NEGATRONS, GRAVITONS AND ELECTRONS[1][1]

Entangled Attractions

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ABSTRACT

This paper follows on from my paper *Black Hole Radiation - Entangled Gravity*, and concentrates on the part Negatrons, Gravitons, Electrons and Entangled particles might play in establishing gravity throughout the universe. The paper provides an explanation of how the Graviton particle might form near a black hole (BH) event horizon. Electrons are generally considered to be fundamental particles, but there appears to be evidence that a BH environment includes both Positron and Negatron particles derived from Electrons. Positrons entangled with Negatrons appear to form Gravitons which are associated with forming gravity, and are fundamental for associating General Relativity gravity with Quantum gravity. This resulted in redrafting the Standard Model of Elementary Particles tabulation. Also, Positrons at a BH stabilise free Neutrons sited inside the BH.

Keywords

PSI, free neutron, negatron, positron, positronium, elementary particles, graviton, scalar boson, gauge boson, tensor boson, entangled particles, ET, chalcocite

[1] http://www.bosmin.com/PSL/NEGATRONS.pdf

1) INTRODUCTION

My paper *Black Hole Radiation - Entangled Gravity* is currently open for PROM review, by Principia Scientific International (PSI).[1][2] One of the key exhibits in that paper is shown in Figure 1. The decay of the neutron into a free neutron is further described and exhibited at *Decay of the neutron by elementary particle physics*,[2][3] and at Researchgate, *How does a neutron interact with atomic electrons?*[3][4]

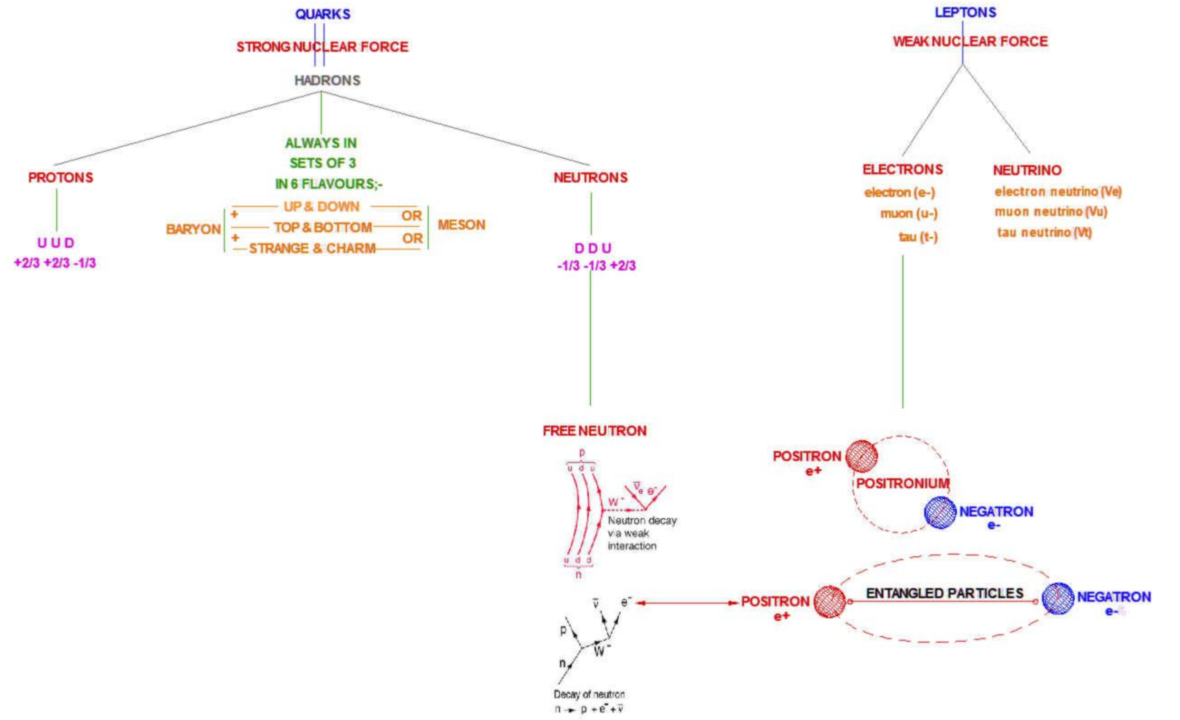

Figure 1.

Figure 1 shows Electrons can form into Positroniums, which include a Positron e+ and an Electron e-. There is a level of confusion used in this terminology showing the word Electron appearing twice, and apparently referring to two different particle conditions.

This confusion extends to the entangled particles consideration where the Positron is permanently captured by the Free Neutron, but inside the BH.

It is proposed to refer to electrons entangled with positrons as negatrons and the not entangled alternate form as electrons.

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1 https://principia-scientific.com/wp-content/uploads/2020/07/blackholeradiationprom.pdf

2 https://en.wikipedia.org/wiki/Neutron#Free_neutron_decay

3 https://www.researchgate.net/post/How_does_a_neutron_interact_with_atomic_electrons

2) POSITRONS

Positrons have recently been discovered in space in significant numbers:[1][5]

> *An excess of positrons has been detected by the Alpha Magnetic Spectrometer (AMS), which collects cosmic rays from its perch on the International Space Station.*

This raises the question, where are the anti particles matching these Positrons?

Another way to describe this situation is for an Electron without a Positron to be regarded as similar to a Neutron without a stabilising Proton, making the Neutron an unstable 'free' Neutron.

Similarly, the Electron without its Positron can be regarded as a 'free' Electron, but herein referred to as a Negatron.

A Negatron and Positron combine to form a Positronium. Outside a BH environment, it has a charge showing positive during the 50% of orbit time, and negative during the other 50%.

However, a Negatron attaching to a Positron, but sited inside a BH, cannot show a positive charge for 50% of time, because the Positron component is permanently entangled with a free Neutron inside the BH. Details shown at reference[2]. This Positronium orbit only shows continuous negative charges.

A Positronium forming into an Electron normally appears to alter charge + - + - + - in a sine format, but a Positronium associated with a BH has a charge appearance of - - - - - - now shown as e-&- (e minus and minus), in a truncated sine format with the positive phase removed and only the intermittent negative phase remaining, as referenced in Figures 2 and 4.

