observed flat dark matter density profiles of galaxies<sup>1617</sup>. Thus QGD precludes the formation of the dark matter cusps predicted by dominant dark matter models (see [cuspy halo problem](#)).

### Rotation Curve of Galaxies

QGD's equation for gravity and its predicted for dark particles ( particles for with  $\|\vec{P}\| < m_{e^-}$  ) explain the observed rotation curves of galaxies.

The orbital velocity of a star is  $\vec{v}_b = \frac{\vec{P}_b}{m_b} = \frac{\Delta \vec{G}(a;b)}{m_b \cos \theta}$  where

$$\begin{aligned} \Delta \vec{G}(a;b) &= \Delta \vec{G}^+(a;b) + \Delta \vec{G}^-(a;b) \\ &= \Delta m_a * m_b k + \Delta m_a m_b * d \end{aligned}$$

Note that the p-gravity and n-gravity components of QGD's equation for gravity

$$\vec{G}(a;b) = m_a m_b \left( k - \frac{d^2 + d}{1} \right)$$

must be differentiated separately since gravity is the resultant effect of the p-gravity force which is a function of mass only while n-gravity force is a function of both mass and distance. When only taking into account two objects with constant masses, then

<sup>16</sup> Moore, Ben; et al. (August 1994). "Evidence against dissipation-less dark matter from observations of galaxy haloes". *Nature*. **370** (6491): 629–631. [Bibcode:1994Natur.370..629M](#). [doi:10.1038/370629a0](#).

<sup>17</sup> Oh, Se-Heon; et al. (May 2015). "High-resolution Mass Models of Dwarf Galaxies from LITTLE THINGS". *The Astronomical Journal*. **149** (6): 180. [arXiv:1502.01281](#). [Bibcode:2015AJ....149..180O](#). [doi:10.1088/0004-6256/149/6/18](#)

$\Delta \vec{G}^+(a;b) = 0$  and  $\Delta \vec{G}(a;b) = \Delta \vec{G}^-(a;b)$ , and objects behave as if governed by Newtonian gravity with gravity diminishing as a function of the square of the distance and

$$\Delta \vec{v}_b = \frac{\Delta \vec{G}^-(a;b)}{m_b} \text{ and } \Delta \vec{v}_a = \frac{\Delta \vec{G}^-(a;b)}{m_a}. \text{ The action is the same but where Newtonian gravity}$$

is strictly attractive with variations due to variations in distance between  $a$  and  $b$ , QGD attributes the change in gravity variations in repulsive gravity (n-gravity) as a function of distance.

In order to describe the rotation curve of a galaxy, we need to consider the influence of both visible and dark matter. That is, if  $R_a$  is a spherical region of space with radius  $r = d$  which center coincides with the center of a galaxy  $a$  and then the mass of matter within  $R_a$  is  $m_{R_a} = m_a + m_{dm}$ , where  $m_a$  and  $m_{dm}$  are respectively the amount of visible matter and dark

$$\text{matter in } R_a, \text{ then } \Delta \vec{v}_b = \frac{\Delta \vec{G}^+(m_{R_a};b) + \Delta \vec{G}^-(m_{R_a};b)}{m_b}.$$

$$\Delta \vec{G}^+(m_{R_a};b) = \Delta m_{dm} m_b k \text{ and since } \Delta m_{R_{dm}} = 4\pi r^2 \Omega_{dm}, \text{ ,}$$

$$\begin{aligned} \Delta \vec{G}(R_a;b) &= \Delta \vec{G}^+(R_a;b) + \Delta \vec{G}^-(R_a;b) \\ &= 4\pi r^2 \Omega_{dm} m_b k - 2\pi r^3 \Omega_{dm} m_b \end{aligned}$$

and

$$\begin{aligned} \Delta \vec{v}_b &= 4\pi r^2 \Omega_{dm} k - 2\pi r^3 \Omega_{dm} \\ &= 4\pi r^2 \Omega_{dm} \left( k - \frac{r}{2} \right) \end{aligned}$$

And if the density of dark matter is inversely proportional to the square of the distance from the center of the galaxy then  $\Delta \vec{v}_b = 4\pi r^2 \frac{\alpha_{dm}}{r^2} \left( k - \frac{r}{2} \right) = 4\pi \alpha_{dm} \left( k - \frac{r}{2} \right)$ , hence the observed flattening of the rotation curve of galaxies.

