Abstract
In the past 100 years, theoretical physics and cosmology development have been conducted almost exclusively on a mathematical basis, leading to abstract mathematical objects or processes such as fields/virtual particles, space-time, curvature in space-time, time dilation, length contraction, action at a distance, extra dimensions, curled-up dimensions, entanglement, dark energy, dark matter etc. It is posited that these myriad of abstract mathematical objects will not lead to the physical model of the universe that can unify all the forces of nature. I abandoned the traditional mathematical approach of doing physics. Instead, I concentrated my efforts to finding the physical models of the universe that can explain the problematic observations that plagued the current theories. The result of this search is a new physical model of the universe called Model Mechanics. This paper describes how Model Mechanics is able to unify all the forces of nature.

The Forces of Nature According to the Standard Model
Current physics posits the following forces of nature: The Electromagnetic Force, The Nuclear Strong Force, The Nuclear Weak Force/The Electroweak Force and Gravity. The best unification of these forces into a single super force is the Quantum Field Theory (QFT). The idea of QFT can be summarized as follows: Each interacting object projects a quantum field into space and the excitation of these quantum fields at any point represents a virtual particle or messenger particle. These messenger particles interact with the interacting objects to cause them to react as observed. The following table summarize these forces, in terms of Strength, Felt by, Range and Force Messenger:

<table>
<thead>
<tr>
<th>Forces</th>
<th>Strength</th>
<th>Felt by</th>
<th>Range</th>
<th>Force Messenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong Force (QCD)</td>
<td>1</td>
<td>Baryons, Mesons, Quarks</td>
<td>$10^{-13}$ cm</td>
<td>Colored gluons</td>
</tr>
<tr>
<td>Electromagnetic Force (QED)</td>
<td>$10^{-2}$</td>
<td>All Charged Particles</td>
<td>Infinite</td>
<td>Photons</td>
</tr>
<tr>
<td>Electro-Weak Force</td>
<td>$10^{-5}$</td>
<td>All particles</td>
<td>$10^{-15}$ cm</td>
<td>$W^+, W^-, Z^0$</td>
</tr>
<tr>
<td>Gravity</td>
<td>$10^{-39}$</td>
<td>All particles</td>
<td>Infinite</td>
<td>Gravitons</td>
</tr>
</tbody>
</table>

The Quantum Electrodynamics (QED)
QED is a theory that describes the electromagnetic interaction between charged particles. The development of the final version of QED was long and tedious. It started with Paul Dirac in 1927, successful in combining quantum theory with special relativity in his theory of the electron. However, when physicists tried to combine quantum theory with Maxwell’s theory of electromagnetism, the resulting equations were full of infinities. The source of the infinities was that QED treats all quantum particles as dimensionless mathematical points and, as such, they give rise to infinite energy for charged particles, such as the electron. This, by the way, is not hard to visualize—a particle such as the electron is negatively charged. Therefore, it will take an infinite energy to overcome the repulsive force resulting from its own charge to compress it to a
dimensionless point. The infinity problems were not resolved until the late 1940s by the trio of Richard Feynmann at Cornell, Julian Schwinger at Harvard and Sin-itiro Tomonaga in Japan. Independently, they came up with a procedure called renormalization that enabled them to get rid of the infinities in the QED equation. This amounts to adding other infinities in the equation to yield an equation that contains no infinity. A number of physicists, including Paul Dirac (one of the founding fathers of quantum mechanics) considered the renormalization technique a mathematical trick. Paul Dirac made the following comments during a lecture given in New Zealand in 1975:

“I must say that I am very dissatisfied with the situation, because this so-called ‘good theory’ does involve neglecting infinities which appear in its equations, neglecting them in an arbitrary way. This is just not sensible mathematics. Sensible mathematics involves neglecting a quantity when it turns out to be small.”