[1] https://physicstoday.scitation.org/do/10.1063/PT.5.028274/full/

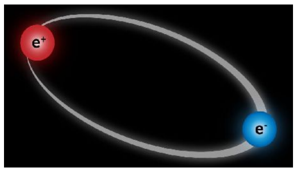
3) NEGATRONS

The duel electron naming anomaly was referred to in 1930:[1][6]

> *Dirac developed in 1930 a model of the vacuum as an infinite sea of particles with negative energy, later dubbed the Dirac sea. This led him to predict the existence of a positron, the antimatter counterpart of the electron. This particle was discovered in 1932 by Carl Anderson,* (Carl David Anderson (September 3, 1905 – January 11, 1991) was an American physicist. He is best known for his discovery of the positron in 1932, an achievement for which he received the 1936 Nobel Prize in Physics, and of the muon in 1936) *who proposed calling standard electrons negatons* (Negatrons) *and using electron as a generic term to describe both the positively and negatively charged variants.*

More recently, a Science News article at[2][7] states;

> *A new measurement of the exotic "atom" — consisting of an electron and its antiparticle, a positron — disagrees with theoretical calculations, scientists report in the Aug. 14* (2019) *Physical Review Letters.*



Positronium

And:

> *While the frequency predicted from calculations was about 18,498 megahertz, the researchers measured about 18,501 megahertz, a difference of about 0.02 percent. Given that the estimated experimental error was only about 0.003 percent, that's a wide gap.*

And:

> *If the experiments and the theoretical calculations check out, the discrepancy might be due to a new particle,*

The Negatron and Positron is a combination of matter and anti matter, and forms a Positronium inherent to an Electron which has one negative charge. However, the Positron has one positive charge, so the Negatron needs two *potential* negatives to balance the charges.

The research finding coincides with the Negatron particle being very similar to an Electron, but not identical and therefore hard to isolate. The Electron is quoted as having a mass of 0.511 MeV/c^2, a charge of -1, and a spin of ½. Based from the previous research, the lower energy finding could be reflected in a lower particle mass and we can expect the Negatron to have a mass of 0.501 MeV/c^2, a charge of -1&-1, and a spin of ½.

If we pursue this line of thought along with entangled particles at a BH, it makes sense to formalise this distinction in a revised version of Figure 1, now shown as Figure 2, and implying that a Negatron is different to an Electron in that it has an entangled association with a parent black hole. However the Negatron can also exist in an electron shell together with standard Electrons.

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1 https://en.wikipedia.org/wiki/Electron

2 https://www.sciencenews.org/article/positronium-energy-levels-exotic-atom-physics

The Negatron can separate from the BH by eliminating the -&- charge and mass, and converting both to a spin of 2. This results in the formation of a Graviton particle.

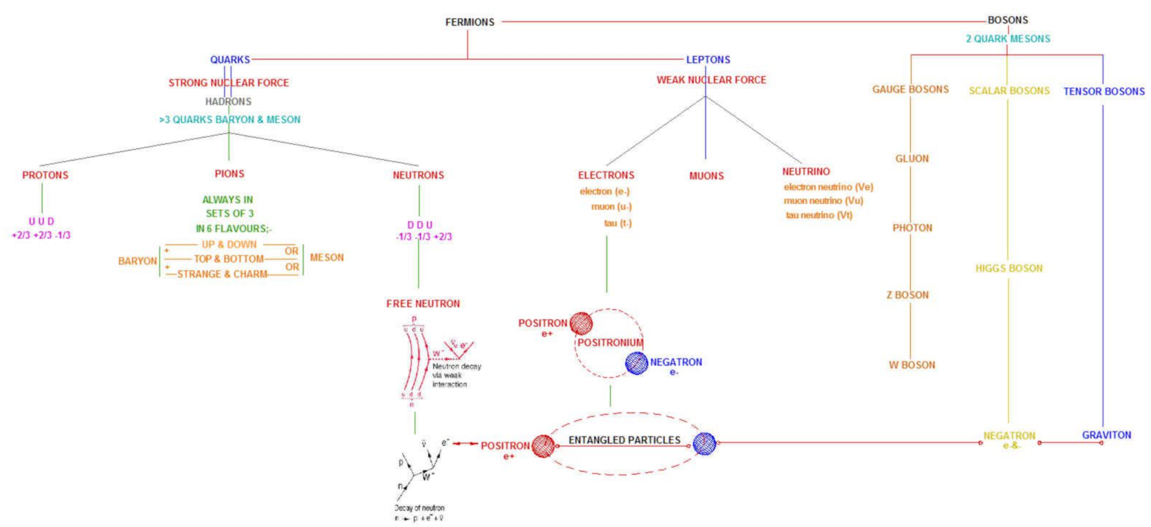

Figure 2.

Figure 2, is a diagrammatic representation of the Standard Model of Elementary Particles information, filed in **Appendix-A** which is now adjusted to include the Positron, Negatron, and Graviton.

Interim Conclusion.

1. Positrons are unexpectedly plentiful in space, showing that an electron should not be regarded as a fundamental particle.
2. Negatrons are anti particles to Positrons.
3. A Negatron is different to an Electron in that it has an entangled association with a parent black hole.
4. A Positron can be captured by a free neutron in a BH environment resulting in the Negatron displaying a -&- charge.
5. The Negatron can separate from the BH by eliminating the -&- charge and mass, and converting both to a spin of 2. This results in the formation of a Graviton particle.

4) GRAVITONS.

Figure 3 is a Kruskal Szekeres diagram, and represents the coordinate system for the Schwarzschild geometry of a BH.[1][8]