## Recession Speed between Large Structures

The rate at which large structures accelerate away from each other is proportional to the variation in the gravitational repulsion between two positions and is given by

$$\Delta v_a + \Delta v_b = \frac{\Delta G(R_a; R_b)}{m_a} + \frac{\Delta G(R_a; R_b)}{m_b}.$$

If the universe evolved from an isotropic state such as we described earlier, then the speed of a structure  $b$  relative to a structure  $a$  is equal to the total acceleration between  $d_\Lambda$ , the threshold distance at which gravity becomes repulsive, and  $d$  the distance between the structures  $a$  and  $b$ . That is,

$$v_{rel} = v_a + v_b = \frac{\sum_{d_\Lambda}^d \Delta G(R_a; R_b)}{m_a} + \frac{\sum_{d_\Lambda}^d \Delta G(R_a; R_b)}{m_b} = \frac{m_a + m_b}{m_a m_b} \sum_{d_\Lambda}^d \Delta G(R_a; R_b).$$

The acceleration from a galaxy from a large structure is independent of its mass but only dependent on the mass of the structure it is receding from.

Like acceleration from attractive gravity, acceleration from repulsive gravity is directly proportional to the distance. The derivative of QGD's equation for gravity over distance gives the gravitational acceleration over a distance or  $v_{R_a} = m_{R_b} d$ .

Then  $v_{rel} = v_{R_a} + v_{R_b} = (m_{R_a} + m_{R_b})d$  where  $d$  may be understood as the proper distance between  $R_a$  and  $R_b$ .

The acceleration of the rate of recession between  $a$  and  $b$  is

$$\Delta v_{rel} \simeq (m_{R_a} + m_{R_b}) \frac{d^2 - d_\Lambda^2}{2} = (m_{R_a} + m_{R_b}) d$$

However, the recession speed between two structures does not only depend on the distance and masses of the structures, but on all masses and structures each interact with, that is, it depends on the gravitational interactions with the rest of the universe, therefore, it depends on each galaxies positions relative to the center of the galaxy. This is measured using the cosmological redshift as discussed in the following section.

## Expansion Rate of the Material Universe and the Cosmological Redshift

According to QGD, space is composed of a finite number fundamental discrete units,  $preons^{(-)}$ , which makes space a static structure through in which all matter exists. Hence space is finite and must have a center and an edge.



Material structures are strictly kinetic and as we have seen in previous sections gravitationally attract or repel one another depending on whether the distances that separate them is smaller or greater than the threshold distance  $d_\Lambda$ .

We define the cosmological acceleration as the effect of gravity on structures at a scale at which structures are separated by distances greater than the threshold distance beyond which gravity becomes repulsive or  $d > d_\Lambda$ . At the cosmological scale, since gravity is repulsive, the structures accelerate away from the center of the Universe at a rate that is proportional to their distance from the center and the inversely proportional to their shortest distances from the edge of the Universe.

For an object  $a$  at a distance  $r$  from the center of the Universe and  $d_U$ , the diameter of the universe, we find that  $\Delta \vec{P}_a = \Delta \vec{G}(m_{R_1}; m_a) + \Delta \vec{G}(m_{R_2}; m_a)$  where  $m_{R_x} = vol_{R_x} \frac{m_U}{Vol_U}$ .

Observationally, objects at the cosmological scale that are closer than we are to the center of the universe will appear blueshifted relative to light from the center of our galaxy and objects that are further than we are from the center of the Universe will appear redshifted relative to it.

However, since the cosmological acceleration affects a galaxy as a whole with negligible differences on individual components of a galaxy, we would observe within a galaxy stars that may be redshifted or blueshifted relative to a reference star depending on whether the observed star is respectively closer or further from the center of the galaxy.

## Black Holes and Black Holes Physics

QGD predicts the existence of structures which exerts such gravitational pull that photons cannot escape. But contrary to the classical black holes predicted by relativity, the black holes predicted by quantum-geometry dynamics are not singularities. The QGD exclusion principle which states that a  $preon^{(-)}$  cannot be occupied by more than one  $preon^{(+)}$  implies that quantum-geometrical space imposes a limit to the density any structure can have. The density of black holes is also limited by the fact that  $preons^{(+)}$ , being strictly kinetic, they must have enough space to keep in motion. It follows that black must have very large yet finite densities.