However, the renormalization process turned out to be a resounding success. The renormalized QED equation made predictions that agreed with experimental results to an astounding accuracy of better than one part in a billion. As a result, most physicists embrace QED with no reservation. At this time, I will summarize the processes of QED so that the reader can visualize more clearly the vista presented in the next section. The processes of QED can be summarized as follows:

1. Space is occupied by a set of abstract fields; these fields are superimposed on top of each other. Each of the fields has its own associated quantum (or quanta) and the intensity of the vibration of a field, at any given point, gives the probability for finding its associated quanta at that point. A field has no physical existence until its associated quanta is measured. When a measurement is made, the field is quantized and the product of quantization is the associated quanta. Some of the most important fields and their associated quanta are as follows:

<table>
<thead>
<tr>
<th>Type of Field</th>
<th>Associated Quanta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Field</td>
<td>Electron</td>
</tr>
<tr>
<td>Electromagnetic Fields</td>
<td>Photons (Virtual Particles)</td>
</tr>
<tr>
<td>Massive Vector Bosons Fields</td>
<td>W⁺, W⁻, Z⁰ (Virtual Particles)</td>
</tr>
<tr>
<td>Quark Fields</td>
<td>Up, Down, Strange, Charm, Bottom, and Top Quarks</td>
</tr>
<tr>
<td>Gluon Fields</td>
<td>Eight Colored Gluons (Virtual Particles)</td>
</tr>
</tbody>
</table>

2. The fields and their associated quanta obey the principles of special relativity and quantum theory.
3. The force between interacting particles is transmitted by the exchange of virtual particles.
4. All charged ½ spin fermions are shrouded by a maelstrom of virtual particles. These virtual particles pop in and out of existence continuously and these processes are within the limits set forth by the uncertainty principle.
5. In the case of QED, the force-carrying particles are the virtual photons. The exchange of these virtual photons gives rise to the electromagnetic force between the charged ½ spin fermions.
6. The virtual photons obey the principle of relativity. In other words, they carry out their missions at the speed of light. Also, a virtual photon can become a real photon if there is enough energy available to finance its permanent existence. This is the case when the orbiting electron gives up a quantum of light by jumping from a higher energy orbit to a lower energy orbit.

The QED process described above depends on the existence of the virtual photons and yet, because of their fleeting existence, there is no way to confirm the existence of these particles experimentally. However, their activities surrounding a particle, such as an electron, do have measurable effects that can be detected experimentally. This task was taken up by Willis Lamb in 1955 when he designed and performed experiments.
that measured the tiny shift in hydrogen’s spectral lines. Lamb won the Nobel Prize for this work in 1955. The tiny shift discovered by Lamb was interpreted as the result of the activities of the virtual particles surrounding the electron.

**Quantum Chromodynamics (QCD)**

The Nuclear Strong Force is responsible for binding the protons and the neutrons in the nucleus. At a more fundamental level, this force is responsible for the binding of the quarks of the protons and neutrons to form the nucleus. According to quantum mechanics, the nuclear strong force is manifested by the interaction between the quarks and the messenger particles known as the colored gluons.

The success of QED prompted theorists to model the nuclear strong force after it and QCD was the result of this effort. It would seem that the positive charge of the protons in the nucleus should blow it apart. Somehow there seems to be an attractive force that not only cancels out the repulsive force of the positive charges but also binds the protons and neutrons tightly together. Yukawa came up with the original concept that this force was the result of the exchange of force-carrying particles between the protons and neutrons. He worked out that this messenger particle should have a mass of 270 that of the electron and was called the meson, later renamed pion (short for pi-meson). Yukawa postulated the existence of pion in 1935 but it was not discovered until 1947 by the British physicist, Cecil Powell during an experiment with cosmic rays.

In 1964, Gell-Mann invented the eightfold way that classified all the known subatomic particles, as well as those particles that have not yet been discovered. From that, he postulated the existence of quarks; it was obvious then that pion cannot be the only messenger of the nuclear strong force. The actual discovery of quarks took place at about the same time. The sequence of events was as follows: Robert Hofstradter, at Stanford University in California discovered that protons and neutrons were not point-like objects but were fuzzy blobs of about $10^{-15}$ cm in diameter. Further investigation at SLAC (Stanford Linear Accelerator) revealed that there were point-like particles inside the protons and neutrons; these particles were thought to be the quarks predicted by Gell-Mann. Finally, experiments at CERN in Geneva confirmed that all quarks had fractional electric charges at increments of one-third as predicted by the theory. There are six flavors of quark and all but the top quark has been found, indirectly.