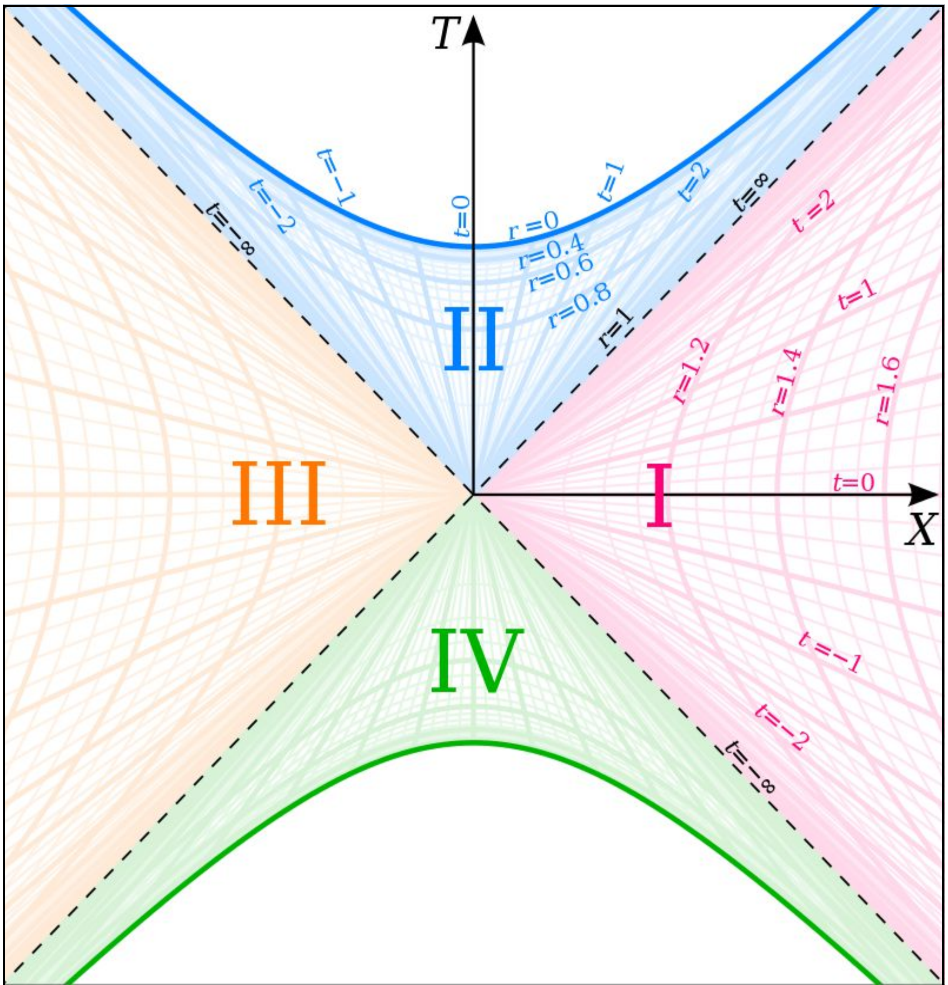

Figure 3.

Figure 4 is derived from a study of the KS diagram, and illustrates a hyperbolic geometry interpretation of a BH.

A key indicator shows mass entering a BH is separated into atomic components due to the high gravity force which is in excess of the electrostatic attraction between the atomic particles. This results in Protons separating from Neutrons which become free Neutrons. The Protons escape the BH as Cosmic Rays travelling at close to the speed of light.[2][9] Electrons include both Positrons and Negatrons, but with the Positrons attaching to the free Neutrons when inside the BH. This stabilises the free Neutrons, and prevents atomic decay.

[1] https://en.wikipedia.org/wiki/Kruskal%E2%80%93Szekeres_coordinates

[2] http://www.bosmin.com/PSL/M87Galaxy.pdf

The e-&- energy charge associated with the Negatron, transfers into a two-spin motion. This allows the uncharged Negatron to escape through the event horizon. However, a Negatron must also be massless to escape from the BH gravity well, so the inherent mass of the Positronium lies exclusively with the Positron remaining inside the BH, and the Negatron has zero mass. This particle emerging from the event horizon has a spin of 2, is massless, and without charge, now described as a Graviton, and capable of exiting a BH environment.

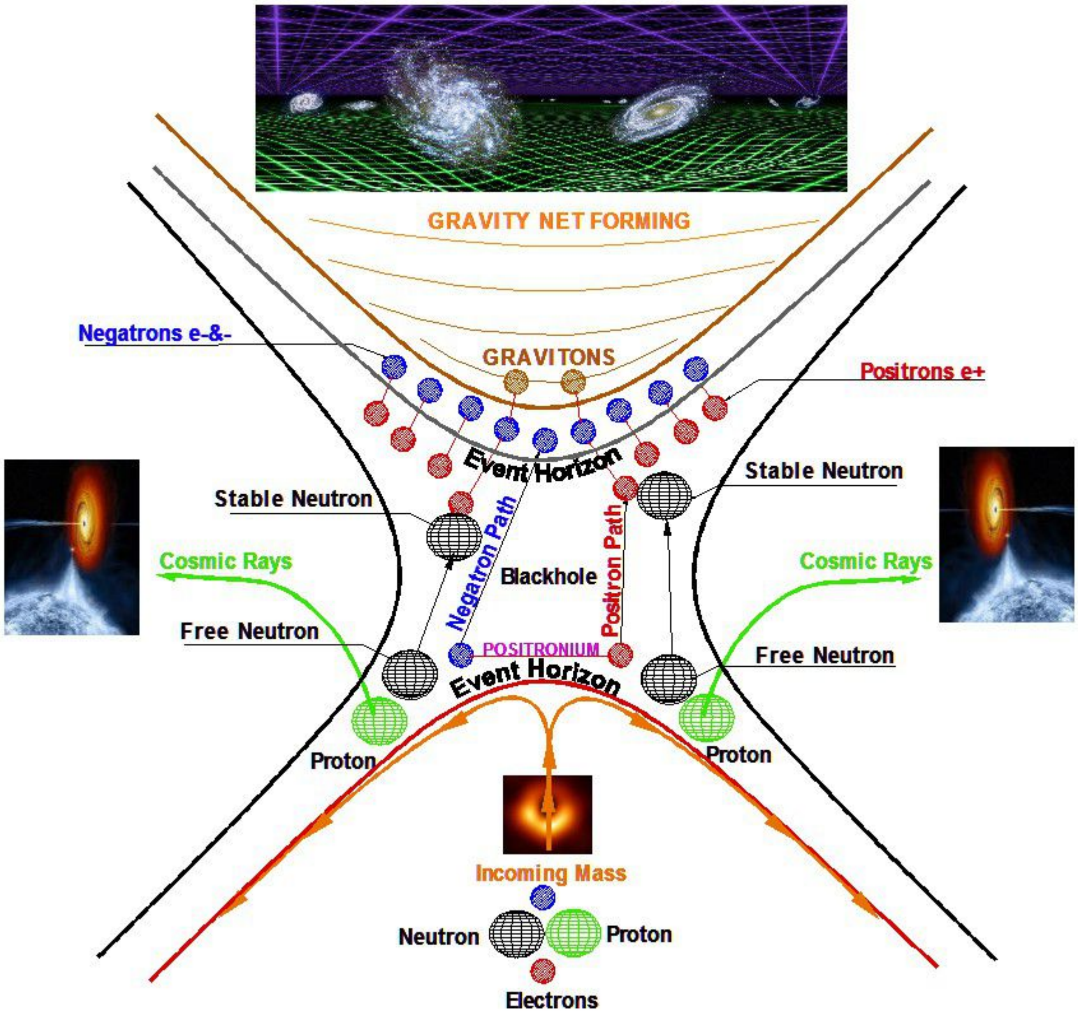

Figure 4.

It is interesting to note that the life of a BH depends on a fairly continuous supply of raw material. If incoming mass stops, the BH becomes unstable through the dissipation of Positron particles leading to instability in the Neutron mass which would return to being free Neutrons.

Interim Conclusion.

1. The Kruskal Szekeres diagram illustrates the hyperbolic geometry present at a BH.
2. The e-&- energy charge associated with the Negatron, transfers into a two-spin motion. This particle emerging from the event horizon transforms to a spin of 2, is massless, and without charge, and described as a Graviton.