## Angle between the Rotation Axis and the Magnetic Axis

The effect of the helical motions of the electrons in direction of the rotation of a body adds up so that, at a large scale, the body behaves as a single large electron which through helical trajectory around the body interacts with the neighbouring preonic region to generate a magnetic field.

Since the magnetic field is the result of the polarization of free  $preons^{(+)}$  along the loops of the helical trajectory, and since the inclination of these loops increases with the speed of rotation,

so does the angle between these loops and the axis of rotation increases. It follows that the angle between the axis of rotation and the magnetic axis for bodies of given material composition is proportional to the speed of rotation about its axis and its diameter.

This angle between the axis of rotation and the magnetic axis is small for slowly rotating bodies but can never be so small that the axes coincide. From the above, it also follows that a faster rotation not only implies a larger the angle between the rotation axis and the magnetic axis is, but also a flattening of the magnetic field and an increase in its intensity.

### The Inner Structure of Black Holes

To understand the structure of a black hole we will look at what happens to a photon when it is captured by it the gravitational pull.

The model for light refraction that we introduced in earlier articles can be applied directly to photon moving through a black hole. Since we assume that the black hole is extremely massive, its trajectory will bring it towards the center of the black hole.

When moving along the magnetic axis of the black hole, the component  $preons^{(+)}$  of the  $preon^{(+)}$  pairs of the photon are pulled away from each other, splitting the photon into free  $preons^{(+)}$  which may or not recombine into neutrinos. This works as follow:

As we have seen earlier in this book, the force binding the  $preons^{(+)}$  of a  $preon^{(+)}$  pairs is gravitational. The QGD gravitational interaction between particles at the fundamental scale is

$$G(a;b) = m_a m_b \left( k - \frac{d^2 + d}{2} \right), \text{ and since } a \text{ and } b \text{ are } preons^{(+)}, m_a = m_b = 1 \text{ and since}$$

$d = 1$ , the binding force between two  $preons^{(+)}$  of a  $preon^{(+)}$  pair is equal to  $k - 1$ .

For a photon moving along the magnetic axis, we have and  $G(p_1^{(+)}; R'_2) - G(p_1^{(+)}; R'_1) > k - 1$  where  $p_1^{(+)}$  and  $p_2^{(+)}$  are the component  $preons^{(+)}$  of a  $preon^{(+)}$  pair of a photon.

The regions  $R_1$  and  $R_2$ , on each side of the black hole axis are equally massive regions. If we call  $R'_1$  and  $R'_2$  the regions each side of  $p_1^{(+)}$  when the photon's trajectory is aligned with the black hole axis then  $R'_2 > R'_1$  and  $G(p_1^{(+)}; R'_2) - G(p_1^{(+)}; R'_1) > k - 1$ . Similarly, if we call  $R''_1$  and  $R''_2$  the region on the each side  $p_2^{(+)}$  then  $R''_1 > R''_2$  and  $G(p_2^{(+)}; R''_1) - G(p_2^{(+)}; R''_2) > k - 1$ . So the force pulling the  $preons^{(+)}$  of  $preon^{(+)}$  pairs being greater than the force that binds them, the  $preon^{(+)}$  pairs are split into single  $preons^{(+)}$ .

The diagram shows a central point labeled  $R_1$  with a blue arrow pointing upwards and a black arrow pointing downwards, both labeled  $G(p_1^{(+)}; R_2) - G(p_1^{(+)}; R_1')$ . A purple line labeled "magnetic axis" passes through the center. A red line labeled "photon" passes through the center. A green circle is centered at the origin. Several red and blue lines radiate from the center, labeled  $R_1'$ ,  $R_2'$ ,  $R_1''$ , and  $R_2''$ . A green dashed line is also shown.

Once the trajectories of the  $preons^{(+)}$  or the neutrino coincides with the magnetic axis of the black hole, the  $preons^{(+)}$  or neutrinos will move through the center of the black hole and will exit it.  $Preons^{(+)}$  and neutrinos can escape the gravitation of the black hole because gravitational interactions, though it affects the directions of  $preons^{(+)}$ , doesn't change their momentums which, as we have seen in earlier articles is fundamental and intrinsic (the momentum of a  $preon^{(+)}$  is  $\|\vec{c}\|$  where  $\vec{c}$  is momentum vector of a  $preon^{(+)}$ ).

