ON THE NATURE OF THINGS

Part I

The Book Of The Cosmos

Cosmos One: The Universe Goes Bang!

Before the beginning, there was absolutely nothing: No space, no time, no matter. And from nothing emerges everything. Thus, in the beginning, everything is an infinitely dense, infinitely hot, singular point of origins. This mysterious point, is what created everything that follows it, and obeys a set of rules known as the laws of physics. The theory of everything is also known as the unified field theory, because that is what reality is made of: Waves! But for now, lets turn our attention to the following sequence of events…

In the first tiniest fraction of an instant, the universe explodes into existence, as a rapidly expanding, tremendously hot and dense firestorm, spread uniformly across space, and that extends infinitely in all directions. It is like dropping a nuke in every cubic micron of space, but then to realize that your cubic micron is now a cubic kilometer, as space itself, ever more slowly, continues to expand out in all directions.

In just another few tiny fractions of an instant or so, the tremendously hot and dense, but uniformly spread firestorm that is infinite in extent, has expanded, cooled, and diluted, into a not so hot, not so dense firestorm, that continues to be uniformly spread, and infinite in extent. For some actual numbers, given that our "not so hot" universe, now means a trillion degrees, imagine how incomprehensibly hot the universe was right at the start: a trillion times hotter than a trillion degrees!

So. With this in mind, lets now track the evolution of our particles. Every particle in existence, is constantly smashing into other particles. We say that the particles are in thermal equilibrium. The average kinetic energy per particle, is uniform throughout the cosmos. Looking at the sound waves within the aether, we can see the waves are vibrating with an extremely high frequency. We will measure frequency with a new system of units. The electron volt. Its written as, "eV". Electron volts are useful because they can be understood as, energies, momenta, frequencies, and wavenumbers. In quantum field theory, everything is measured in electron volts. Light speed is 1 foot per nanosecond, and one electron volt of energy corresponds to a wavelength of 1.24 microns. As of now, the weak interaction and the electromagnetic interaction, are one and the same. Moreover, every particle is massless, and moves at the speed of light. This will change soon, when the temperature drops below 246 GeV.

Passing 1 femtosecond, all of the quarks, antiquarks, leptons, antileptons, and the bosons, are almost in thermal equilibrium, and haven't yet aquired mass from this so called higgs boson. Yet after 10 picoseconds, the temperature drops below the threshold

of 246 GeV, and the higgs boson activates. The electromagnetic force carried by photons, is now distinct from the weak nuclear force, carried by the W plus, W minus, and Z bosons. These intermediate vector bosons, along with the higgs boson itself become very massive, on the order of 80 GeV, 92 GeV, and 125 GeV respectively. Since the electroweak bosons interact between themselves, we would expect to find confined states of these bosons. However, now that some of these electroweak bosons have a great deal of mass, removes any possibility of confinement. However these are not the only massive particles around. Every flavor of quark now has three possible masses. There are the up, charmed, and top flavors, and then the down, strange, and bottom flavors. The same applies to the charged leptons, which are the electron, the muon, and the tau. The neutral leptons, the neutrinos, do not have mass, and as such continue to move at light speed. The three top quarks, which are the heaviest flavor of the up type quarks, have masses of 173 GeV. That is much heavier than the W, Z, and the higgs boson.

After the next few hundred picoseconds, the top quarks and antiquarks, higgs bosons, Z bosons, and the W plus and minus bosons, are all gone. The energy of their annhililation, gets dumped into the remaining lighter particles. With these particles out of the picture, the weak interaction, reemerges as a short ranged force, 100 times shorter than a femtometer. In contrast, the quarks and gluons, are starting to feel their presence. This is why we call this the strong nuclear force. This force has litterally several metric tons of strength.

As we pass the ten nanosecond mark, the 4.5 GeV bottom quarks, 1.7 GeV tau leptons, and the 1.2 GeV charm quarks, annhililate away next. This seems like a losing battle, as all of the precious universe building particles, are just dissapearing, one by one, until nothing is left. After all of this, the only massive particles left are, the strange quarks, muons, down quarks, up quarks, and electrons, along with their antiparticles. So, to summarize. In these first instants, all sorts of exotic forms of energy and matter existed, such as quark matter, strange matter, and even antimatter, existed in great abundance.

Cosmos Two: The Quarks Held Hostage!

Then, all of a sudden, right after 30 microseconds, the quarks and antiquarks bind together, into subatomic particles known as hadrons. Hadrons made of three matter quarks are known as baryons, and hadrons made of a quark antiquark pair are known as mesons. The lightest baryons are the nucleons, which have a mass of 940 MeV. The lightest mesons are the pions, which have a mass of 135 MeV. However the up quarks with masses of 2.01 MeV, and the down quarks with masses of 4.79 MeV, that make up these subatomic particles only contribute 1% of the total mass of the hadron. Strange quarks are the only exception to this rule, as they have a mass of approximately 95 MeV. These hadrons are confined, as it is impossible to remove any quarks or gluons for that matter, without creating other hadrons in the process. The fundamental strong nuclear

force only acts within one of these subatomic particles, because of this confinement. This confinement is caused by the taffy life gluon flux tubes that emerge from the center of the hadron, and stretch out to the locations of the quarks. Again this is caused by the self interaction of the 8 types of gluons. Most hadrons have a physical size of around 1 femtometer. This is 100 times larger than the weak force can carry. In terms of electron volts, this corresponds to a value of 197 MeV. The temperature is dropping below 200 MeV.

Over the course of a few picoseconds after the quark gluon plasma transitions to a baryon meson gas, the resulting subatomic particles are much to heavy to exist, and as such they annhililate away. The small excess of matter quarks over antimatter quarks that are left behind, is now in the form of nucleons, which are the protons and neutrons. This is the very first real tangible matter in the universe. A proton is made of 2 up quarks and 1 down quark, and a neutron is made of 2 down quarks and 1 up quark. Yet these nucleons are outnumbered in the billions by the rediculous numbers of pions, that are being copiously produced in the seething 150 MeV heat. But what is important here is that as all kinds of quarks and all kinds of antimatter quarks, warred for supremacy, emerged a thin excess of protons and neutrons: The particles of matter we know today.

Yet the temperature not going to be this hot for long. So as the temperature drops below 135 MeV, pions begin to decay. The pions being made of quark antiquark pairs are very unstable. The charged pions are made of one up quark, and one anti down quark, or vise versa, and thus take a few nanoseconds to decay. The neutral pions on the other hand, are made of a quark antiquark pair of the same quark flavor, and so annhililate almost immidiately. Muons which weigh around 105 MeV, go next.

And finally we reach the 100 microsecond mark in the history of the universe. If we were to take a census of all the particles in the universe as of now, there are 52.5 billion neutrinos, 20 billion photons, 17.5 billion electrons, 17.5 billion positrons, and finally 8 protons and 8 neutrons. There is also an excess of 8 electrons, that meet the requirement of the universe being electrically neutral. Like the W and Z bosons, the charged and neutral pions, act as short ranged force carriers. Since the pions are hundreds of times lighter than the electroweak bosons, they carry the residual nuclear force out to a 2.5 femtometers of distance, which is around three nucleons wide. However, it is still way too hot for the first nuclei to form. Yet.

But going back to a fraction of a thousandth of a second since the beginning, for every proton or neutron created in this cosmic game of pinball, billions of photons, of gamma-ray light, were also created! The universe was dominated by energy, and yet again, what I referred to as a thin excess will amount to all of the matter in our universe that will ever exist! Along with the billions of gamma rays, there also exist billions of electrons and antimatter electrons, also known as positrons. The temperature is still too high for electron-positron pairs to begin annihilating, and they remain in flux. The universe continues to expand and cool.

Now we reach the 1 millisecond mark. The temperature is in the tens of MeV. Electrons and positrons also known as antielectrons, even the sea of photons and neutrinos, continue to bash into the few isolated protons and neutrons, turning them into one another. This happens due to the weak nuclear force that acts at a scale 100 times smaller than a proton or neutron. When an electron gets near a up quark inside a proton, of which the quark has a electric charge of +2/3. If it is close enough, the up quark will transmute into a down quark, with a charge of -1/3. The proton has turned into a neutron. If this neutron hits a positron, it will convert back into a proton. The massless neutrinos, that act exclusively with the short ranged weak force, also have the ability to convert protons and neutrons into eachother. So at this point in time, protons and neutrons are always converting back and forth. So at first, the firestorm of mostly gamma radiation and electron-positron pairs, contains an equal number of protons and neutrons.

However the neutron is only 780 keV heavier than a proton, and the electrons weigh in at a tiny 511 keV. So as the temperature drops to a few MeV, it becomes much easier to make protons than to make neutrons in these conversions, and so there are fewer and fewer neutrons around as compared to protons. Over the next second or so, electrons and positrons are also starting to go through the same annihilation, that the quarks went through right at the start of creation. Then, as we pass the 1.8 second mark, the electron positron pairs begin annhililating, and over the next few hours, the concept of antimatter will become a distant memory.

Also around this time, the neutrinos have not annhililated with their antineutrinos, because of their massless nature. Yet, as the universe continues expanding as it always does, the neutrinos and antineutrinos are having great difficulty turning protons and neutrons into one another. This is because of the extremely short range of the weak force. When this process begins, the ratio of number of neutrons to number of protons, was dropping dramatically for a few seconds.

So now that neutrinos cannot change the number of protons or neutrons, the declining neutron number then settles at a value of 3 neutrons per 13 protons. Yet, neutrons are ever so slightly heavier than protons, and should decay. As of now the lifetime of a neutron is around 880 seconds, which is too far into the future as of now. The universe continues to expand and cool.

Cosmos Three: Lets Go Nuclear!

One second passes, then five, then 20 seconds have elapsed. Then a minute passes. The residual nuclear force, is strong enough to bind the nucleons together, but this isn't happening at all. This is because when a proton and neutron collide and form a deuteron, a high energy photon will break the first nuclei right back down to the nucleons that already exist. But a deuteron has a binding energy of 2 MeV, so it should be stable enough to exist. Nope. Remember that there exist 20 billion photons. Even if the average temperature of this thermal radiation is on the order of 100 keV, or 0.1

MeV, there will still be a few outliers with energies over 2 MeV. Even if a few very high energy photons exist, its over for a deuteron.

Yet again, as always, the universe expands and cools. Also, neutrons decay, so given that we started with 3 neutrons at first, after 3 minutes, there are only 2 neutrons left, as one of the neutrons has beta decayed back to a proton, along with an electron and an antineutrino. We now have 20 billion gamma ray photons, along with 14 protons and 2 neutrons. Also, an excess of 14 electrons also exist, along with the hundreds of millions of electron-positron pairs that are under constant annhililation.

So this means that for the next four minutes or so, not much changes to the firestorm of gamma-rays and annihilating electron-positron pairs. A few of the many neutrons that still exist, have naturally decayed back into protons, so while the neutron to proton ratio used to be 1 in 5 a few minutes ago, right now its closer to 1 in 7. I should note that although the temperature is well high enough for fusion to occur, the sheer energy and number of gamma ray photons will shred down any nuclei that try to form, so the universe, as of now, contains only free protons and free neutrons. The universe continues to expand and cool.