5) REVISED STANDARD MODEL OF ELEMENTARY PARTICLES

The Standard Model of Elementary Particles is included in **Appendix-A.**

However,[1][10] "*the Standard Model is inconsistent with that of general relativity, to the point where one or both theories break down under certain conditions. Theories that lie beyond the Standard Model include various extensions of the standard model through supersymmetry, such as the Minimal Supersymmetric Standard Model (MSSM) and Next-to-Minimal Supersymmetric Standard Model (NMSSM).*"

The Model of Elementary Particles is redrawn to include the Tensor Boson column, with Positron, Negatron, and Graviton shown in Figure 5.

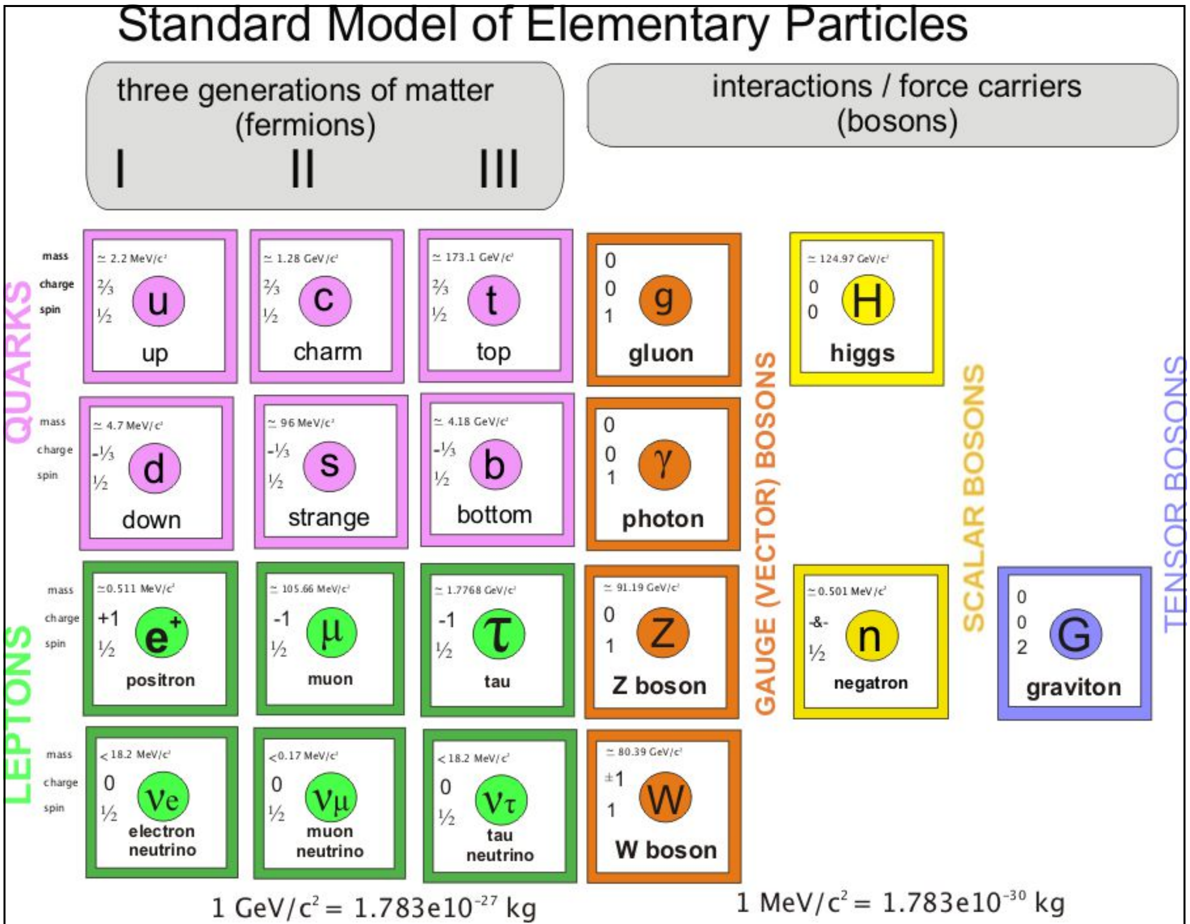

Figure 5.

Figure 5 shows the Negatron added under the Scalar Bosons grouping and the Graviton sited in the Tensor Boson column. In this location more than one boson (Higgs and Graviton) can associate with atomic particles to deliver both atomic mass and gravity. However, the Graviton is massless when escaping the Black Hole but regains some mass from standard Electrons when it associates in an atomic shell as a Negatron. The Negatron has a 0.02% miss

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[1] https://en.wikipedia.org/wiki/Physics_beyond_the_Standard_Model

match with Electron frequencies [7] due to it's entangled association with the Black hole.

Gauge (Vector) Boson definition: "*The weak gauge bosons were discovered due to momentum change in electrons from neutrino-Z exchange. The massless photon mediates the electromagnetic interaction. These four gauge bosons form the electroweak interaction among elementary particles.*"

Scalar Boson definition: "*A scalar boson is a boson whose spin equals zero. Boson means that it has an integer-valued spin; the scalar fixes this value to 0. The name scalar boson arises from quantum field theory. It refers to the particular transformation properties under Lorentz transformation.*"

Tensor Boson has a spin of 2 and is associated with the anticipated Graviton particle. "*They are described by a Tensor of 2nd rank. A scalar is a Tensor of 0th rank and therefore a scalar field particle is a spin-0-particle, a vector is Tensor of 1st rank and if a particle is a vector boson, it is a spin-1-particle.*"

This position fits with our general understanding of Fermions and Bosons shown in **Appendix-B Fermions and Bosons**,[1][11] Exhibit 2 and indicates that Gravitons could associate with atoms containing an even number of neutrons and protons.

The Graviton Table of Elements, Figure 6 is derived from the Periodic Table of Elements[2][12]