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interact too weakly with instruments to be detected by our instruments, they are invisible to them. In order to see the  $preons^{(+)}$ -neutrinos jets from a black hole, instruments may need detectors larger than our solar system. However, the jets can be observed indirectly when they interact with large amount of matter when the polarized  $preons^{(+)}$  and neutrinos they contain impart it with their intrinsic momentum. It is worth noting that polarized preons and neutrinos jets, as described by QGD, would contribute to the observed dark energy effect.

Based on QGD's model of the black hole, we can predict that the  $preons^{(+)}$ /neutrino jets will form an extremely intense polarized  $preons^{(+)}$  field along the magnetic axis creating the equivalent of a repulsive electromagnetic effect at both poles. The polarized preonic field would repulse all matter on their path, which may explain the shape of galaxies.

From what we have discussed in the preceding section, we can define a black hole as an object which mass is such that it can breakdown all matter, including photons, into  $preons^{(+)}$ . Therefore, any emission by a black hole being preonic, they are not visible. However, intense preonic fields (which as we have seen are essentially intense magnetic fields), will impart momentum to particles and structures, bringing them into excited states from which they emit photons.

The QGD model of the physics of black hole has another important implication. The  $preons^{(+)}$  and neutrinos resulting from the breakdown of a particle or structure are indistinguishable from the  $preons^{(+)}$  or neutrinos resulting from the breakdown of any other particle or structure. This means, if QGD is correct, that all information about the original particle or structure is lost forever. That said, since this consistent from QGD's axioms set and since, unlike quantum mechanics, QGD does not require that information be preserved, the loss of information it predicts does not lead to a [paradox](#) ( see [this article](#) for an excellent introduction to subject).

### Density and Size of Black Holes

QGD predicts that black holes are extremely dense but not infinitely so. Considering that  $preons^{(+)}$  are strictly kinetic and that no two can simultaneously occupy any given  $preons^{(-)}$

then  $\max density_{BH} = \frac{1 preon^{(+)}}{2 preons^{(-)}} or \frac{1}{2}$ . It follows that  $\min Vol_{BH} = 2m_{BH} preons^{(-)}$  or, since

$preon^{(-)}$  is the fundamental unit of space, we can simply write  $\min Vol_{BH} = 2m_{BH}$  for the

minimum corresponding radius  $\min r_{BH} = \left[ \sqrt[3]{\frac{3m_{BH}}{2\pi}} \right]$ .

For the radius of the black hole predicted to be a the center of our galaxy,  $m_{BH} \approx 4*10^6 M_{\odot}$

and  $\min r_{BH} = \left[ \sqrt[3]{\frac{3m_{BH}}{2\pi}} \right] \approx 1.24*10^2 M_{\odot}$  where the mass is expressed in  $preons^{(+)}$  and radius

in  $preons^{(-)}$ . Though converting this into conventional units requires observations to determine the values of the QGD constants  $k$  and  $c$ , using relation between QGD and Newtonian gravity, we also predict that the radius within which light cannot escape a massive

structure is  $r_{qgd} = \sqrt{G_{const} \frac{M}{c}}$  where  $G_{const}$  is used to represent the gravitational constant. Since

the Schwarzschild radius for a black hole of mass  $M_{BH}$  is  $r_s = G_{const} \frac{M_{BH}}{c^2}$  then  $r_{qgd} = \sqrt{cr_s}$ .

Using  $r_{qgd}$  to calculate  $\delta_{r_{qgd}}$  the angular radius of the shadow of Sagittarius A\*, the black hole at the center of our galaxy, where  $M_{BH} = 4*10^6 M_{\odot}$  we get  $\delta_{r_{qgd}} \approx 26.64*10^{-5}$  arcseconds which is about 10 times the angular radius calculated using the Schwarzschild radius which is  $\delta_{r_s} = 27.6*10^{-6}$  arcseconds. This prediction will be tested in the near future by the upcoming observations by the [Event Horizon Telescope](#).