Then, right after the clock strikes 4 minutes and 20 seconds, does something dramatic happen: Nuclear fusion! Now, as the temperature decreases, there are less and less photons with energies of 2 MeV, and when the temperature, or average photon energy, drops below 78 keV, deuterons are stable, and the fusion process continues on. In other words, the intensity of gamma radiation is now low enough for the first nuclei to not be blown apart. Most nuclei that could form at this point, like tritons or helions, also have binding energies not much more than deuterons. However there is one special kind of nucleus, known as a alpha particle. It has a whopping binding energy of 28.3 MeV. That is to say 28,300 keV!

It consists of two protons and two neutrons. The stability of alpha particles, is extremely important in the near future of the nuclear reactions. Every proton and every neutron in existence are now smashing together to build alpha particles: Clusters of 2 and 2, that is to say, 2 neutrons with 2 protons. The universe is now 265 seconds, or 4 minutes and 25 seconds old. At this point, as soon as alpha particles form, it becomes extremely difficult to destroy them. All nuclei that contain any neutrons, including the soon to decay neutrons themselves eventually get locked up inside these alpha particles.

For the next 10 seconds, the number of alpha particles, grows to a value of 1 alpha particle for every 12 protons. The story of alpha particles, is not over yet. As the clock reaches 4 minutes and 30 seconds, all of the neutrons get used up in the reaction, and the 10 seconds of nuclear fusion grinds to an immediate halt. Why so early? The universe is aging past the 20 minute mark. Even though fusion is still occurring in vast quantities, not much happens to the composition of the nuclei. The 12 protons, and 1 alpha particle, are all smashing into one another. When such a collision takes place, it produces an

unstable nucleus with 5 or 8 nucleons. Such a nucleus will undergo alpha decay, and revert right back to the same nuclei as before.

However, these stable nuclei are positively charged, and like charges repel. This means that there is an electric potential barrier right beyond the reach of the residual nuclear force. As the nuclei slow down, there is less and less kinetic energy available, and by the end of the first hour of the universe, almost every nucleus avoids every other nucleus around it. The ever expanding and cooling universe now has a chemical formula of 12 protons, 1 alpha particle, which goes along with an excess of 14 electrons over millions of electron-positron pairs, and also the 25 billion photons of gamma-ray light. The universe continues to expand and cool. The fusion process halts completely, as the 12 protons, and 1 alpha particle, not only fail to create new nuclei, but at this point they don't touch eachother in the first place. The nuclei just avoid eachother from now on.

Hours into the creation of the universe, the last few dozen electron-positron pairs finally annihilate away into even more photons of gamma-ray light. The particle count is now, 12 protons, 1 alpha particle, 14 electrons, and 26 billion photons. This it will remain for almost an eternity. As a sense of comparison, a proton weighs as much as 1,836 electrons, and an alpha particle weighs as much as 7,294 electrons.

Cosmos Four: Let There Be Light!

This whole time, electrons and photons, pinball one another. The scattering of, electrons and photons, is fully described by the theory of QED. QED begins with the spacetime of special relativity. This spacetime is described by the $O(3,1)$ group. The particles of QED, are representations of this symmetry group. Electrons are massive charged spinors. Photons are massless neutral vectors. Put together, they interact via a minimally coupled $U(1)$ internal symmetry group. As of now, QED was not the main player in the history of the universe, as it was unified with other internal symmetries, into the $SU(5)$ group.

However, now that the nuclear reactions have stopped, QED is what is left over. The electrons and photons form a plasma known as the cosmic soup. In it, electrons are known as cathode rays, and photons are known as X rays. The chemistry of the universe is pretty much constant after the first few hours have elapsed. The cosmic soup clocks in at a temperature of 1 keV. Otherwise put, 11.6 million degrees kelvin, and dropping. In fact, it's still too hot for anything tangible to exist at all.

A day passes, then a week goes on by. The only thing that changes is the expansion of the universe. Nothing has happened to the plasma. Even after a year of this expanding and cooling, the temperature, pressure, and density, are all surely dropping, yet nothing else has happened to the cosmic soup. Why? As compared to the nuclei, which are femtometers in size, and weigh in at many GeV, electrons are nothing in comparison. Even the photons that carry the electromagnetic force, is 137 times weaker than the other forces. So not only do the electrons need to slow down, they need to be captured by the nuclei, for the first atoms to form.

Every electron, cannot be crammed into a volume smaller than 386 femtometers, without producing antimatter. This is assumming that the cathode rays are moving near light speed. But, at this day and age, the cathode rays have much longer wavelengths than this, since they're moving much slower than light speed. The math of QED, says that the electrons must be moving 137 times slower than light speed for them to be captured. With the electrons so spread out compared to the nuclei already, the cathode rays must have wavelengths hundreds of thousands of times longer than the nuclei are big. And that is a big problem.

As months turn into years, the gamma ray photons have stretched out so much, they are now X-ray photons. As the firestorm of a universe continues to expand and cool, not much happens for a very long time. The universe as a firestorm that is uniformly spread and infinite in extent, continues to expand and cool. Decades pass by, then centuries, and eventually millennia pass by in the hundreds. The universe is so much more diluted now that its self gravity, which is slowing down the expansion of the universe, takes more time to expand by the same amount as usual. Moreover, all of the photons of X-ray light, have stretched out into photons of Ultraviolet light. The universe continues to expand and cool.

Moreover, as the universe expands, a new problem surfaces. Billions of photons might have an average energy of 5 eV or 58 thousand degrees kelvin, yet the truth is that as always there are high energy outliers. Some photons have huge energies well over 269.3 eV and as such we will have to wait until these high energy photons are gone until atoms can fully form.

As the universe expands and cools below 16 thousand degrees, each and every alpha particle captures an electron forming helium ions. Next, as the universe expands and cools below 7 thousand degrees, each and every helium ion captures another electron, this time forming helium atoms. Then, as the universe expands and cools below 4 thousand degrees, each and every proton captures an electron, forming hydrogen atoms. After that, as the universe expands and cools below 3 thousand degrees, the electrons clear up, leaving the now visible light photons to begin streaming freely throughout the cosmos. Let There Be Light!

Cosmos Five: Trouble Brewing In The Cosmic Darkness!

The universe continues to expand and cool. 377 millennia have elapsed since the beginning, and is flooded with atomic hydrogen and helium. The color temperature of the radiation is pushing 3 thousand degrees Kelvin, but is gradually dropping as we speak.

So far, we have been talking about only a small fraction of what matter and energy exists out there. It is like saying we have a jar filled with 100 grams of gas. As we know from earlier, 75 grams would be atomic hydrogen-1, and 25 grams would be atomic helium-4. The truth that has been overlooked is this conundrum: An additional 530 grams of invisible intangible matter also exists.

This form of matter consists of countless microscopic black holes. A black hole is a region of space with a gravitational pull that is so strong that not even light, the fastest thing in the universe, cannot escape from its deadly grip. In physics, we know a few things:

1). Universal Gravitation: All particles attract all other particles, with an inverse square force field, in three dimensional space. This is why all objects fall to the ground at the same rate, why the planets move around the sun in ellipses with the sun at one focus and the other focus empty, and why a line drawn from the sun to a planet sweeps out equal areas in equal time intervals, and also explains why the semi major axis of a planet's orbit cubed is proportional to the orbital period squared, along with many other gravitational effects. It is the gravitational acceleration of space itself, sourced by a particle, that spreads out according to an inverse square law in 3D space. This is what keeps your feet on the ground, and the earth orbiting the sun.
2). Special Relativity: The dimensions of space and time, arrange themselves such that the speed of light is the same, from all moving perspectives. This means that among many new phenomena, fast moving clocks run slow, fast moving rulers contract along their direction of motion, high speed motion breaks the simultaneous nature of time, and most importantly nothing moves faster than the speed of light. The fact that the speed of light moves at the same fixed speed no matter how its source is moving, means that the dimension of time rotates in an opposite way, than the three other dimensions of space rotate.
3). Quantum Mechanics: Every wave can be thought of as a stream of particles. The total kinetic energy of such a particle is directly proportional to its corresponding probability wave frequency. Moreover, waves with shorter wavelengths correspond to identical particles with more momentum, that is to say, the product of mass and velocity. This leads to the notion that objects can be in more than two places at once, how particles and waves are actually the same thing, how these quantum waves have discrete harmonics like the specific notes on a musical intrument, and the weird notion that measuring one particle can reveal corelations in the properties of all other particles of the same type.

This is an extremely important concept: All fundamental particles are rotating black holes with the same mass and same spin as the wave they constitute. This means that all black holes are fundamental waves too in the same sense as of any other wave, such as the electrons of electricity and the photons of light are all fundamental waves. This means that we should widen our search for extremely exotic wave types that hardly interact with anything. These microscopic black holes will be a fundamental turning point in the evolution of what follows.

The fate of the universe rests on the unification of physical law. There are three main sets of new phenomena, that were incorporated into the three pillars of modern science. The three pillars are: universal gravitation, special relativity, and quantum mechanics. The associated physics reduces to our common sense, by making a series of approximations. So even though our common sense worldview works well in the everyday, in the grand scheme of things, our universe is stranger than fiction.

With this in mind, a black hole is simply a natural consequence of these three main concepts of physics. In a sense, every black hole is just as fundamental as every other particle of matter and light that exists. In fact, the only difference is their mass and spin. Therefore, all rotating black holes are just as "real" as anything else that exists. Lets see what has happened to this mysterious form of matter, so that we can continue our story of everything!

All of these black holes have been colliding and merging, since the beginning, forming a sprawling network of black holes, called the cosmic web. The cosmic web is truly massive. But the reason I bring this up is because, before now, the radiation pressure was holding up the ordinary matter from gravitational collapse. But now, the light has been set free, there is no more radiation pressure to prevent collapse, and collapse it goes.

As the universe expands and cools, over the next few million years, the color temperature drops from white, to pale yellow, to vivid orange, to cherry red, and finally fades into the near infrared. If we were somehow around back then, we could feel these rays as radiant heat, although there would be nothing to see. Just a uniform still darkness all around.

As for the matter, the gas is no longer uniform, and as the contrast increases, the gravity of both the black holes and the atoms of hydrogen and helium, becomes unstoppable. In just a few hundred million years, the cosmic web of gas starts resembling the cosmic web of black holes. This is like the scaffolding of a building. The black holes are the scaffolding, and the gas of normal matter is following the same pattern.

As this new consolidated cosmic web continues to expand and grow, the scene will soon change dramatically to include new structures never seen before! The cosmos is still cold and darkness envelops the night sky. But a chain of events will form a hierarchy of scale, where everything will eventually depend on everything else.

Cosmos Six: Cosmic Evolution Of Stars And Galaxies!

As the cosmic web continues to expand and grow, the first irregular galaxies form along the filaments of the cosmic web. Just like dew drops on a spider's silk, each of these galaxies is a loose collection of stars, gas, dust. As time marches on in the billions of years, the irregular galaxies merge into larger irregular galaxies. As it turns out, the densest regions of the cosmic web are where the irregular galaxies form. But since the cosmic web grows, the galaxies are carried along with the filaments of the invisible

matter that consitutes most of the cosmic web. Whenever the filaments of the cosmic web lock together, is when most galaxies cluster and merge.