The discovery of quarks suggested that a new strong force was needed to bind them together in protons and neutrons; eight colored gluons were postulated as the messengers for this new strong force. Gell-Mann came up with the scheme that all quarks carry a color charge and that these color charges are as follows: red, blue, green, anti-red, anti-blue and anti-green. In the case of the force-carrying gluons, they all carry two color charges -- one of the regular color plus another of the anti-colors. The process that gives rise to the inter-quark force is the exchange of the colored gluons. When a gluon is absorbed or emitted by a quark, it changes the color of the quark; this process gives rise to the nuclear strong force. Physicists now believe that the inter-quark force is also responsible for binding the protons and the neutrons together in the nucleus. This superseded Yukawa’s idea that pion was the messenger of the strong force.

Although QCD was able to explain the nuclear strong force, one got the feeling that it was somewhat contrived. To start with, we needed to invent a total of eighty-four particles (six quarks with six different color charges and eight gluons with six different color charge combinations) to explain the nuclear strong force. In the theory of QCD, the gluons were described as massless; however, the extremely short effective range of the nuclear strong force suggested that gluons should be very massive.
The Electroweak Theory (Nuclear Weak Force)

The nuclear weak force was not well understood until the electroweak theory was invented in 1967 by Abdus Salem and Steven Weinberg. The weak force is responsible for the radioactive decay of all unstable nuclei and subatomic particles. For example, neutrons left by themselves will decay in about 16 minutes into protons, electrons and antineutrinos. All radioactive processes are random and statistical and so it is not possible to predict the decay of a particular particle at any time. Also, experiments demonstrated that observed particles will never decay as expected. Also, all radioactive decay involves the gradual loss of mass of the material in question. The radioactive decay of a material resulting in an electron as a by-product is known as the beta decay. With beta decay, all the mass of the by-products added together does not equal the original amount. This apparent violation of the law of conservation of mass led Wolfgang Pauli to postulate the existence of an elusive particle, later named neutrino by Enrico Fermi. Pauli made the postulation of the existence of neutrino in 1931 but it was not discovered until 1957, by Clyde L. Cowan and Frederick Reine.

The original weak force theory was advanced by Enrico Fermi in the 1930s. He claimed that the neutrons in the nucleus were being forced to turn into protons, electrons and antineutrinos. According to his calculation, this force was much weaker than the electromagnetic force and thus, was named the weak nuclear interaction. However, Fermi’s theory was only partially successful as it failed to define the mechanism for this interaction.

In the mid-1930s, Hideki Yukawa came up with a radical new view of force interaction based on the idea that force between particles is being transmitted by the exchange of messenger particles. For the weak force, the messenger particle is appropriately called the W-particle. With the messenger particle concept, Julian Schwinger was able to draft a theory that appeared to be able to unify the weak and the electromagnetic interactions together. However, his theory required the presence of another messenger particle for this unification to work. In 1961, Sheldon Glashow of the University of California at Berkeley came up with a theory that included this new particle called $Z^0$. Glashow’s theory called for the $W^-$, $W^+$ and the $Z^0$ to be massless, like the photons of the electromagnetic interaction. However, the extremely short range of the weak interaction suggested that these messenger particles must have huge mass in comparison with proton. At this point, the effort to unite the electromagnetic and nuclear weak interactions came to a screeching halt. Fortunately, Steven Weinberg at Harvard and Abdus Salem of Imperial College, London, continued the work. Independently, they used the idea advanced by Peter Higgs at Edinburgh University to endow the massless $W^-$, $W^+$ and $Z^0$ of Glashow’s theory with mass. The Weinberg-Salem theory implied that at very high energy level all the messenger particles of the weak and electromagnetic interactions were in perfect symmetry with each other and they were all massless. As the universe cooled, the $W^-$, $W^+$ and the $Z^0$ soaked up energy from the Higgs field--some physicists refer to this process as ‘eating’ the Higgs particle to gain mass. This made the $W^-$, $W^+$, $Z^0$ to become massive. However, the photons, for some reason, were not affected by the Higgs field and thus remained massless. This process is called the spontaneous breaking of symmetry. The final triumph of the electroweak theory came when Gerhard ‘t Hooft at the University of Utrecht, Holland, confirmed that the theory is free of infinities and when both the $W^-$ and the $Z^0$ were found by a team of physicists at CERN led by Carlo Rubbia in 1982.