### Neutron Stars, Pulsars and Other Supermassive Structures

When the mass of a structure is sufficient to bind photons, but insufficient to breakdown photons, electrons and positron, we get a stellar structure which can emit these particles.

The internal gravitational interactions will redirect particles towards the magnetic axis of the stellar structures where, when its trajectory coincides with an axis, the gravitational force from the stellar object acting on the particles will cancel out and the particle will escape the object into outer space. Such structures may correspond to what we call [neutron stars](#). So what distinguishes neutron stars from black holes is that we have  $G(p_1^{(+)}; R_2') - G(p_1^{(+)}; R_1') < k - 1$  and  $G(p_2^{(+)}; R_1'') - G(p_2^{(+)}; R_2'') < k - 1$ . That is, the gravitational force within the neutron star which acts on particles is insufficient to breakdown photon, electron and positrons.

Another prediction is that distinguishes quantum-geometry dynamics is that neutron stars are not composed of neutrons. The internal gravitational forces being such that they would break down all particles into neutrinos, photons, electrons and positrons.

### Pulsars

When a neutron star rotates at a sufficiently high rate, it interacts with the preonic field in such a way that it creates an intense magnetic field. Such magnetic field will be sufficiently strong to curve the trajectory of all neutrinos, photons, electrons and positrons that move past its surface back into pulsar. Particles that move along its axis of rotation, along which the electromagnetic

force cancel out, will escape at the magnetic poles producing the known bidirectional emission characteristic of [pulsars](#).

### The Preonic Universe

According to the principle of strict causality we can deduce the following:

*Preons*<sup>(+)</sup> and *preons*<sup>(-)</sup>, are fundamental. As such and in accordance with the [fundamentality theorem](#), they have no components; hence they require no pre-existing conditions to exist. From this and to be in accordance with the Law of Conservation, all *preons*<sup>(+)</sup> and *preons*<sup>(-)</sup> always existed.

That is, *preons*<sup>(+)</sup> and *preons*<sup>(-)</sup> not only existed at the origin of the Universe. They are the origin of the Universe.

It follows that in its initial phase, the Universe consisted of *preons*<sup>(+)</sup> uniformly distributed throughout the entire quantum-geometric space of the Universe; the preonic universe.

The theory proposes that the n-gravity and p-gravity fields were in perfect equilibrium. That is:

$$k(m_U^2 + m_U) / 2 = (Vol_U^2 + Vol_U) / 2$$

Where  $m_U$  is the mass of the preonic universe and  $Vol_U$  is the number of *preons*<sup>(-)</sup> its space is composed of. But since  $\lim_{x \rightarrow \infty} \left( \frac{x}{x^2} \right) = 0$ , at the macroscopic scale, the relative value of  $m_U$  and  $Vol_U$  become negligible and we can simply write<sup>18</sup>:

$$km_U^2 / 2 \approx Vol_U^2 / 2$$

Also, from the QGD definitions of heat, temperature and entropy we know that, since in the primordial universe contained only free *preons*<sup>(+)</sup>, the heat it contained was equal

to its energy, that is  $Heat = \sum_{i=1}^{m_U} \|\vec{c}_i\| = m_U c$ , its temperature was  $\frac{m_U c}{Vol_U}$  and its entropy

being the difference between its energy and heat, and heat and energy being equal in the preonic universe, its entropy was equal to zero.

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<sup>18</sup>Since QGD implies that all quantities are finite, even mathematical quantities,  $\infty$  represents the largest theoretical quantity of any physical property. In this equation it may be taken as the number of n-gravity interactions in the universe.



Interestingly, since  $Vol_U = \sqrt{km_U^2}$  the temperature of the preonic universe is given by

$$\frac{m_U c}{\sqrt{km_U^2}} = \frac{c}{\sqrt{k}} .$$

Hence, the temperature of the preonic universe is a ratio of  $c$  and  $k$  ; the two fundamental constants of quantum-geometry dynamics.

### **Future Evolution of the Universe**

If QGD's description of the universe is correct, then most matter would eventually collapse into black holes where it would be broken down in into  $preons^{(+)}$  which would be emitted and would reseed the universe; resetting the initial isotropic state.

One question remains. What will happen to the galaxies that will be pushed to the limits of the universe?