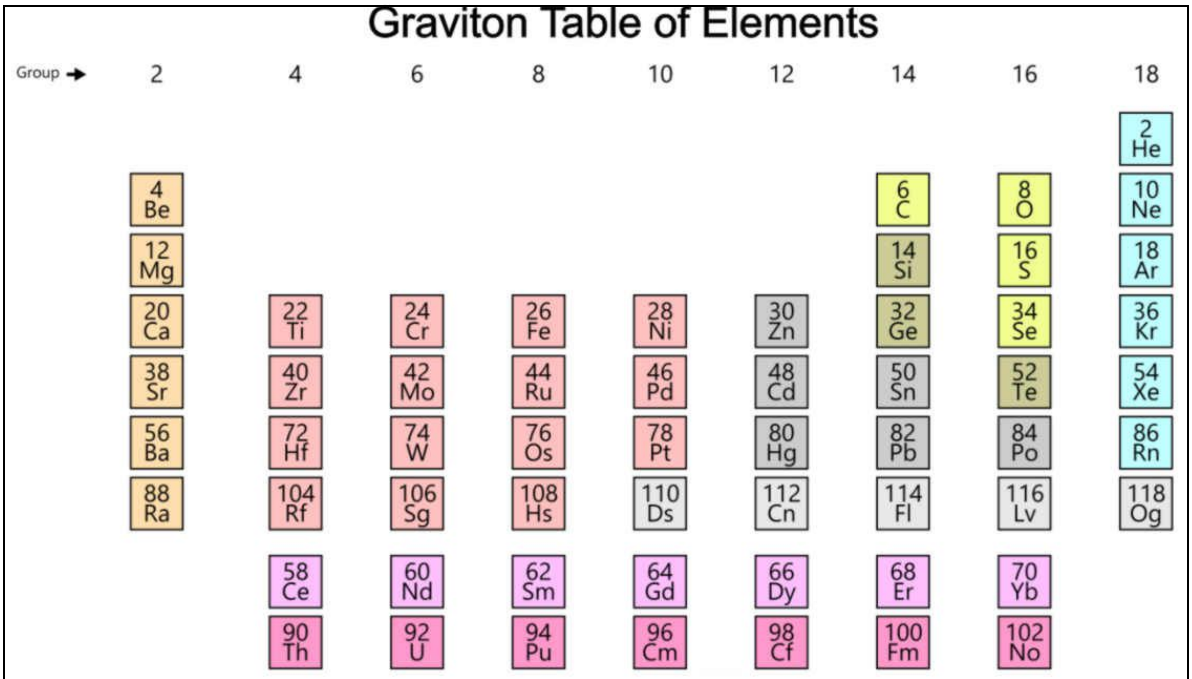

Figure 6.

[1] https://particleadventure.org/fermibos.html

[2] https://en.wikipedia.org/wiki/Periodic_table

The even-numbered columns in Figure 6 are the elements suitable for combining with Gravitons.

The Higgs boson is responsible for featuring the mass property of an atom, and the Graviton has long been thought to provide the gravity property associated with mass. The Graviton is an essential requirement in String theory which is proposed to bridge the knowledge gap between Quantum gravity and Einstein's theory of gravity. This paper prefers to regard entanglement as the knowledge gap bridge.

Interim Conclusions

1. The Positron combined with the free neutron inside the BH takes all the mass from the Positronium. The massless Negatron is capable of leaving the BH as a Graviton.
2. Gravitons provide the gravitational force which is very long range and appears to propagate at the speed of light. Once the gravitational link is established, it remains entangled with its BH host, and provides instantaneous recognition to mass influences.
3. Graviton is massless when escaping the Black Hole but regains some mass from standard Electrons when it associates in an atomic shell as a Negatron.
4. Negatron and Graviton are shown in the Standard Model of Elementary Particles as Scalar and Tensor Bosons, respectively. In these locations more than one boson can associate with atomic particles to deliver both atomic stability and gravity.
5. Electrons are generally considered to be fundamental particles, but there is evidence that both Positron and Negatron particles are derived from Electrons.
6. If incoming mass stops, the BH could become unstable through dissipation of Positron particles, and gradually cease to exist.

6) GRAVITON ASSOCIATION WITH STRINGS

The Positronium combination discussed previously resulted in an entangled association between the Negatron outside the event horizon and the Positron within the BH. Under these circumstances the Negatron e-&- charge transforms into a Graviton with spin of 2, which is suited for incorporation within the String Theory,[1][13] or Entangled Tie as referred to in this paper:

> *In physics, string theory is a theoretical framework in which the point-like particles of particle physics are replaced by one-dimensional objects called strings. String theory describes how these strings propagate through space and interact with each other. On distance scales larger than the string scale, a string looks just like an ordinary particle, with its mass, charge, and other properties determined by the vibrational state of the string. In string theory, one of the many vibrational states of the string corresponds to the graviton, a quantum mechanical particle that carries gravitational force. Thus string theory is a theory of quantum gravity.*

String Theory climaxed with the M-theory,[2][14] which included:

> *M-theory is a theory in physics that unifies all consistent versions of superstring theory. Edward Witten first conjectured the existence of such a theory at a string-theory conference at the University of Southern California in the spring of 1995. Witten's announcement initiated a flurry of research activity known as the second superstring revolution.*

Also from Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, Mühlenberg 1, D-14476 Potsdam, Germany, August 17, 2009 [3][15]

> *Quantum field theoretic extensions of Einstein's theory of gravity tend to suffer from incurable infinities, but a theory called N=8 supergravity may actually avoid them—against expectations held for almost 30 years.*

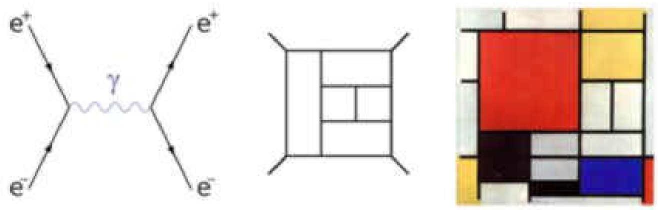

Exhibit 1.

Illustration: (Right) Piet Mondrian, "Composition with Large Red Plane, Yellow, Black, Grey and Blue" (1921), © 2009 Mondrian/Holtzman Trust c/o HCR
Exhibit 1: (Left) In the 1940s, Richard Feynman invented a graphical method for carrying out calculations in quantum electrodynamics. A typical Feynman diagram

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1 https://en.wikipedia.org/wiki/String_theory

2 https://en.wikipedia.org/wiki/M-theory

3 https://physics.aps.org/articles/v2/70

shows the electromagnetic force mediated by photons. (Center) Bern et al. use different kinds diagrams in their calculations of N=8 supergravity that permit integration of a large number of subdiagrams. Image shows an example of one of many planar diagrams used in these kinds of calculations. (Adapted from Bern et al.) Owing to their resemblance to the work of artist Piet Mondrian (Right), these graphical computational devices are sometimes referred to as Mondrian diagrams.

Gravity is different. It is mediated by particles (gravitons) of spin 2, unlike the other known forces in nature (electromagnetism and the strong and weak interactions), which are carried by particles of spin 1. This explains why like gravitational charges (that is, masses) attract, whereas in electrostatics, like charges repel, thereby accounting for the fact that gravity dominates physics at large distances, despite its incredible weakness in comparison with the other fundamental forces (think of a little magnet whose force on a safety pin beats the gravitational pull of the whole planet Earth). Modern understanding of gravity rests on Einstein's theory of general relativity. This theory is based on the principle of general covariance (according to which, the laws of physics should not depend on which coordinate system is used to formulate them) and the principle of equivalence, enabling Einstein to write down "in one stroke" his gravitational field equations and thereby to revolutionize our understanding of gravity, replacing Newtonian gravity by a theory based on spacetime geometry and curvature.

There is another key aspect in which gravity differs. Matter is governed by the laws of quantum mechanics, but so far, Einstein's theory has resisted all attempts to reconcile it with quantum mechanics.