Although the electroweak theory was free of infinities and the messenger particles were found, there is still the following unanswered question: Does the Higgs field(s) and thus, the particle(s) really exist? The Higgs particle was arbitrarily put into the equations to give the weak messengers mass. In 2014 a group at CERN successfully discovered the Higgs Boson and the group was awarded the Noble Prize of physics in 2015.
Some of the other questions are as follows: In any radioactive decay, what are the interacting particles that exchange the messenger particles that start the process? If the process is self-initiating, what stops the neutron from decaying in the nucleus? Why does it take a free neutron an average of sixteen minutes to decay? This suggests that it is not a self-initiating process because, if it was, it would have a precise decaying time. Also, it suggests that other more random and statistical processes are involved before the decaying process.

**Quantum Gravity**

The messenger particles for gravity are the gravitons. However, there is no valid theory of quantum gravity. The reason is that all quantum equations that are based on gravitons contain infinities and these infinities are not renormalizable.

In the 1970s, Joel Scherk from Paris and John Schwarz from the California Institute of Technology published a paper in which they showed that string theory could include gravity in its description. However, physicists showed lack of interest on string theory because at about the same time the development of quantum chromodynamics (QCD) was in full bloom. In 1984, the interest in string theory began to pick up again. What started this sudden interest was the publication of a paper by John Schwarz and Michael Green of Queen Mary College, London. They showed that the built-in left-handedness of some particles, such as the electron neutrino, can be explained by the string theories. This caused theorists to concentrate their effort on the string theories for their search for the theory of everything. What emerged from this extended effort was a new version of the string theory called heterotic strings. The heterotic string was the result of combining the string theory with abstractive supersymmetric principles. It was capable of describing all the matter particles and all the forces of nature. So what are the problems of the heterotic string theory? First of all, all string theories require that space-time has ten or twenty-six dimensions. Our space-time consists of only four dimensions where did all those extra dimensions go? One suggestion was that they were curled up or compactified to a scale of \((10^{-33} \text{ cm})\) that we would not notice them. However, this raises the new question: Why should some, but not all of the dimensions be compactified? To answer this question, string theorists invoke the concept known as the anthropic principle. Basically, what the anthropic principle implies is that intelligent beings as us need three dimensions of space and one dimension of time to exist. There may exist a region of space-time that all the dimensions are curled up or other regions where more than four space-time dimensions exist but in those regions there would be no intelligent beings to observe these effective dimensions. The above discussion is based on the assumption that the extra dimensions really exist but if that turns out to be wrong then the whole idea of string theory is reduced to an abstractive mathematical exercise. Another problem with the superstring theories is that they were derived from complicated and abstractive mathematics and as such they have no basis in physical reality. Finally, it is not possible to confirm or reject superstring because Planck energy is required to probe the string and this energy level is forever beyond the reach of experimental physics.

**Model Mechanics: The Physics of Absolute Motion**

The Quantum Field Theory description of the forces of nature are overly complicated. Furthermore, it failed to include gravity in its description. This leads to the conclusion that the field concept is not able to unify all the forces of nature. Model Mechanics replaces the field concept with a structured and elastic ether called the E-Matrix and absolute motions of the interacting particles or particle system in the E-Matrix gives rise to all the
forces of nature. The following is a description of the current state of our universe according to Model Mechanics:

All of the pure-space in our universe is occupied by a substance called the E-Matrix. Subsequently, the E-Matrix is perceived by us as space. The E-Matrix, in turn, is composed of E-Strings. The diameter of an E-String is not known. It is probably in the region of Planck length that is defined by current physics as the smallest length that has any meaning and its value is in the region of $10^{-33}$ cm. The length of an E-String is not known. It could be a big loop and in that case the diameter of the loop is not known. Away from matter, E-Strings are oriented randomly in all directions, but near matter, E-Strings are more organized: some emanate from the matter, and the number of these passing through a unit area at a distance “r” from the matter is inversely proportional to $r^2$. Matter particles will follow the local geometry of the E-Strings as they travel in the E-Matrix. In turn, the motions of matter particles in the E-Matrix will distort the geometry of the E-Strings locally. These provisions are responsible for the peculiar properties of the gravitational force. Also, it explains why the propagation of light and gravity obeys the inverse square law.