Zooming inside one of these irregular galaxies, there is plenty of gas from the big bang, and along with the dust from previous supernovae explosions, creates a cloud of diffuse gas known as nebula. The nebula fragments into a few collapsing clouds, which in turn forms the next generation of high mass stars: Blue main sequence stars. 10 solar masses, and their surfaces burn brightly as 20 thousand degrees in the ultraviolet, as a sky blue color. The nuclear fusion has restarted once again, this time within the cores of stars!

After another brief 100 million years later, the blue main sequence star, runs out of its initial supply of nuclear fuel. It expands from a radius of 5 suns to 530 suns. Its surface temperature drops to 4000 degrees, or about that color of incandescent white light bulb. It is now an orange supergiant star, with its core temperature skyrocketing, inside, it has onion shells of fusing elements and isotopes. It lasts for only another 10 million years.

Every massive orange supergiant star explodes as a type II supernova! This star is no exception. The core has fused its last supply of elements into Iron-56, the most stable nucleus that exists. The core implodes in fractions of a second, into a neutron star remnant. The resulting conversion of nuclei into pure neutrons relases plenty of energy, that ricochets the rest of the stellar matter, creating a massive shockwave that blows it up. The energy from such an explosion outshines the rest of its galaxy for weeks, if not months. The explosion leaves behind a neutron star, which is a dead stellar core of compact neutron matter.

The resulting elements from type II supernovae contains: 23 carbon-12 nuclei, 5 nitrogen-14 nuclei, 156 oxygen-16 nuclei, 14 neon-20 nuclei, 2 neon-22 nuclei, 6 magnesium-24 nuclei, 4 silicon-28 nuclei, 2 sulfur-32 nuclei, and 2 iron-56 nuclei. Massive star explosion, after massive star explosion, the galaxies are being seeded with the elements needed for life itself. Elements like oxygen, which when combined with hydrogen from the big bang, forms lots and lots of water, the universal solvent. The gases and dust grains disperse into the interstellar medium.

A neutron star remnant is a very amazing object. A dense quantum object made of a plasma of only neutrons. However the neutrons are as compact as they can be. This is the same force that prevents solid matter from passing through itself, but here, it applies to the whole neutron star remnant at once: An atomic nucleus as massive as a star. For some facts, a neutron star remnant, has the mass of up to 3 suns, and a radius of a large city.

We zoom back out to the intergalactic scale. A few billion years have elapsed since the first irregular galaxies formed. As the invisible matter of the cosmic web locks together, two sheets of this invisible matter, with each sheet being a network containing more than a few dozen irregular galaxies, merge together. What was two

galaxy clusters is now a grouping of a few larger galactic mergers. Gas, stars, dust, are all flung in all directions. Gravity brings the matter back together into three large spiral disk galaxies, which in turn ignites more stars within these new spiral galaxies. This creates their spiral arms and pinwheel character. In the mean time, the invisible cosmic web has grown so much by now, that what was a network of irregular galaxies is now three huge hubs of the invisible matter, inside each a spiral galaxy. It is as if a cosmic dance is taking place, with the skaters replaced by huge incandescent galaxies. The three new spiral galaxies continue to absorb more and more irregular galaxies into their spiral arms. This slightly disrupts their spiral arms, but after another few billion years, each of these spiral galaxies has grown considerably, now as three grand pinwheels.

Zooming inside one of these spiral galaxies, there is still lots of gas from the big bang, and along with even more of the dust from previous supernovae explosions, which creates several more clouds of diffuse gases that we know as nebulae. These nebulae fragment more, and due to extra turbulence from supernova explosions in nearby spiral arms, they collapse and fragment further into a few hundred collapsing clouds, which in turn forms the next generation of intermediate mass stars. One of these stars is the sun! 4.6 billion years ago! Our sun and all the others in the loosely bound cluster, known as an open star cluster, burn with a surface temperature of 6 thousand degrees, which looks more or less, like white daylight. The open star cluster disapates its sun-like stars into the disk of the spiral galaxy that birthed them. Nuclear fusion has it's torch passed down to the next generation of stars!

10 billion years later, the sun expands to 60 times its original radius. This red giant star, and has a surface temperature of 3000 degrees, about that color of an older incandescent light bulb. The sun's core has begun to fuse its helium-4 ash into carbon-12 and oxygen-16. This bloated angry red giant star, lasts for another 1 billion years, until it's core becomes dangerously unstable. The core gets denser and energy waves from it, expelling plenty of stellar matter away from the diffusing red giant star into what is known as a planetary nebula. After a few thousand years later, what is left over is a very dense dead stellar core of compact atomic matter known as a white dwarf.

The resulting planetary nebula contains: 69 carbon-12 nuclei, and 12 nitrogen-14 nuclei. Like the other supernovae explosions, the planetary nebulae from countless red giant stars seed the galaxies with even more matter, necessary for life, which includes a plenty surplus of carbon. The gases and dust grains disperse into the interstellar medium.

A white dwarf remnant is a quite amazing object. A dense quantum object made of a plasma of nuclei and electrons. However the electrons are as compact as they can be. This is the same force that prevents solid matter from passing through itself, but here, it applies to the whole white dwarf remnant at once: An atom as massive as a star. For some facts, a white dwarf remnant, has the mass of up to 1.4 suns, and a radius of a planet or moon.

Since many sun like stars can come from the same fragmenting nebula, it is very common for this generation of stars to orbit in pairs, and rarely triplets. This allows for a new phenomenon to occur. With an orbiting pair of sun like stars, one might form a planetary nebula first, before the other star even expands out to become a red giant. When the red giant's atmosphere touches the other white dwarf remnant, it captures lots of gas and dust. The nuclei slam onto its surface, and sometimes can temporarily cause nuclear explosions called novae. However, once the white dwarf remant starts to fuse elements into Iron-56, the same element that kills massive stars one by one, the remnant detonates. The resulting shockwave shreds the other star down to a cloud of plasma. This is called a type Ia supernova. The energy from such a supernova explosion outshines the rest of its galaxy for many weeks. Since every white dwarf remant always reaches the same mass before they explode, each exploding white dwarf remnant always has the same luminosity. A standard candle if you will…

The resulting type Ia supernova contains: 2 silicon-28 nuclei, 1 sulfur-32 nucleus, 1 argon-36 nucleus, and 3 iron-56 nuclei. Although iron as a nuclear fuel, is a star killer, most of the iron in the cosmos comes from supernovae like these. The gases and dust grains disperse into the interstellar medium.

We zoom back out to the intergalactic scale once again. At this point the three main spiral galaxies are about to merge together. In front of us is the Milky Way galaxy. A barred spiral galaxy about 100 thousand light years across. 2 million light years, over to the left is the grand spiral galaxy: Andromeda. It is 250 thousand light years across. Another 800 thousand light years, further left of the Andromeda galaxy, is a much smaller pinwheel galaxy: Triangulum. This galaxy is 70 thousand light years across. However, as time passes in the tens of billions of years, the Milky Way galaxy and Andromeda galaxies approach one another, spinning through space, in a knife edge configuration. During their collision, they pass right through each-other, flinging their guts millions of light years into space. Meanwhile, the Triangulum galaxy, shoots right through the crime scene at a relatively high speed. The seemily double spiral galaxy with two long tails, gradually reforms itself into a new conglomeration of old stars known as an elliptical galaxy. The remants of the two tails continue to get eaten up by the newly formed elliptical galaxy's immense gravity. The Triangulum galaxy, comes back into the scene and is absorbed into the new Milkomeda galaxy. A slightly flattened eliptical galaxy, known as a lenticular galaxy.

The last stars to form are red dwarf stars: stars smaller than the sun, and far dimmer. Their surface temperature is around 3500 degrees, and are about a quarter of what was our sun's mass and radius. They steadily fuse hydrogen-1 into helium-4, over a great timespan. The first of these stars will only fade after many trillions of years into the future. Most red dwarf stars, come in pairs, triplets, or even larger solar systems. Again this is due to the fragmenting nebulae. With much more dust, and plenty of turbulence, from previous supernovae, later and later generations of stars, will be

smaller, and more numerous. By then, the milkomeda galaxy, will just be a universally spread out galaxy, with stars receding away from one another faster and faster. Due to a cosmic vacuum expansion, driving the acceleration of the universe's expansion history. It isn't long until a red dwarf star sits there in the whole universe, completely isolated, no record of the big bang, no other matter or stars that can even reach us from here. After these stars fade is the universe over. What remains is an ever expanding vacuum of empty space!

The Book Of The Atoms

Atoms One: Lennard Jones Potential and Atoms in Motion

All material things are made of atoms. All atoms move in perpetual motion. They weakly attract one another when close, but repel each other strongly when squeezed too close. This pattern is known as an inter-molecular potential, and is key to understanding the phenomena of solids, liquids, and gasses.

In gasses, the atoms are scattering off one another in all directions, colliding like a game of cosmic pinball. This is what a gas actually is. But, on the other extreme we have solids. In solids, the atoms are all stuck together in a regular lattice of rows and columns, and cannot move around. In liquids however, the atoms are able to move around, sliding past each other, but cannot break free all together. This is what makes something a liquid.

With an intuitive grasp of atoms in motion, it is interesting to look at the characteristics that this motion can take. For example, imagine a cluster of atoms vibrating at a bunch of different frequencies. Such waves in the atomic structure of a material are called sound waves. Sound waves with a high frequency or pitch have a short wavelength, while sound waves with a low frequency and low pitch have long wavelengths.

Heat is also atoms in motion. In fact, it's the random motion on the scale of the atoms themselves. Therefore, the very highest frequencies of sound are actually modes of vibration that constitute the temperature of an object. In other words, remove all high pitched sounds within the material, including the sound waves with wavelengths on the atomic scale, and the temperature would drop to absolute zero.

The sound spectrum also continues to the low end with very long wavelengths and very low frequencies. We can also think of vibrating atoms in terms of their period of oscillation. A material object that moves back and forth slowly enough, has wavelengths so long, that they cover the entire object at a macroscopic scale. Since the atoms are moving in unison, its no longer a sound wave, but simply the motion of the object as a whole. Yes, even the atoms in a speeding bullet are moving as it flies.

So, as we can see, motion, sound, and heat, are all just different manifestations of atomic vibrations. However, one might imagine what happens if we include just a feeble touch of self-gravity to our inter-molecular potential. Given by Newton's laws of motion

and universal gravitation, the interplay between gravity on our fluid will have some interesting effects.

On a small scale, gravity is negligible. But as we zoom out, the amount of atoms in our view increases, and the amount of gravity accumulates. Eventually, as we zoom out past the scale of entire worlds, and we can treat each world as a single object, accelerating objects toward it, according to the inverse-square law in 3D space. It's this self gravity of large enough worlds, that makes them spherical, such as the Earth itself. And it is also the reason the solar system holds together. But don't even get me started on the complicated dynamics that gave birth to our solar system in the first place.

Take an expanding cloud of gas, with atoms that obey the inter-molecular potential and also Newton's gravity. The gasses first cool down, and tiny grains form, like a cloud of snow particles. As the cloud fragments, the particles collide and stick, with larger fragments orbiting around one another. Within a relatively short time, you end up with a cosmic web, filled with galaxies that look like spinning pinwheels, and within each galaxy, solar systems containing stars, planets, moons, asteroids and comets, all in orbit around each other. Not bad, because this is exactly what the large scale structure of our actual universe looks like in the first place.