And:[1][16]

If it exists, the graviton is expected to be massless because the gravitational force is very long range and appears to propagate at the speed of light. The graviton must be a spin-2 boson because the source of gravitation is the stress–energy tensor, a second-order tensor (compared with electromagnetism's spin-1 photon, the source of which is the four-current, a first-order tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field would couple to the stress–energy tensor in the same way that gravitational interactions do. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton.

So far, the Graviton has not been found in nature, but Negatrons and/or Gravitons appear to be entangled with Positrons inside a BH.

Interim Conclusions.

1. Identifying a possible source for the Graviton is a significant finding.
2. The proposed operation of a BH provides a step towards understanding the importance of BHs in the universe**.**

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[1] https://en.wikipedia.org/wiki/Graviton

7) GRAVITON ASSOCIATION WITH MOLECULES

This feature may distribute an entangled tie attraction between the mass molecules and a parent BH, to form a gravity bond.

Figure 7 shows a BH Entangle Tie (ET) between the Graviton and a Chalcocite (Cu_2S) molecule. The bond is preferably established with the sulphur atom, as a two-meson bond, discussed under **Appendix B**, Exhibit 2.

An ET tie forms a double bond with the sulphur atom, involving both the proton and neutron, because elements with even atomic numbers on the Graviton Table of Elements Figure 6, associate exclusively with the twin spin Graviton boson. This mechanism appears to provide the gravitational force holding mass together.

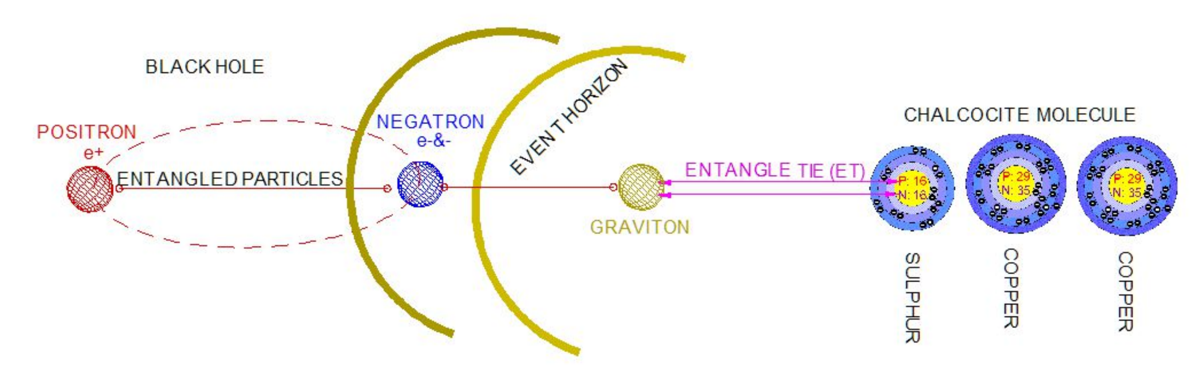


Figure 7.

A process similar to this is proposed at *How Quantum Pairs Stitch Space-Time*, [1][17] reports of a study by Brian Swingle of MIT along with Mark Van Raamsdonk, a string theorist at the University of British Columbia who *imagines entanglement creating space-time gradually: Individual particles become entangled with each other. These entangled pairs then become entangled with other pairs. As more particles become entangled, a three-dimensional structure of space-time emerges.*

Interim Conclusions.

1. The Graviton has not been found in nature, but may be a particle only found in an identifiable form near a BH boundary.
2. Negatrons entangled with their Positrons inside a BH may transit over the event horizon and radiate throughout space as Gravitons associated with the ET gravity effect. In this mode, particles form into a three-dimensional space-time structure.

[1] https://www.quantamagazine.org/tensor-networks-and-entanglement-20150428/

8) NEGATRON CONCENTRATION.

My paper Big Bank or Steady State?[1][18] and[2][19] includes the information:

It is reported that:

> *the gravitational force can appear extremely weak compared with other fundamental forces. For example, the gravitational force* (Fg) *between an electron and proton one meter* (d1) *apart is approximately* 10^{-67} *newton, while the electromagnetic force between the same two particles still I metre apart is approximately* 10^{-28} *newton. Both these forces are weak when compared with the forces we are able to experience directly, but the electromagnetic force in this example is some 39 orders of magnitude (i.e.* 10^{39}*) greater than the force of gravity - which is even greater than the ratio between the mass of a human and the mass of the Solar System!"*

This information is useful for checking to see how far away a Black Hole would have to be from Earth if the cause of our gravity turned out to be a Black Hole stripping electrons. Now we can check to see if the gravitational attraction on Earth is related to the much stronger electromagnetic force at a Black Hole.

Let us assume Fg (gravitational force) between the two objects (electron and proton) reduces with distance from a Black Hole, as per the inverse square law, and d1 is 1 metre. Then d2 is the distance to a Black Hole and the electromagnetic force between the electron and its atom is Fe.

$$\frac{F_e}{F_g} = \frac{d1^2}{d2^2}$$

So d2 is equal to $\sqrt{\frac{F_e/F_g}{d1^2}}$ the term d1 is equal to 1, and d2 becomes $\sqrt{F_e/F_g}$

We can calculate the distance d2 which is 3.16^{19} metres away. Converting that distance to light years, (divide by 9.64^{15} metres). Distance from Earth is 3,343 light years.

1 http://www.bosmin.com/PSL/BigBangOrSteadyState.pdf

2 https://en.wikipedia.org/wiki/Gravitational_constant

This information was used to show the position of the Solar System relative to Black Hole V616, which is reported to be roughly about 3300 light-years away as illustrated in Figure 8:

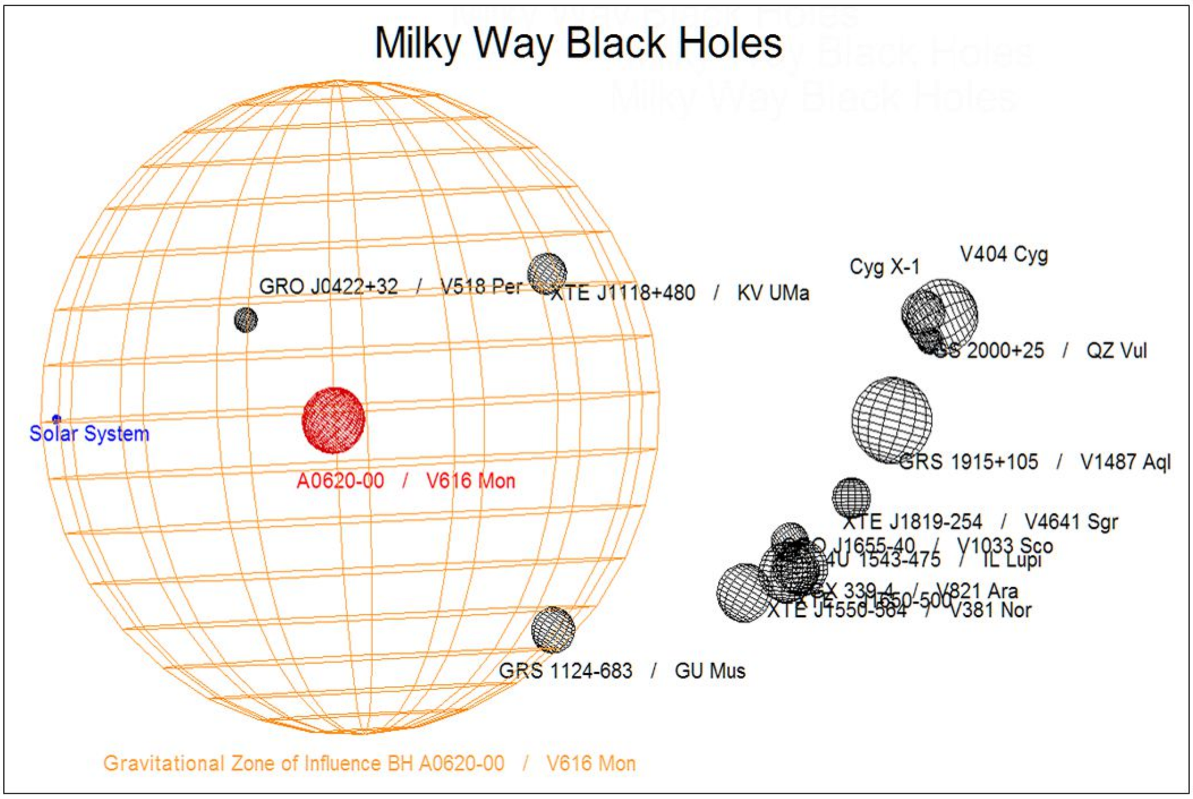


Figure 12 Stellar Masses considered as potential Black Holes in Earth's region of the Milky Way Galaxy

Figure 8.

This information is used to calculate the concentration of Negatrons at a solar system location:

We assume Gravitons are the only new atomic components outside the black hole event horizon, and the concentration at V616 is taken as:

$$G_{bh} = K$$

The constant K can vary in magnitude depending on the size of the BH. In this way, more massive BHs have larger Gravisphere zones of influence.

Gravitons report in the Solar System as Negatrons at a much smaller concentration, following the inverse square relationship of:

$$N_{ss} = Kx10^{-39}$$

The Negatrons integrate with Electrons surrounding atomic structures thereby providing the property of gravity attraction to any object, but at an average concentration of one Negatron for every 10^{39} Electrons. More massive objects will contain more Negatrons and therefore exhibit stronger gravity attraction.

Interim Conclusions.

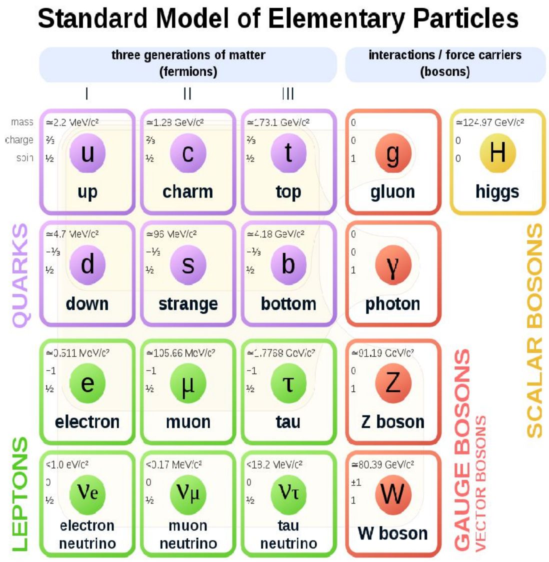
1. Black Hole V616 is at the centre of the Solar System's gravisphere.
2. Gravitons forming at V616 result in Negatrons concentrating in the Solar System at the rate of one Negatron for every 10^{39} orbiting Electrons.
3. Negatrons integrate with Electrons surrounding atomic structures and provide the property of gravity attraction to any object.
4. More massive objects contain more Negatrons and exhibit stronger gravity attractions.

9) CONCLUSIONS.

1. Positrons are unexpectedly plentiful in space, showing that an electron should not be regarded as a fundamental particle.
2. Negatrons are anti particles to Positrons.
3. A Negatron is different to an Electron in that it has an entangled association with a parent black hole.
4. A Positron can be captured by a free neutron in a BH environment resulting in the Negatron displaying an e-&- charge.
5. The Negatron can separate from the BH by eliminating the -&- charge and mass, and converting both to a spin of 2. This results in the formation of a Graviton particle.
6. The Kruskal Szekeres diagram illustrates the hyperbolic geometry present at a BH.
7. The e-&- energy charge associated with the Negatron, transfers into a two-spin motion. This particle emerging from the event horizon, transforms into a spin of 2, is massless, and without charge, and described as a Graviton.
8. The Positron combined with the free neutron inside the BH takes all the mass from the Positronium. The massless Negatron is capable of leaving the BH as a Graviton.
9. Gravitons provide the gravitational force which is very long range and appears to propagate at the speed of light. Once the gravitational link is established, it remains entangled with its BH host, and provides instantaneous recognition to mass influences.
10. Graviton is massless when escaping the Black Hole but regains some mass from standard Electrons when it associates in an atomic shell as a Negatron.
11. The Negatron and Graviton are shown in the Standard Model of Elementary Particles as Scalar and Tensor Bosons, respectively. In these locations more than one boson can associate with atomic particles to deliver both atomic stability and gravity.
12. Electrons are generally considered to be fundamental particles, but there is evidence that both Positron and Negatron particles derived from Electrons.
13. If incoming mass stops, the BH could become unstable through dissipation of Positron particles, and gradually cease to exist.
14. Identifying a possible source for the Graviton is a significant finding.
15. The proposed operation of a BH provides a step towards understanding the importance of BHs in the universe**.**
16. The Graviton has not been found in nature, but may be a particle only found in an identifiable form near to a BH boundary.
17. Negatrons entangled with their Positrons inside a BH may transit over the event horizon and radiate throughout space as Gravitons associated with the ET gravity effect. In this mode particles form into a three-dimensional space-time structure.
18. Black Hole V616 is at the centre of the Solar System's gravisphere.
19. Gravitons forming at V616 result in Negatrons concentrating in the Solar System at the rate of one Negatron for every 10^{39} orbiting Electrons.
20. Negatrons integrate with Electrons surrounding atomic structures and provide the property of gravity attraction to any object.
21. More massive objects contain more Negatrons and exhibit stronger gravity attractions.

<u>**Appendix - A Standard Model of Elementary Particles**</u> [1][20]

In physics, an elementary particle or fundamental particle is a particle that is not made of other particles.