The E-Strings exert a repulsive force on each other. This force is fundamental. This means that there is a compacting force that is compacting the E-Strings together to form the E-Matrix and this compacting force is also fundamental. The compacting force could be the result of tightly wound-up E-Strings or the E-Matrix is just composed of a finite number of E-Strings that are compacted together by an unknown outside force. The compacting force and the repulsive force between the E-Strings are in a delicate equilibrium and this equilibrium is self-restoring when it is disturbed by the motion of particles in the E-Matrix.

With this description of the E-Matrix, the next relevant question is: What is matter? The answer to this question: All matters are made from a fundamental particle called the S-Particle. The different orbiting motions of the S-Particles around the E-Strings give rise to all the observable particles such as the electron and quarks. Also, these orbiting motions give rise to the intrinsic and extrinsic properties such as charge, spin and mass of the Basic particles. The S-Particle is a three dimensional entity. Its internal structure is not known. Its diameter also is not known although it is probably in the range of Planck length ($10^{-33}$ cm). The S-Particles and the E-Strings are exerting a repulsive force on each other and this force is fundamental. This allows the S-Particles to travel unimpeded in the E-Matrix. The different absolute motions of the S-Particles and S-Particle systems give rise to all the forces of nature.

**Forces Based on Absolute Motions**

The idea that absolute motion of interacting particles in the same direction gives rise to an attractive force, while absolute motion of interacting particles in the opposite directions gives rise to a repulsive force, is derived from the familiar electric current experiments in parallel wires. These experiments show that when electric currents are flowing in the wires in the same direction, the wires are attracted to each other, and when the currents are flowing in the opposite direction, the wires repel each other. Figs. 3.2 and 3.3 illustrate these experiments graphically. The absolute motions of the electrons in the same direction cause distortions in the E-Matrix that pulls the wires together--an attractive force. Conversely, the directions of absolute motion of the electrons in the opposite directions will cause distortion in the E-Matrix that pulls the wires apart--a repulsive force.
Fig. 3.2: Currents (electrons) in the wires are flowing in the same direction, and therefore the force between the electrons is attractive. The right diagram that shows that the tension created in the E-Strings by the absolute motions of the electrons is pulling the wires together.

Fig. 3.3: Currents (electrons) in the wires are flowing in the opposite direction, and therefore the force between the electrons and thus the wires is repulsive. The right diagram shows that the tension created in the E-Strings by the absolute motions of the electrons is pulling the wires apart.

Extending the Model Mechanics interpretations of the results of the electric-current experiments to include the orbiting motions of the S-Particles around the E-Strings will enable us to explain all the nuclear forces between the interacting up quarks and down quarks. This interpretation becomes the most important concept of Model Mechanics and it enables Model Mechanics to unite all the forces of nature naturally.

**Cosmological Repulsive Effect (CRE) Force**

Current physics posits that there are four forces of Nature: the electromagnetic force, the nuclear weak and strong forces, and gravity. Model Mechanics posits that there is a fifth force of Nature; the new force being the CRE force (Cosmological Repulsive Effect Force). As the name implies, the CRE force between any two objects is repulsive. While the CRE force is new to physicists, it is not new to experiments; it is what we commonly refer to as inertia. In other words, the resistance between two objects to change their state of absolute motion is the CRE force between them. The CRE force between any two objects moving in the same direction in the E-Matrix is always repulsive, and it is derived from the confinement of the interacting objects to the diverging structure of the E-Matrix.