Atoms Two: Abundances of Hydrogen and Helium in the Universe

From this idea, all we need is an empty box, that we fill with a gaseous mix of atoms. But one question arises… What atoms do we use, and by how much? By studying the cosmic abundances of the elements, we can determine that by mass, 75% of the universe is Hydrogen-1, and 25% is Helium-4. Almost. However, there are tiny impurities that makes life possible. Lets take a closer look.

These impurities also are atoms. Bigger atoms. Atoms like Oxygen, Carbon, and Nitrogen, which are essential for the building blocks of life. They and all other atoms only adds up to another 2% of the universe by mass. If the total mass of all atoms is a metric ton, roughly only 20 kilograms of these impurities would be needed.

Lets begin with Oxygen. Oxygen is the 8^{th} element on the periodic table. It is a very reactive and corrosive gas, as it needs 2 more electrons to complete its outer valence shell. Burning Hydrogen and Oxygen together, forms water vapor in an explosive crack. Oxygen also forms diatomic molecules, which constitute 21% of our atmosphere. So, air, water, and even rocks contain lots of oxygen. So lets add 10,420 grams of Oxygen-16 to our box.

Next up is Carbon, Carbon is the 6^{th} element on the periodic table. Commonly seen in soot or charcoal as graphite, it needs 4 electrons to complete its outer shell. Hydrocarbons such as Methane, are what happens when carbon and hydrogen combine. Carbon Dioxide, are what happens when carbon and oxygen combine. In fact carbon can form more molecules and compounds, than all other molecules without carbon combined. Carbon is therefore the next element that is essential for life. Lets now add 4,680 grams of Carbon-12 to our box.

After this, elements get harder to find. In the case of Neon, it is a noble gas, in the sense that neon atoms don't bond with any other atoms, including themselves. Because its completely non-reactive, means that an atom of neon is a loner. It is the 10th element on the periodic table. Lets include 1,340 grams of Neon-20 to our box.

Iron is the 26th element of the periodic table. It is a transition metal. It is a very dense metal, usually likes to lose 2 or 3 electrons depending on the situation, and is found in abundance in the earths outer and inner core. On the surface, it is used as the main component of steel, and therefore modern bridges, ships and skyscrapers will be impossible without it. Lets add 1,090 grams of Iron-56 to our box.

Then there is Nitrogen, Nitrogen is the 7th element on the periodic table. The most natural form is of a diatomic gas, comprising 78% of our atmosphere, with Nitrogen atoms needing 3 electrons to complete their outer shells. In Ammonia, it is achieved by combining with Hydrogen. Nitrates are Nitrogen with Oxygen, and Cyanide is Nitrogen with Carbon. Not exactly pleasant, but is also a key component of amino acids in proteins, some vitamins, and even DNA. Lets thus add our 960 grams of Nitrogen-14 to our box.

Silicon is the 14th element of the periodic table. It is a semi-metal, which means its properties are between that of a metal and a non-metal. It is this property that makes modern computers possible. Silicon tends to lose 4 electrons to Oxygen, forming a mineral known as Quartz. Glass crystal is just Quartz, and most of the Earth rocks in the Continental Crust are mainly Quartz. Lets add 650 grams of Silicon-28 to our box.

Magnesium is the 12th element of the periodic table. It is an alkaline earth metal. From its name, Magnesium tends to lose 2 electrons to Oxygen, and when combining with quartz minerals, forms a mineral known as Olivine, a green jewel that is a key component of most of the Earth's mass in its Mantle, even including some Oceanic crust. Lets add 580 grams of Magnesium-24 to our box.

Second to last is the stinkiest element, Sulfur. Sulfur is the 16th element of the periodic table. Some common forms of sulfur include hydrogen-sulfide, the gas with the characteristic rotten egg smell, and sulfuric acid which is found in car batteries, and is extremely corrosive. Sulfur combines with other elements in our bodies in many proteins, and a few vitamins. Lets add 440 grams of Sulfur-32 to our box.

Lastly, we have Argon. Like Neon, and Helium before it, it is a noble gas, comes as single atoms, and is completely inert and non reactive. It is the 18th element of the periodic table. Lets finish by adding 200 grams of Argon-36 to our box.

So in short, many of these elements make like possible. With a universe as large as ours, it would be quite strange if earth life is the only life out there. With Oxygen, Carbon, and Nitrogen, in the mix from the get go, alien life should be inevitable. But this is the last 2% of all atoms by mass. Hydrogen and Helium make the atomic majority.

Hydrogen-1 makes 75% of our metric ton box, and Helium-4 makes 25% of our metric ton box. Hydrogen-2 and Helium-3, although stable, are quite rare in terms of mass, but by number, 26.4 ppm is Hydrogen-2 and 10.3 ppm is Helium-3. Also by number

this means that we have 750,000 ppm of Hydrogen-1, and 62,500 ppm of Helium-4. Hydrogen tends to form diatomic molecules, and Helium being a noble gas is an inert gas of single atoms. Hydrogen is the 1st element of the periodic table, and Helium is the 2nd element of the periodic table.

But! That is not all there is, and far from it. In fact, remember that all material things are atoms, but that isn't to say that other forms of energy exist out there that are not atoms. You might be surprised to know that 5 metric tons of microscopic black holes have to be added to the box, in order to match cosmological observations. These black holes are essentially invisible and intangible, just like a ghost. This is because the invisible matter that holds galaxies together into the cosmic web, interacts only through gravity. As we know already, a rotating black hole is a particle with mass and spin, just like an electron in an atom or photon of light. In other words, the fleeting existence of quarks and gluons inside the atomic nuclei we discussed are also microscopic black holes. Everything is black holes! It's just that the black holes in atomic matter have properties with such small mass, that they act more like ripples in fields, but nonetheless, the invisible matter that holds the galaxies of the cosmic web together is real.

Atoms Three: Atomic Structures and Substructures

As it turns out, every atom of the periodic table consists of a heavy and dense, positively charged nucleus, surrounded by two fields, the electronic field and the optic field. The discrete vibrations of the electronic field are the negatively charged low-mass electrons in atoms, while the discrete vibrations of the optic field are the photons of light, which carry the electric and magnetic forces from one place and time to another. Put together, electrons and photons create all of the solid state and chemical forces within any substance.

Within an atom, the electrons fill "shells" or orbitals two electrons at a time. Each of these orbitals is a standing wave of the electronic field. Since the nucleus is heavy and positively charged, it creates a sink for electrons to be attracted to. The reason why electrons fill one orbital at a time is because they are anti-symmetric under exchange. This is what makes an electron a particle of matter. For comparison, photons of light carry the electric and magnetic forces, because they are symmetric under exchange. Ultimately the reason why electrons are anti-symmetric, rather than symmetric, is tied to the fact that the electronic field itself only transforms half as much as the optic field does under a change in spacetime perspective. But enough about electrons and photons, what is the atomic nucleus anyways? After all, if electrons and photons were all there is, there would be only a single type of atom: Positronium and nothing else, and even then, given that Positronium atoms annihilate by themselves in less than a billionth of a second, what gives?

The answer lies in the fact that there are roughly 250 stable nuclei, and thousands more unstable nuclei. Once we zoom inside the nucleus, we understand that it is a chaos of nucleons and pions. It is said that nucleons are quark triplets, and pions are

quark-antiquark pairs. But, in reality, the nucleus is a swarm of quarks and gluons, that are discrete waves in their respective fields, that only resonate fully as composite units. There is much to know as of yet about the field equations, such as their non linear behaviors, which are important to the structure and function of various nuclei, such as properties like radioactivity and binding energies. But all of the nuclei would not exist, without a chain of events of the early universe, known as the big bang.

The Book Of The Theory

Theory One: Time, Space, Matter

Before we begin, let's first understand orders of magnitude. Take one million marbles, as an example. We have a unit of measurement, the number of marbles. I could write this as "1,000,000 marbles", or as "1 * 10^6 marbles", or even as "one million marbles". If I define this as a mega-marble it means that I have now simplified this setup, by introducing a new unit of measurement. Since numbers can get very huge very fast, it becomes useful to define a new system of prefixes for our numbers. We have already met one prefix, mega, which means million. There are others too. A marble is 1 marble. A kilo-marble is 1,000 marbles. A mega-marble is 1,000 kilo-marbles. A giga-marble is 1,000 mega-marbles. A tera-marble is 1,000 giga-marbles. A peta-marble is 1,000 tera-marbles. This pattern continues on, by multiplying by one thousand every time. If we divided by a thousand instead of multiplying, we arrive at the following units of, milli-marbles, micro-marbles, nano-marbles, pico-marbles, and femto-marbles.

Now with this in mind, imagine two marbles floating in the void. Both marbles each maintain their motion, as they both independently travel in straight lines with a constant speed. Time runs at the same universal rate for both marbles. The two marbles both have definite positions as well as definite velocities. This all makes perfect sense. In order to define what is going on, we introduce a system of units that measure space, time, and matter.

Space is measured by using a three dimensional coordinate grid. The X dimension runs from left to right. Next, the Y dimension goes from the back to the front. Lastly, the Z dimension points straight up. By measuring these three numbers, we can find the position of any marble. This is just like the addresses in a city, which uses the street numbers, avenue numbers, and floor numbers. We thus define the meter as our unit of distance in space.

The Meter is defined as follows: Walking in a straight line from the equator to the north pole is by definition 10 million meters. One centimeter is 0.01 meters. An inch is 2.54 centimeters. A foot is 12 inches. A yard is 3 feet. A mile is 1,760 yards. Similarly, a kilometer is one thousand meters, and a millimeter is a thousandth of a meter.

The amount of matter in a marble measures its resistance to a change in its motion. Marbles like everything else are made of fundamental indivisible particles, called

atoms. These atoms behave just like tiny identical marbles, since they too, like everything else, maintain their state of motion. This means that the amount of matter in a marble maintaining its motion, is then just the total number of atoms in that marble, which are all maintaining their motions. Similarly for two or more marbles, the total amount of matter is just the total number of atoms in all of our marbles. We call the amount of matter inherited to an object, as its mass, and is measured in grams.

The Gram is defined as follows: By definition, a cubic centimeter of water has a mass of a gram. One ounce is 28.349523125 grams. A pound is 16 ounces. A ton is 2 thousand pounds. Similarly, a kilogram is one thousand grams, and a milligram is a thousandth of a gram.

Time controls the evolution of the marbles. This is because, since the marbles are moving, their positions change over time. At every moment or snapshot of time, there is a unique configuration of our marbles. To specify which configuration we are talking about, it becomes useful to introduce a clock that measures which snapshot we are in. Playing each snapshot back in sequence, moment after moment, we recover the evolution of the scene. This is just like the pages in a flip book or the frames of film in a movie projector. The clock time is universal and we count the frames with a new unit of measurement, the second.

The Second is defined as follows: A full day by definition lasts 86,400 seconds. A minute is 60 seconds. An hour is 60 minutes. A day is then 24 hours. One week is 7 days. One month is 4 and 1/3 weeks. A year is 12 months. A decade is 10 years. A generation is 3 decades. Similarly, a kilosecond is one thousand seconds, and a millisecond is a thousandth of a second.