1 GeV/c2 = 1.783x10-27 kg. 1 MeV/c2 = 1.783x10-30 kg.

An elementary particle can be one of two groups: a fermion or a boson. Fermions are the building blocks of matter and have mass, while bosons behave as force carriers for fermion interactions and some of them have no mass. The Standard Model is the most accepted way to explain how particles behave, and the forces that affect them. According to this model, the elementary particles are further grouped into quarks, leptons, and gauge bosons, with the Higgs boson having a special status as a non-gauge boson.

Of the particles that make up an atom, only the electron is an elementary particle. Protons and neutrons are each made of 3 quarks, which makes them composite particles, particles that are made of other particles. The quarks are bound together by the gluons. The nucleus has boson pion fields responsible for the strong nuclear force binding protons and neutrons against the electrostatic repulsion between protons. Such virtual pions are composed of quark antiquark pairs again held together by gluons.

There are three basic properties that describe an elementary particle: ‘mass’, ‘charge’, and ‘spin’. Each property is assigned a number value. For mass and charge the number can be zero. For example, a photon has zero mass and a neutrino has zero charge. These properties always stay the same for an elementary particle.

- Mass: A particle has mass if it takes energy to increase its speed, or to accelerate it. The table to the top right gives the mass of each elementary particle. The values are given in MeV/c2s (that is pronounced megaelectronvolts over "c" squared), that is in units of energy over the speed of light squared. This comes from special relativity, which tells us that energy equals mass times the square of the speed of light. All particles with mass-produce gravity. All particles are affected by gravity, even particles with no mass like the photon (see general relativity).
- Electric charge: Particles may have positive charge, or negative, or none. If one particle has a negative charge, and another particle has a positive charge, the two particles are attracted to each other. If the two particles both have negative charge, or both have positive charge, the two particles are pushed apart. At short distances, this force is much stronger than the force of gravity which pulls all particles together. An electron has charge -1. A proton has charge +1. A neutron has an average charge 0. Normal quarks have charge of ⅔ or -⅓.

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[1] https://simple.wikipedia.org/wiki/Elementary_particle

▸ Spin: The angular momentum or constant turning of a particle has a particular value, called its spin number. Spin for elementary particles is one or ½. The spin property of particles only denotes the presence of angular momentum. In reality, the particles do not spin.

Mass and charge are properties we see in everyday life, because gravity and electricity affect things that humans see and touch. But spin affects only the world of subatomic particles, so it cannot be directly observed.

Fermions
Fermions (named after the scientist Enrico Fermi) have a spin number of ½, and are either quarks or leptons. There are 12 different types of fermions (not including antimatter). Each type is called a "flavor". The flavors are:

▸ Quarks: up, down, charm, strange, top, bottom. Quarks come in three pairs, called "generations". The 1st generation (up and down) is the lightest and the third (top and bottom) is the heaviest. One member of each pair (up, charm and top) has a charge of ⅔. The other member (down, strange and bottom) has charge -⅓.
▸ Leptons: electron, muon, tau, electron neutrino, muon neutrino, tau neutrino. The neutrinos have charge 0, hence the neutr- prefix. The other leptons have charge -1. Each neutrino is named after its corresponding original lepton: the electron, muon, and tauon.

Six of the 12 fermions are thought to last forever: up and down quarks, the electron, and the three kinds of neutrinos (which constantly switch flavour). The other fermions decay. That is, they break down into other particles a fraction of a second after they are created. Fermi-Dirac statistics is a theory that describes how collections of fermions behave. Essentially, you can't have more than one fermion in the same place at the same time.

Bosons[1][21]
Bosons, named after the Indian physicist Satyendra Nath Bose, have spin 1. Although most bosons are made of more than one particle, there are two kinds of elementary bosons:

▸ Gauge bosons: gluons, W+ and W- bosons, Z0 bosons, and photons. These bosons carry 3 of the 4 fundamental forces, and have a spin number of 1;
• Gluon: Gluons are massless and chargeless particles, and they are the carriers of the strong force interaction. They, along with quarks, join together to make composite particles called hadrons, which include protons and neutrons.
• W and Z bosons: W and Z bosons are particles that carry the weak force. The W boson has a matter particle (W+) and an antimatter particle (W-), whereas the Z boson is its own anti-particle. The W boson is produced in beta decay, but almost immediately turns into a neutrino and an electron. The W and Z bosons were both discovered in 1983.
• Photon: Photons are massless and chargeless particles that carry the electromagnetic force. Photons can have a certain frequency that determines what electromagnetic radiation they are. Like all other massless particles they travel at the speed of light (300,000 km/s).

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[1] https://m.youtube.com/watch?v=1_HrQVhgbeo

- Higgs boson: Physicists believe that massive particles have mass (that is, they are not pure bundles of energy like photons) because of the Higgs interaction.

The photon and gluon have no charge, and are the only elementary particles that have a mass of 0 for certain. The photon is the only boson that does not decay. Bose-Einstein statistics is a theory that describes how collections of bosons behave. Unlike fermions, it is possible to have more than one boson in the same space at the same time.

The Standard Model includes all of the elementary particles described above. All these particles have been observed in the laboratory.

The Standard Model does not talk about gravity. If gravity works like the three other fundamental forces, then gravity is carried by the hypothetical boson called the graviton. The graviton has yet to be found, so it is not included in the table above.

The first fermion to be discovered, and the one we know most about, is the electron. The first boson to be discovered, and also the one we know most about, is the photon. The theory that most accurately explains how the electron, photon, electromagnetism, and electromagnetic radiation all work together is called quantum electrodynamics.

Appendix-B Fermions and Bosons

Fermions and bosons

FERMIONS

A **fermion** is any particle that has an odd half-integer (like 1/2, 3/2, and so forth) spin. Quarks and leptons, as well as most composite particles, like protons and neutrons, are fermions.

For reasons we do not fully understand, a consequence of the odd half-integer spin is that fermions obey the Pauli Exclusion Principle and therefore cannot co-exist in the same state at same location at the same time.

BOSONS

Bosons are those particles which have an integer spin (0, 1, 2...).

All the **force carrier particles** are bosons, as are those composite particles with an even number of fermion particles (like mesons).

Fermions		Bosons	
Leptons and Quarks	Spin = $\frac{1}{2}$	Spin = 1*	Force Carrier Particles
Baryons (qqq)	Spin = $\frac{1}{2}$, $\frac{3}{2}, \frac{5}{2}$...	Spin = 0, 1, 2...	Mesons ($q\bar{q}$)

* The predicted graviton has a spin of 2.

The nucleus of an atom is a fermion or boson depending on whether the total number of its protons and neutrons is odd or even, respectively. Recently, physicists have discovered that this has caused some very strange behavior in certain atoms under unusual conditions, such as **very cold helium**.

Exhibit 2.

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