To understand the CRE force, recall the inverse square law of physics. This law states that the intensity of light, gravity and electromagnetic force decreases with increasing distance from the source is inversely
proportional to $1/r^2$. The geometry of neighboring E-Strings emanating from any two objects also obeys the inverse square law. This means that each object will follow the diverging geometry of these neighboring E-Strings. Therefore, their path of motions in the E-Matrix will have a tendency to diverge from each other. This repulsive effect is identified as the CRE force. The CRE force between any two objects is not constant; it increases with the square of the distance between the objects. The CRE force is not the cosmological constant that Einstein inserted into his original GRT field equations. Although the cosmological constant is repulsive, it is not the CRE force predicted by Model Mechanics, for the simple reason that it is not constant.

The CRE force played an important role in the formation of our Universe, and is continuing to do so today. The repulsive CRE force, along with the attractive electromagnetic force between gravitating objects shaped the primeval Universe into the Universe that we see today. The CRE force also played an important role in the manifestation of the nuclear weak force. Without the CRE force, there would be no nuclear weak force. It is the CRE force that initiates the radioactive decay of atoms. Perhaps, the most important function of the CRE force will be a role, in combination with the electromagnetic force, in the processes of life.

Model Mechanics predicted the repulsive CRE force in 1993. However, it was not discovered until 1998 when two independent groups of astronomers discovered that the Universe at the far reached regions is in a state of accelerated expansion. This observation is in direct conflict with the prediction of GRT. In order to explain this observation astronomers are now re-introducing the discarded repulsive Cosmological Constant to the GRT equation. The CRE force eliminates the need for this ad hoc approach.

### The Force of Gravity (DTG)

Newton posited that gravity is a force, but he did not provide a mechanism for it. Newton’s gravity model involved the unexplained phenomenon of action-at-a-distance, which was troublesome for the physicists of his time. Also, Newton’s equation for gravity was eventually found to be slightly inconsistent with observations. Recognizing the deficiencies in Newton’s theory, Einstein formulated GRT, which is not a theory of force, but rather a theory of space-time, amounting to an extension of SRT to include gravity. However, GRT also encounters problems with some current observations as outlined in the next section of this paper.

As a means to resolve the problematic observations encounter by GRT a new theory of gravity called Doppler Theory of Gravity (DTG) is formulated. DTG is based on the following provisions of Model Mechanics:

1. As the Universe expands, all neighboring objects (or neighboring galaxies) are expanding in the same directions and this causes an attractive force between them.
2. On the other hand, objects expanding in the same direction are confined to the divergent structure of the E-Matrix. This causes a repulsive effect between them.

Like Newton’s theory of gravity, DTG also treats gravity as a force but with an identified mechanism. Based on the provisions of Model Mechanics, the mechanism of gravity between two objects A and B moving in the stationary E-Matrix is as follows:

1. If both A and B are moving absolutely in the same direction, this gives rise to an attractive force because A’s absolute motion distorts the surrounding stationary E-Matrix and B’s absolute motion is confined to follow the distortion created by A; conversely, B’s absolute motion distorts the surrounding stationary E-Matrix and A’s absolute motion is confined to follow the distortion in the E-Matrix created by B.
2. The global structure of the stationary E-Matrix is divergent. Both A and B are confined to this global divergent structure as they travel in the stationary E-Matrix. This gives rise to the repulsive CRE force between A and B globally.
3. The force of gravity between A and B is the combined result of items 1 and 2 above. It is noteworthy that gravity is the sum of an attractive and a repulsive force acting on both A and B. This explains why the force of gravity is so weak compared to the electromagnetic and nuclear forces.

4. The above description for gravity suggests that the Newtonian equation for gravity can be modified to make it consistent with observations as follows:

\[ F_g = \left( \frac{F_{ab}}{F_{aa}} \right) (G \frac{M_a M_b (j_a \cdot (\pm j_b))}{r^2}) \]  

(3.1)

\[ F_{aa} = f_{aa} = \text{Frequency of a standard elementary light source in A's frame as measured by A.} \]

\[ F_{ab} = \text{Transverse Doppler Frequency of an identical standard elementary light source in B's frame as measured by A.} \]

The dot product \((j_a \cdot (\pm j_b))\) in Eq. (3.1) expresses the concept that not all objects in the Universe attract each other gravitationally. A positive dot product represents an attractive force, but a negative dot product represents a repulsive force. Those objects that have the same direction of absolute motion are attracted to each other, but those objects that have absolute motions in the opposite direction exert a repulsive force on each other. Assuming the Big Bang model is correct then the dot product of the vectors for all local regions of the Universe is +1. This means that gravity in the local region is attractive. The dot product for a distant region, say beyond the radius of the observable Universe, is -1. Therefore, gravity for all those distant regions is repulsive. This is the reason why the far reached regions of the Universe are in a state of accelerated expansion.