As it turns out, it doesn't matter what units of measurement we use to describe the marbles, the result is always the same. As an example, we could define a totally new system of units with miles, pounds, and hours, instead of meters, grams, and seconds. Even though the numbers will be different, the physics of our two marbles will be exactly identical. This is true, even in different setups. We can therefore get rid of our units of measurement, and claim that the physics of the marbles will work regardless. With the physics of our two marbles, it seems like our lives are also a linear mechanical progression, because like the marbles, we too are made of atoms. We then conclude that our clockwork universe is made up of atoms meaninglessly drifting in the void, and is completely deterministic. This is sadly just the way it is. Or is it?

Theory Two: Relativistic Quantum Gravity and the CGH Physics Cube

This was the physics of the industrial revolution, written in 1687 by the greatest scientist who ever lived. Isaac Newton. However, by the turn of the 20th century, experiments began to show that Newtonian mechanics is not always right, and had to be modified to agree with these radically new groundbreaking experiments. There are

three main sets of new phenomena, that were incorporated into the three pillars of modern science. The three pillars are universal gravitation, special relativity, and quantum mechanics. The fate of humanity rests on the unification of physical law.

Universal Gravitation was discovered by Newton himself while trying to unify the motion of heaven and earth, and was published in his book, called the Mathematical Principles of Natural Philosophy. All marbles attract all other marbles, with an inverse square force field, in three dimensional space. This is why all objects fall to the ground at the same rate, why the planets move around the sun in ellipses with the sun at one focus and the other focus empty, and why a line drawn from the sun to a planet sweeps out equal areas in equal time intervals, and also explains why the semi major axis of a planet's orbit cubed is proportional to the orbital period squared, along with many other gravitational effects.

In the theory of Universal Gravitation, there is a Universal Constant. The constant of Gravity has the value of 6.67408 / 10^14 m^3/g/s^2, in our system of units. This means that the strength of gravity is very weak. To get an idea on how weak gravity is, imagine two cars in deep space, each weighing a ton, parked right next to one another a yard apart. It will still take many hours for the two cars to stick together. Therefore, we can continue to say that, both marbles each maintain their motion, as they both independently travel in straight lines with a constant speed. Despite the fact that these gravitational effects can be ignored in the everyday regime, we still live in a universe dictated by the physics of, universal gravitation. The fact that universal gravitation works at all, shows us just how weird our universe really is.

Special Relativity was put together by Albert Einstein in 1905, in order to describe the strange behavior of the speed of light, along with four other papers that shake physics down to its foundations. The dimensions of space and time, arrange themselves such that the speed of light is the same, from all moving perspectives. This means that among many new phenomena, fast moving clocks run slow, fast moving rulers contract along their direction of motion, high speed motion breaks the simultaneous nature of time, and most importantly nothing moves faster than the speed of light.

In the theory of Special Relativity, there is a Universal Constant. The constant of Relativity has a value of 2.99792458 * 10^8 m/s, in our system of units. We recognize this as the speed of light. This means that the speed of light is very fast. To get an idea on how fast this is, imagine a foot long segment of fiber optic cable. The latency of your internet connection would be a nanosecond. A nanosecond is a billionth of a second. Therefore, we can continue to say that, time runs at the same universal rate for both marbles. Despite the fact that these relativistic effects can be ignored in the everyday regime, we still live in a universe dictated by the physics of, special relativity. The fact that special relativity works at all, shows us just how weird our universe really is.

Quantum Mechanics was constructed by a band of nuclear physicists in order to explain the rainbow of a fluorescent light source. The total kinetic energy of a marble is

directly proportional to its corresponding probability wave frequency. This leads to the notion that objects can be in more than two places at once, how marbles and waves are actually the same thing, how these quantum waves have discrete harmonics like the specific notes on a trumpet, and the weird notion that measuring one marble can reveal the properties of another marble instantly.

In the theory of Quantum Mechanics, there is a Universal Constant. The constant of Quantum has a value of 6.62607015 / 10^31 m^2*g/s, in our system of units. This means that the amount of quantum uncertainty is very certain. To get an idea of how certain quantum physics is, imagine a grain of dust, weighing less than a microgram, sitting on your desk at school. After 30 years, your kid, now sitting at your desk at school, notices that the same exact dust grain has moved by a millionth of an inch. Therefore, we can continue to say that, the two marbles both have definite positions as well as definite velocities. Despite the fact that these quantum effects can be ignored in the everyday regime, we still live in a universe dictated by the physics of, quantum mechanics. The fact that quantum mechanics works at all, shows us just how weird our universe really is.

To conclude, each of these pillars of physics, has radically altered our understanding of our two marbles. Our common sense vision of life as a mechanical linear progression, is just all wrong. Every pillar of physics, introduces a new universal constant. The associated physics reduces to our common sense, by making a series of approximations. So even though our common sense worldview works well in the everyday, in the grand scheme of things, our universe is stranger than fiction.

Theory Three: Rotating Black Holes and Discrete Field Quanta

At this point, we have all of the pillars of physics we need, in order to unify all of physics into the theory of everything. However, such a unification of physics will require two radical paradigm shifts. The first idea is all about special relativity, and how to unify it with the rest of physics. The second idea is to reconsider the properties of matter, such as mass and spin. Lets review some key ideas in special relativity before we move on. The spacetime of special relativity, also known as Minkowski spacetime, replaces the idea of absolute time, with the idea of an absolute light speed. With this idea in mind, the symmetries of space and time, unify into a structure known as spacetime.

To unify special relativity with universal gravitation, imagine two gravitating marbles. Placed at rest an infinite distance apart, the two marbles will gradually begin to accelerate toward one another. The speed needed to break the fall, is known as the escape velocity, and is also the speed at which space itself carries the marbles together. However, we know that gravity spreads out with distance, meaning that the escape velocity would exceed light speed at a close enough distance. In a sense, space itself is falling inwards, faster than light can. And since nothing can propagate faster than light, everything inside this distance is trapped forever. This is the event horizon of a black hole!

Going back to our two marbles, we know that they are actually two black holes. The mass of each black hole, is simply the size of its own event horizon. The year is 1915. Albert Einstein completes his General Theory of Relativity. Weeks later, Carl Schwarzschild found the spacetime geometry around a simple black hole. The Schwarzschild spacetime reduces to special relativity and universal gravitation, in their respective domains. However, black hole orbits do things not seen before in science. Time slows down, light bends, orbits precess around. Closer in, gravity increases like a rip tide, rendering circular orbits unstable. Even closer, and it is possible for light to orbit temporarily. Crazy stuff.

For fun, lets dive into a Schwarzschild black hole. Far away from the hole, its gravity seems normal, since the paths of objects around it, the orbits, behave as we would expect. The slowest orbits are the elliptical orbits, like the earth around the sun for example. Faster orbits, like that of a comet passing by a planet, are known as fly-by orbits. The fastest orbits are the straight lines that light takes to reach your eyes. Closer in, say within a few dozen black hole radii away, the gravity is so powerful that light rays will noticeably bend, just like the flyby orbits we mentioned. On the other hand, the slower elliptical orbits are also acting very strangely. They undergo a phenomenon known as precession, which is to say that the closest point of the orbit, the perihelion, shifts in the same direction of the orbit itself, turning a simple ellipse into a daisy pattern. Then, at three black hole radii from the black hole, circular orbits become unstable. This means that a small push will either send us flying into the hole, or off into deep space. At this distance, orbits zoom and whirl around the hole. The orbital precession and time dilation effects are clearly noticeable. Closer in than three radii from the hole, faster and faster elliptical orbits become unstable, until we arrive at two black hole radii from the black hole, at which flyby orbits start being unstable too. The only orbits possible are the highly bent light rays, which also follow flyby orbits. Then, at a special distance of one and a half radii away from the black hole, light can orbit the black hole. However this orbit is unstable, and the light rays either fly off to infinity, or plunge into the black hole. Even closer than this, and orbits do not exist, since the orbital speed needed would be faster than light. Just above the event horizon, it is still possible to escape the gravity of the black hole. However, as we approach the horizon at one black hole radius, the chance to fly away gets slimmer and slimmer. Time slows to a halt, when seen from the outside. Then as you cross the invisible spherical boundary, you are doomed to hit the central singularity, where everything you know comes to an end. Seen from outside however, nobody even sees you cross the event horizon at all, as your image fades away on the black hole surface.

In 1964, Roy Kerr found another solution to Einstein's Theory, one that extends the Schwarzschild solution to include a new phenomenon, spin! In effect, spacetime gets dragged along with the rotation, causing even more mayhem to our orbital path around the hole. This is known as frame dragging. There are an inner and outer event horizon,

and even an inner and outer ergo sphere, within which it is possible to extract rotational energy. Moreover, a rotating black hole, spinning as fast as possible, has unstable orbits all the way out to nine black hole radii out going against the spin, yet can have stable circular orbits traveling along with the spin of the black hole, all the way down to the outer event horizon itself. Even so, the Kerr spacetime, reduces to the Schwarzschild spacetime, for a black hole that does not spin. The spin of the black hole, is what causes this so called frame dragging. As an example, the orbit of the earth around the sun, is a near circular ellipse. The constellations of the zodiac, are the stars on the far side of the earths orbit during that month. The path of the earths orbit traces a two dimensional plane, known as the ecliptic plane. For our rotating black hole scenario, this is no longer the case, as any non equatorial orbit about the black hole, tilts. That is to say that the ecliptic plane of our orbit is shifting like that of a spinning top on the table. This is even more wild than anyone could ever imagine!

Now imagine we have a handful of rotating black holes, all orbiting through a common spacetime, with their own masses and spins. At this point, we cannot solve the equations of general relativity directly, and will need to solve the equations on a supercomputer. Black holes spiral inwards towards one another and merge, releasing gravitational waves. These tremors in spacetime, then bend around other nearby black holes, which are merging themselves. Its just a gigantic mess of curved geometries. After a while, everything settles down to a few large black holes, with higher masses and new spins, all moving away from one another. In the theory of general relativity, matter tells spacetime how to curve, yet spacetime tells matter how to move. The matter we are referring to are the black holes themselves. Note that it is not just space or time itself that is bending, but our full spacetime geometry. This is the worldview we get, after unifying special relativity with universal gravitation.

To unify special relativity with quantum mechanics however, imagine two quantum marbles. You roughly know their distance and relative velocity after measuring them. Lets say we want to measure the separation between the two marbles, this time with a much greater precision. The uncertainty in the relative velocity of the marbles will have increased by a similar factor. By measuring the distance precisely enough, the uncertainty in relative velocity will exceed light speed. When this happens, you have discovered antimatter!

Going back to our two marbles, we know that they are actually two quantum waves. The mass of each quantum wave, is simply its own frequency. The year is 1925. Erwin Schrodinger finds a relativistic wave equation for these quantum waves. Weeks later, Klein and Gordon rediscover this relativistic wave equation, after Schrodinger abandoned it. These Klein Gordon waves reduce to special relativity and quantum mechanics, in their respective domains. However, Klein Gordon waves do things not seen before in science.

Just for fun, lets take a closer look at these Klein Gordon waves. Like all waves, Klein Gordon waves can be decomposed into a series of plane waves with definite frequencies and wavelengths. Take one of these plane waves for example. It is called a plane wave for a reason. Simply because as the wave scrolls through space, it has wave fronts that are flat two dimensional surfaces, or planes. The perpendicular distance between the parallel wavefront planes, is the wavelength. The frequency is just the number of cycles per second. So in other words, a plane wave is the building block of any wave. Lets now boost to a moving perspective, such that we are moving with the wave. At this point, the wavelength is so long, that for our purposes, the plane wave is now a synchronized sine wave. Its like the tides going in and out of the shore, as the whole flat ocean seems to rise and fall every day, in perfect unison. As we boost to a slowly moving perspective, the frequency has increased very slightly, however the synchronized wave is now out of sync again, as another plane wave, with a very long wavelength. At such slow speeds, the frequency of the waves is fairly constant, and could be ignored. The remaining phase angle of our wave, now has a much lower frequency, now in proportion to the kinetic energy of its associated quantum marble. The inverse wavelength of our nearly synchronized plane wave on the other hand corresponds to the linear momentum of our marble. As we boost away with faster and faster velocities, the wavelengths of our plane wave get shorter and shorter, and the frequency increase becomes noticeable. As we boost much faster, ever closer to light speed, the plane wave now has a very high frequency and a very short wavelength, such that the plane wave now seems to travel at exactly the speed of light. Boosting more will only make the waves even shorter, as they continue to travel at exactly the speed of light.

In 1928, Paul Dirac found another relativistic wave equation, one that extends the Klein Gordon equation, to include a new phenomenon, spin! The spin of the Dirac waves, is due to a new direction that these waves can vibrate in. In some sense, the more ways in which these quantum waves can vibrate, the greater the spin. Spin can only increase or decrease by half steps. In this case, we have a spin up and spin down electron, along with a spin up and spin down positron. Each and every component, are themselves Klein Gordon waves. It is only when we change our point of view, that the components mix into one another. For example, take a Klein Gordon plane wave vibrating purely as a spin up electron. If we rotate this wave, and look at it from another angle, the plane wave, with everything else being the same, is now vibrating as a spin down electron. Similarly, if we boost our whole setup so far, the vibration in the first two matter electron components, is now slightly vibrating the last two antimatter electron components also, also known as the spin up and down positrons. We say that Klein Gordon waves and Dirac waves, have the spin that they have based on this simple idea. Klein Gordon waves have a spin of zero, because if we rotate the setup by a full turn, everything stays the same. This is obvious. However, if we rotate a Dirac wave by a full turn, the components mix only half of what we expect. This means that it takes two full turns of a Dirac wave to return to

its initial configuration. We say that a Dirac wave has a spin of a half, for this very reason.

Now imagine we have a bunch of Klein Gordon and Dirac waves, all undulating independently throughout spacetime. Every quantum wave, vibrates in its own abstract dimension, with every dimension corresponding to the probability coordinates of every marble. This is similar to how the spin of all these marbles acts like. The Klein Gordon waves, overlap and build up, whereas the Dirac waves interfere and sometimes cancel out. In this theory, it is all about a new entity called a relativistic quantum field. Imagine a crystal array of quantum marbles that extends out to infinity in all directions. If we hit this crystal with a hammer, it will vibrate just like a big block of rubber. As it turns out, these vibrations are completely identical to our Klein Gordon and Dirac waves. Since these vibrations are nothing but sound waves living in a crystal lattice made of quantum balls and quantum springs, there should be a minimum unit, or quantum of a field. As luck would have it, every field quantum acts independently, just like a marble. Therefore our system of a bunch of Klein Gordon and Dirac waves, is thus nothing more than a collection of field quanta. This is our worldview after unifying special relativity with quantum mechanics.

Our two worldviews, one of the heavy, and the other of the light, both share some common features. Black holes and quantum waves, both have mass, and also both have spin. Because of this fact, a setup of the exact same physical system in one worldview, will mimic the behavior in the other worldview. It turns out that the atoms and subatomic particles, of which we are made, are not marbles at all. They are instead a kind of quantum black hole. A quantum black hole, behaves more like an actual black hole if it is really heavy, yet also acts like a quantum wave if it is really light. Therefore, in order to understand this, we needed to unify the three pillars of physics into a single framework. This means that everything is one. Literally!

Theory Four: How Everything Arises From Nothing

The spacetime of special relativity, called Minkowski spacetime, has certain symmetries, known as Lorentz Transformations. They keep the speed of light constant, under a change in perspective: The relativity principle. They are the symmetries of spacetime itself: 3 Hyperbolic Boosts, 3 Spacial Rotations, 4 Spacetime Translations. From these symmetries, emerges new phenomena.

In classical field theories that involve relativistic wave equations, which live on Minkowski spacetime, the mass and spin of these field equations, are a direct result of spacetime symmetries. Mass is the minimum frequency for a wavepacket at rest. Spin is the amount of change between field polarizations under a change in spacetime perspective. Due to the quantum principle, the mass and spin of a wavepacket, when zoomed far enough away, appears to act like a spinning top, with the mass being the top's inertia, or resistance to changes in motion, and its spin being its angular momentum while spinning.

However, all relativistic wave equations, still live on flat Minkowski spacetime. Sure, there could be interactions between fields that give rise to non-gravitational forces. This is what the standard model does, as it is a classical field theory, that maps out the possible interactions between wavepackets. However, in Einstein's General Theory of Relativity, gravity is the result of the curvature of spacetime itself. Therefore in General Relativity, spacetime is a classical field theory in its own right. The reasoning to this approach is astonishing, because one has to invent a new way to produce classical field theories involving symmetries.

The answer is a new kind of symmetry known as local symmetry. So far, relativistic wave equations had global spacetime symmetries: Mass and Spin. However local symmetries are symmetric only in small regions of the field spaces. We already encountered local symmetries in the standard model. They were not local spacetime symmetries, but local field symmetries. However, one might ask what happens when one makes spacetime symmetries local in their own right. The answer: General Relativity!

Okay not quite, as I must admit. Although General Relativity is a classical field theory, where spacetime curvature gives rise to gravity. It doesn't have all of the local symmetries of spacetime. Only spacetime translations become local symmetries in Einstein's theory. However, what we are asking is what happens when all spacetime symmetries become local symmetries. In the general case scenario, one must intoduce a new concept known as torsion… Just like energy density currents and momentum density currents couple to gravity, spin densities couple to torsion. And, just like how the curvature of spacetime is the definition of gravity, torsion has to be included to make sure the boost and rotation symmetries are also local in nature. The result is a new theory called: Poincare gauge theory, or gauge theory gravity, which has field equations known as the Einstein Cartan Theory.

However, in our theory, we are not to couple the fields of the standard model to the einstein cartan theory. And here's why? Solutions of the einstein cartan theory produce black holes, whether or not we couple other fields to the theory. I mean why not let everything be fields, including spacetime curvature and torsion, and what is the deal with black holes? This is a bug, not a feature. Black holes have to be associated with a point particles… And as we know, point particles do not exist. At least in classical field theory. But, in this oberservation comes a truly surprising result.

As we know we applied quantum physics to a single point particle, and recovered a classical field theory of relativistic wave equations. Therefore, if black holes are also points, means one thing: Every rotating black hole with a given mass and spin, must be associated with a discrete field quantum of a relativistic wave equation! And, in our einstein cartan theory, which we just coupled to the standard model field theory doesn't do it justice. Black holes exist regardless of field content. What we need is a theory where black holes exist, only when the fields are vibrating, and when no fields are

vibrating, there shoudn't be any black holes present. Moreover their mass and spin should also be completely identical. How to do this?

Since Minkowski spacetime has the same global symmetries, even in the case with the Einstein Cartan theory, there shoudn't be any extra local symmetries. By coupling the standard model to it, we included plenty more extra symmetries that the Einstein Cartan theory couldn't handle. Let me say it backwards: All local symmetries have to have global symmetry counterparts. And in the standard model, we only have a global spacetime symmetry, there are no global field symmetries. Therefore, lets keep the standard model and the Einstein Cartan theory separate, for now.

Thus, in the vacuum, the Einstein Cartan theory, reduces back to good old General Relativity. How? Without any mass or spin present from other field theories, the right hand side of the Einstein Cartan theory vanishes. Spin vanishes, and so does the mass. Torsion is algebraic, so it completely vanishes without spin, leaving us with general relativity. But in general relativity, the energy momentum tensor is also all zero, due to vanishing mass. Therefore, one is left with general relativity without any sources.

In vacuum general relativity, there are plenty of solutions. One can consult a numerical relativity simulation, just to be sure… rotating black holes orbit and collide, gravitational waves propagate around everywhere. And, everything is just vacuum. So clearly, one has sources without a source, particles in vacuum, or otherwise put: Everything from nothing!

What we need now, is a way to directly couple these rotating black hole solutions, to our discrete field quanta. We need a way to produce the spacetime geometry straight from its solutions, and not the other way around.

Enter the cartesian Kerr Schild spacetime geometry! In laymans terms, it is the spacetime geometry for a rotating black hole in orthogonal light cone coordinates. They have some nice properties, such as being exactly linear solutions to vacuum general relativity. They have constant metric determinant, are lorentz transformed solutions of one another, and in these coordinates, the vacuum einstein's equations, becomes a simple tensor relativistic wave equation. Everything is exactly linear! No gravitons, no renormalization, no issues, just solutions that coorespond to point particles. And since, these solutions are the result of a exactly linear coordinate system, tells us that the superposition principle still holds. Therefore, one can reconstruct the entire spacetime geometry in the Kerr-Schild form.

What is needed now, is to propagate the standard model as a classical field theory over this curved background geometry. We introduce covariant derivatives for all fields. However for the matter fields which use Dirac spinors, there is a sublety, which needs to be addressed: We need the spacetime frame instead of the metric tensor. Luckily Kerr himself, used the so called tetrad approach to produce his spacetime geometry for a rotating black hole. In some research articles, it has been reproduced in cartesian

Kerr-Schild coordinates. Using a set of light cone adapted null geodesics, one can produce the correct tetrad frame field.

Therefore to conclude the theory of everything, the standard model is a classical field theory. A consious observer collapses the field to discrete mode amplitudes. Then the collapsed field acts as a single pilot wave, that carries multiple trajectories, with each path being a singularity. The Kerr metric or kerr tetrad is computed for each singularity, in Minkowski spacetime. The fields propagate through this curved spacetime geometry, and the computation loop closes. This is what is required so that a computer simulation can be performed for the entire universe.

Theory Five: The Many Failures of Quantum Particles

What is a particle? Newton thought that particles are tiny points. Even Einstein's theory predicts black holes as points. However by that time, science has caught up, but every scientist continued to believe in point particles. Even with the birth of quantum theory, the point particle persists. Why? Could we be wrong all along? The answer is a resounding yes. As it turns out, reality is not made of particles at all… But something else: a field!

To really see the significance of such a paradigm shift, we first need to come to grips with what a quantum particle even is. Every quantum theory begins with a single equation: The schrodinger equation. This equation is what one gets when one applies quantum physics to a single particle. In other words, it is the quantum version of Newton's point particle! Interpretations aside, the schrodinger equation is actually a field equation. A field is just a mathematical object that takes a value at every point in space, just as a particle is a mathematical object with a position in space. It is that simple. But, the details matter here, such as why the schrodinger equation has so many people baffled about what a particle is.

For quantum physics 101, we recall how to apply quantum physics to a point particle. Back in classical physics, we know a particle is an actual point that travels in a straight line with a constant speed. Just like a billard ball. It has linear momentum, and kinetic energy. The momentum is just its mass times its velocity vector. Whereas the kinetic energy is simply half of the dot product between its velocity and its momentum. However, the shrodinger equation tells the same story, with a central modification. The solutions of the equation are now sine waves, with their wavelength inversely proportional to their momentum, and their frequency directly proportional to their kinetic energy. By adding many sine waves together, one can create wave packets: Traveling waves that look like a collection of point particles from a great distance.

However, most scientists didn't see it that way. They invented a slew of new methods to coax particles out of the wave equation. Lets examine each case, one by one. So here we return to our original question: What is a particle?

One way is to reinterpret the wave equation as describing not a field, but a probability wave, known as a wavefunction. The amplitude squared of the wavefunction

gives the probability density of finding the particle in space. Therefore during measurements, the wavefunction "collapses" to a single point of interaction. This collapse gives us the definite position for our point particle. But this gives new problems. Since the collapse is a result of a single measurement of a single particle, means one thing: One must introduce new dimensions of space to handle more particles… 1 particle is 3D, 2 particles is 6D, 3 particles is 9D, 4 particles is 12D, and so on… This phenomenon is known as quantum entanglement, or spooky action at a distance. And this is used to compute corelations between multiple particle probabilities.

Another way is to keep our original interpretation of the wave equation as describing a field. From this, we apply the whole procedure of quantum physics all over again, not to our point particle, but to the entire field! The "quantum" field as it is called, has an infinite number of dimensions, each one describing the value of the field at a particular point in space. Each sine wave in the field, has a physical amplitude, just like the position of a particle. Therefore, the resulting "quantum field" is an infinite collection of coupled quantum harmonic oscillators, and is no different than our original use of wavefunctions for describing the system. Then, the energy levels of each quantum harmonic oscilator, corespond to a collection of identical quantum particles. From this, we have come full circle, as "quantizing" the field, gives the same result as reinterpreting the field as a multiple particle wavefunction. Something seems off here, due to the persistence of point particles.

The reason for using quantum mechanics then has nothing to do with the shrodinger equation itself, and rather is all about the probabilities of measurements having to do with some sort of wavefunction, which lives in an abstract space of possibilities known as a hilbert space.

We should pay attention to what the schrodinger equation is actually describing, and not force particles into our paradigm. By doing so, we lose track of what reality is, as human centric constructs enter our most fundamental theories. Particles are just one example of this. In everyday life, we see solid objects in motion: Particles. And objects move through a physical medium: Space. If particles are such a human centric construct, we have to make sure that this doesn't creep into physical theory…

However, there is more to the shrodinger equation than this! Every relativistic wave equation, reduces to the shrodinger equation in the domain that the speed of light becomes instantanious. So, if the shrodinger equation describes a field, and this field is what one gets in this regime where the speed of light tends to infinity, means one thing: All relativistic wave equations describe fields too!

And it is this idea which makes some serious sense. Here's why… The standard model of particle physics, believe it or not, is a field theory. If one took the field equations, and run them on a supercomputer, that would be all that is needed to simulate the universe. The fields equations are just relativistic wave equations, or otherwise put, versions of the shrodinger equation, that obeys Einstein's theory of special relativity. In

the regime where the speed of light becomes instantanious, does one recover the shrodinger equation. Therefore the shrodinger equation is not fundamental to quantum physics, but instead, all of quantum physics including the shrodinger equation emerges from relativistic field equations. Classical Field Theory is more fundamental than Quantum Mechanics! And the standard model, is exactly that: a classical field theory. Since quantum theory is emergent, there is no need to apply it to a theory which is already "quantum" in nature. Therefore the standard model is a theory which satisfies both quantum physics and relativity. It's that simple!

Theory Six: Why Fields Are Fundamental

In standard quantum field theory, one promotes field values to operators that act on a wavefunction of field configurations. However, as we know, this leads to issues related to the fact that standard quantum theory is an emergent phenomenon. So what do we do? We see particle trajectories in particle colliders, atoms in electron microscopes, and photons of light in the photosensors of a digital camera. What is going on here?

The answer might not be what you expected, since reality is all classical fields, we cannot afford to reintroduce quantum theory, to make particles pop out. Moreover, the introduction of quantum physics to matter fields like the Dirac equation, leads to other issues like the use of anti-commuting variables. These "numbers" don't have a wavefunction associated with them, so altogether, we lack a particle interpretation anyways, and the fields are treated inconsistently. However, there is a loop hole.

Whenever we see a "particle", what is going on is that the field has been localized. After all, wave packets, do act like particles. What if, it is possible for fields to collapse. Not like wavefunction collapse, but in a different way, that I call field collapse. This is similar to a Jpeg image file. The image is the field. One takes the fourier transform to find the frequencies that make it up, and then rounds their amplitudes. The result is stored on the computer's storage drive. This introduces discrete amplitudes, for all field modes. What we are doing is much the same.

To be rigorous, there is a theory known as the old quantum theory. Each fourier mode of a field is just a sine wave, as we discussed previously. Since these sine waves are solutions to a simple harmonic oscilator, we need to find the "old quantum" counterpart. The process of quantizing the harmonic oscilator, in standard quantum theory only produces the wavefunction for bosons, not fermions. However, the old quantum theory does describe both bosons and fermions. For bosons, one has the commutation relations, and for fermions, one has the anti-commutation relations. These are the same relations that gave us the anti-commuting numbers, and harmonic oscilator wavefunctions. But with a twist…

Instead of quantizing everything, we discretize everything. Since all fields are relativistically invariant, one only needs to quantize a field mode in its rest frame, and then one can lorentz boost to any other frame. This ensures that the field mode

amplitudes are all unchanged by a change in perspective. Thus a field mode at rest, is just a single sine wave, vibing at a frequency of its rest mass energy.

Applying the old quantum theory to such a sine wave, one selects amplitudes whose square is an integer. Just like the wavefunction squared gives a probability that integrates to one over all spacetime, here the total value is an integer, as we are dealing with multiple levels of energy, each one a discrete field quantum: A particle.

What makes this interesting, is that the transition matrices used for quantizing a harmonic oscilator, are the exact same that are used for the discrete harmonic oscilator. For field theory, these are the raising and lowering operators. But here, we are using these matrices to select discrete amplitudes for our field modes. The amplitudes are all square roots of the integers. For bosons, the whole numbers are allowed. For fermions, they are the binary numbers which are allowed. Therefore Qbits, in quantum computing, are just these anti-commutation relations.

So, from this, one can discretize the field modes. But a question arises, how does this reproduce the Pauli exclusion principle, and the stats for particle exchanges with varying degrees of spin? Since each fourier mode, has an uncertainty principle built in, with each sine wave having a definite momentum, implies that matterial fermions must take up space. Why? Since the mode amplitudes must be binary, and since they are states with definite positions or definite momenta, but not both, means that cannot overlap, because this would mean the ampltudes would be greater than one. Therefore, the exclusion principle is derived directly from the anti-commutation relations used not to quantize but to find discrete binary amplitudes for each field mode.

For bosons its a similar story, as their harmonic oscilator amplitudes are all resulting from the use of commutation relations. The same statistics, the same polarizations, the same exclusion principles, the same everything as the standard theory, but just a discrete classical field theory. For the spin stats, one must realize that it takes two full turns for a spinor to complete its rotation, but a vector takes just one full turn to do its rotation. This is the same reason why the exchange symmetry works for both bosons and fermions. Whenever we observe a field, it takes on discrete values. But what discrete values does it take?

Imagine the setup. You reading this, are in a simulated virtual universe. The VR headset tracks your movements, and the screens update. Its the same here. The fields you see are discrete because of the VR headset. Without you being here, the fields will continue their evolution determined only by previous updates. Therefore as soon as consious observers evolved on our world, the spaceship earth, was the time that the fields started to collapse to discrete values.

The collapse rules are as follows: 1). Bosons and fermions both have fields that before collapse can take on any field mode amplitude all real valued. 2). Bosons have amplitude A = sqrt N, where N = 0,1,2,3,etc, and their collapses occur with a poisson distribution to any N. 3). Fermions have amplitude A = 0,1, where N also = 0,1, and their

collapses occur with a bernulli distribution between N=0,1. 4). Fermions and Bosons both share P(N=0) = exp(-A^2). 5). Phase angles for the field modes, follow the relativistic bohmian trajectories on the field, and are updated to the trajectory's positions a priori, and not just follow the field's mode' phase angle at all times, after collapse.

Now that we have a method for finding our discrete field quanta, its time to use our single classical field theory. In Bohmian mechanics, or pilot wave theory, there is a wavefunction that guides a single trajectory in hilbert space. The gradient of the wavefunction in each of the dimensions gives the momentum of the cooresponding particles. In our theory it's similar with another twist…

Previously, we abandoned quantum theory, and replaced it with a discrete but classical version. So to be compatible with our theory, we have to redefine our pilot wave theory not for a wavefunction, but for our field theory. Now, we still use the same gradient rule, but replaced with a field. Now since there are not 3N dimensions anymore, its seems natural to just let our single field theory, guide multiple independent trajectories. Not, a single trajectory on a high dimensional wavefunction. But rather is this: Many particles guided by a single field theory!

Here, everything seems fine, so what happens to quantum entanglement and exchange symmetries? Since the field modes are discrete, and since non locality is generated by the trajectories, not the field, means that every particle is indeed coorelated with every other particle. Lets take a closer look to a famous experiment. The double slit experiment!

Here particles are shot into a wall with two slits in it. The particles are detected on a recording screen behind the wall. Since the particles are all wave packets, means one thing: We see an interference pattern on the back wall. The same thing occurs with single particles too. Its only when a single particle is observed before it passes through one slit or the other does the pattern split into a two band pattern of hits, not an inferference pattern of many bands.

What is going on? Are there some spooky things going on? Nope, wrong again. The field theory describes the same thing as the quantum theory, because the field equations are identical to the shrodinger equation. Even for a single particle quantum theory, its the same… And thats why an interference pattern is seen, even when struck one particle after another!

But now, something interesting occurs when one observes it before it passes through. Everything the same, the discrete field theory, collapses just like the wavefunctions do. Therefore its no difference what theory we use, but the field approach is much simpler, and thus must be the correct one!

Turn down the intensity, and fewer particles pass through the experiment at any given time. The field discretness becomes more visible. Until one discrete field quantum is passing through any given time. The pilot wave trajectories are used because the discrete field behaviors are what encodes the multiple particle exchanges. Without the

entanglement directly encoded in the wavefunction's phase space, we are free to include multiple trajectories in our field theory. After all, when we turn the intensity back up, we recover the trajectories as actual particles. It's just the fields themselves collapsing, creating the illusion of particles. Here is how this works:

1). Take the standard model of particle physics. As sean carroll's core theory, it is a domain specific truth, verified to a great undreamt of precision. Specified by a lagrangian density. Next, Reinterpret it as a classical field theory. Use the relativistic field theory version of the euler lagrange equations, to derive the equations. Then solve them numerically using a fourier pseudospectral method.

2). Introduce discrete field collapse using old quantum theory and the canonical transition matrices. Just like a harmonic oscilator in the old quantum theory, every plane wave decomposed field mode has discrete classical amplitudes, which are lorentz frame independent. Using canonical commutation and anticommutation relations to derive bosonic and fermionic heisenberg matrices, one can recover the transitions through the coorespondence principle. Not by canonical quantization, but by associating transition matrices with probabilities for discrete field mode amplitudes. For bosons one uses the simple harmonic oscilator in the # basis. For fermions one uses the 2 state quantum system in the Qbit basis. Therefore quantum wavefunction collapse is just the collapse of a single classical field to a superposition of multiple VR consious interaction events.

3). Each discrete classical field quantum is associated a relativistic bohmian trajectory. Not using quantum entanglement nor using feynman rules, which is wrong since they use a single trajectory in 3N+1N dimensions projected down to all N particles. Rather we use a single classical field theory guiding our N trajectories independently. The pauli exclusion principle occurs from the 1st order spinorial nature of the Dirac equations and the lack of it occurs from the 2nd order vectorial nature of the Proca equations. Thus the spin statistics theorem is derived from the fourier modes of collapsed field modes guiding our bohmian trajectories, think of the exchange symmetries but applied to the double slit experiment as a CFT(Classical Field Theory).

4). Each trajectory using the Kerr NP(Newmann Penrose) tetrads in the cartesian Kerr Schild spacetime geometry, sources the spacetime geometry from flat Minkowski spacetime, using the Poincare Gauge Theory, and with it the classical fields are coupled to this geometry. This goes full circle and completes the code. The point is simple, every discrete classical field quantum is by definition a rotating black hole. Using the xKS(cartesian Kerr-Schild) coordinates, one can perform Poincare transformations to spacetime frame hop from one bohmian trajectory in its own retarded time to the other's trajectories calculated from the exactly linearly perturbed classical fields surrounding it. From a global minkowski spacetime with Poincare symmetries, mass and spin, one gauges the symmetry in vacuum resulting in the Kerr geometry, which you

guessed it describes particles with mass and spin. In a sense we got everything from nothing. A Theory Of Everything!

And from nothing emerges everything. The only assumption we made was that of spacetime symmetries. By applying CGH physics to this void, we learned that rotating black holes and discrete field quanta are one and the same. From the field dynamics we can build our universe. Our universe is all there was, all there is, and all there ever will be.

However, with this said, there is still plenty of work to still be done. We need to see how the theory of everything applies to our universe. We will learn that all everyday phenomena arise from the motion of atoms in the void, governed by a given inter-molecular potential. From this we can deduce similar processes occuring in deep space, and show how everything from the most common elements to the structure of atoms themselves came about from events that occurred fractions of a second after the big bang itself: 13.8 billion years ago.

We ourselves are a byproduct of the universe's existence, so it's really no surprise that we found ourselves in a universe such as this. The trick is to understand our universe by being able to show that the theory of everything does indeed give rise to the universe we see around us. After all we and everything else follow the same rules. The question then is: What are those unbreakable rules that the universe always obeys to the letter.

Theory Seven: The Theory of Everything

The theory of everything, is all about a material. The aether! Within, exist a chaos of sound waves. As they undulate across space, their vibrations propagate in all sorts of exotic ways. All of this happens automatically, without any sort of divine intervention. The fact is, that the whole cosmos is entirely built out of these waves. In order to find out what these waves can do, lets first analyze their physics. In so doing, we will learn about all of the complex and intricate structures that these waves can form. This truly is, the theory of everything!

As it turns out, a wave can only affect other waves nearby. This means that it takes some time for a wave over here, to influence a wave over there. The sphere of influence grows at a constant speed. This speed is the speed of light. Since light speed is always the same, means that from a moving perspective, it is time itself that runs slow. As such, space and time are unified into a new framework. Spacetime!

Imagine finding a concentrated lump, or packet of waves. Seen from far away, this so called wave packet, looks very much like a dot, moving in a straight line with a given speed. A particle. However, "particles" act very strangely at microscopic distances. They act randomly, yet also are in many places at once. How can this be? This is because they are not particles, but waves. After all, waves are spread out entities. So it makes sense why particles seem to act like this.

Moreover, these matter waves can also experience forces, meaning that they can push and pull on each other. This happens, because waves of matter and waves of force, can interact. If we take two matter waves, placed some distance apart. They might attract one another, because both matter waves are disturbing the waves of force in between.

So, given this, waves of matter and waves of force can act very differently. Matter waves, have a property called mass, whereas force waves do not. All waves with shorter wavelengths, tend to vibrate with a faster rate, or frequency. It is this excess frequency, in addition to its frequency due to its wavelength, that is the mass of the waves. This is the reason why some waves, have the property that they can vibrate faster, yet be very spread out. These waves are our matter waves.

However, there is more! Mass isn't the only property that waves can have. Waves can also have a property, known as spin. That is to say, that the direction that the waves are vibrating in, its polarization, depends on our point of view. The amount of spin, takes on discrete values, of zero, one half, one, one and a half, two, and so on. For example, we say that, matter waves are spin half, because it takes two full turns for their polarization vectors to take one full turn. On the other hand, force waves are spin one, because under a full turn, its polarization vectors also take a full turn. Otherwise put, the more ways, or degrees of freedom, the greater the spin.

But, what about particles? It turns out, that all of these waves are actually sound waves, vibrating within a material called the aether! The aether has the property, that it cannot just vibrate with any given intensity. The sound energy, or loudness, comes in chuncks, known as quanta. By definition, every quantum is a particle. The quanta of our matter waves are electrons, particles of electricity. The quanta of our force waves are photons, particles of light. That's not all. Every particle is a wave of probability. An electron's probability wave, is exactly identical to its matter wave. Similarly, a photon's probability wave, is exactly identical to its force wave. The same applies to every particle in existence. This is where the similarity ends. For many particles, we need to know the combined probability, of finding all the particles at all of their positions. The fact is, since all particles of the same kind are completely identical, means that it is impossible to tell them apart. Because of this, our combined probability, can either add or subtract, when we swap two particles. Electrons are fermions, because their probabilities subtract away. On the other hand, photons are bosons, since their probabilties add together. Surprisingly, particles with odd multiples of spin half are all fermions, and those particles with even multiples of spin half are all bosons.

Imagine the scene. Within spacetime, all kinds of waves, with all sorts of exotic properties, are all interacting in every possible way. It's pure chaos! The violence of this mess of particles is just insane. Particles smashing into other particles. Its all about how these particles behave. Therefore lets now take an inventory of all the particles.

We have already met the electrons and the photons. Electrons interact with photons, because they have a property known as the electric charge. The electric charge of electrons is either positive one or negative one. The matter electrons are all negatively charged. The positively charged electrons are the opposite of matter, known as antimatter. Matter particles and antimatter particles can cancel eachother out, in a violent release of light energy. We say that photons, particles of light, are carriers of the electromagnetic force. After all, light waves are electromagnetic waves. Photons are themselves electrically neutral. The electric charge is not the only charge that exists in the cosmos. There are two others, the flavor charges, and the color charges.

There are four flavors of fermions, the up and down quarks, and the charged and neutral leptons. The electrons are an example of charged leptons. Every up quark has an electric charge of positive two thirds, and every down quark has an electric charge of negative one third. Like electrons, the antimatter quarks also have opposite electric charges. Just like how photons interact with electric charge, there are three other bosons that interact with the flavor charges. These bosons carry a force known as the weak nuclear force, and interconvert flavors into one another. Unlike photons, which do not self interact, the bosons which carry the weak nuclear force, certainly do self interact. We call these bosons, the W plus, the W minus, and the Z zero.

Then there are the color charges. Quarks are the only fermions with color charge. They come in three varieties of red quarks, green quarks, and blue quarks. The gluons interact with these three color charges. They carry a force, known as the fundamental strong nuclear force. The leptons no not experience the strong nuclear force, because they are color neutral, and as such, do not interact with gluons. Gluons, like quarks, have a color charge. In fact gluons come in eight varieties, with each kind of gluon having a unique color charge. This means that like the W and the Z bosons, gluons self interact. Gluons have a color charge of a given color, say red, and a given anticolor of a different type, say anti green. So a possible color charge for a gluon is red anti-green.

As usual, there is more to it than this. Each flavor of fermion, has three possible amounts of matter, or mass. The up type quarks, are the up quarks, charm quarks, and top quarks. The down type quarks are the down quarks, strange quarks, and bottom quarks. Electrons also have two heavier versions, the muon, and the tau. Why? The answer is the interaction with a particle known as the Higgs boson. It is very heavy, and has an unusual spin of zero. All of the other bosons, interact with charges, and have spin one. The higgs bosons don't carry forces, but they do give mass to the other particles that have it. There are exceptions though. The neutral leptons, we call neutrinos, don't have mass, unlike all the other fermions. The photons are massless, along with the gluons, which also are massless. However like the higgs boson itself, the W and Z bosons do have a huge mass. Therefore, the higgs boson interacts with itself.

The aether's material properties, are what gives rise to these particles in the first place. There is one material property of the aether that is the most important for

our story, which is that the aether is a fluid. On large scales, lots and lots of particles can act like a fluid. But what is really interesting, is that the aether itself also acts like a fluid. Therefore, we would expect to find out, that the aether is made of aether particles, on the tinest of scales. It is the collective motions and vibrations of our aether particles, that give rise to sound waves within the aether. Then it follows that the minimum units of vibration, the quanta of sound, are not actually particles as we usually think of them. We call such particles, phonons, after "phone" for sound. Every electron, photon, quark, higgs boson, and every thing else, are all aether phonons. On the other hand, the aether itself is a different kind of fluid, consisting of its own particles. So just like how some phonons, be it electrons in electricity, photons in light, and composites of quarks in nuclear matter. We now know, that the actual particles that the aether is made of, should reflect the fluid properties of the aether itself. Well there is such a thing. Gravity!

The ripples in the aether may describe matter, but the flow of the aether itself is the most important thing of all. Gravity. On large scales, gravity is the universal attraction of everything with everything else. This attraction looks and feels like a force. However there are no mediating particles to carry the force. Hypothetically, this so called graviton, would have a spin of two, and would move at light speed. It isn't so easy, because gravitons do not exist. This is because we already used up all the aether phonons in the form of other particles. So how does a fluid aether give rise to gravity, without gravitons? Lets find out!

The aether is a fluid like substance. It responds to the pressure, density, flow, and viscocity, of the sound waves within it. This response causes a curvature, or flow gradient in the aether itself. This is just like a whirlpool, sucking the aether down the hole. Far away from the hole, the gravity is weak, and the flow of aether towards the hole is very slow. Closer in however, the gravity increases like a rip tide, dragging sound waves into orbit. At a close enough distance from the hole, the aether flows inwards faster than the sound waves can propagate outward. Everything within, is trapped forever. This is the event horizon of a black hole! Therefore, these aether particles, are not vibrations within spacetime, but as a particle constituting space itself. So to summarize, matter tells spacetime how to curve, and spacetime tells matter how to move. In reality, sound waves tell the aether how to flow, and the aether tells the sound waves how to vibrate. Every aether phonon, is its own black hole.

Part II