The DTG description of the force of gravity uses the same mechanism as that for the electromagnetic and nuclear forces. This enables Model Mechanics to achieve the elusive goal of uniting gravity with the electromagnetic and nuclear forces naturally.

**The Electromagnetic Force**

This is the force observed between charged particles. It was determined that like-charged particles exert a repulsive force on each other while unlike charged particles exert an attractive force on each other. The reader will recall that a charged particle is the result of a clockwise or counterclockwise orbiting motion of its S-Particle around a specific E-String. A clockwise orbiting motion of the S-Particle gives rise to a positively charged particle. A counterclockwise orbiting motion of the S-Particle gives rise to a negatively charged particle. The charges between the interacting particles determine whether the force between them is attractive or repulsive. The following diagrams describe the electromagnetic force in Model Mechanical terms:

**Interaction between Negatively Charged Particles**

![Interaction between Negatively Charged Particles](image)

Fig. 3.4: The force exerted on each other by two negatively charged particles. In this case, the S-Particles are traveling in the opposite directions at the closest approach and therefore the force between them is repulsive.
Interaction between Positively Charged Particles

Fig. 3.5: The force exerted on each other by two positively charged particles. In this case, the S-Particles are traveling in the opposite directions and therefore the force between the resulting particles is repulsive.

Interaction between Negatively-Positively Charged Particles

Fig. 3.6: The force exerted on each other by a negatively and a positively charged particle. At the nearest point of approach the S-Particles are traveling in the same direction and therefore the force between them is attractive.

Note: The net attractive or repulsive force between any two interacting charged particles is not a constant force. The net force is determined by the direction of orbiting motions of their S-Particles at the closest point of approach. When the S-Particles are moving in the same direction at the closest point of approach then the net force between the charged particles is attractive. Conversely, when the S-Particles are moving in the opposite directions then the net force between the charged particles is repulsive. It is noteworthy to point out that the force between any two charged particles is alternating between attractive and repulsive for one complete orbit of their S-Particles. This property of the electromagnetic force is due to the fact that the direction of orbiting motions of the S-Particles is alternating between the same direction and opposite directions. This unique characteristic of the electromagnetic force agrees with Maxwell’s equation that the propagation of the electromagnetic force is alternating between the electric field and magnetic field.

The above diagrams illustrate how the electromagnetic force is manifested between charged particles. This force is long range because the distortions created in the E-Strings are long range. This description of the electromagnetic force eliminates the need for the complicated and abstractive quantum mechanical explanation. In addition, this explanation has no infinities to contend with because the electric charge is not within the particle itself. Therefore, there is no need for the dubious renormalization procedure to get rid of the infinities as in the quantum mechanical description of this force.

The Nuclear Strong Force

This force is responsible for binding the protons and the neutrons in the nucleus. At a more fundamental level, this force is responsible for the binding of the quarks of the protons and neutrons to form the nucleus. According to quantum mechanics the nuclear strong force is manifested by the exchange of messenger particles known as gluons.
The Model Mechanical description of the nuclear strong force is very simple. It is caused by the absolute motion \((V_{suq} \text{ and } V_{sdq})\) of the S-Particles of the quarks in the protons and neutrons. This description of the nuclear strong force raises the question: Since the quarks in the protons and neutrons are negatively and positively charged particles, how do they manage to stick to each other? The answer is stacked-interaction. When two particles of the same charge are stacked on top of each other, their S-Particles are traveling in the same direction. Therefore, they exert an attractive force on each other. The following diagrams illustrate the stack interaction concept.

![Diagram](image1)

**Fig. 3.7:** The stacked interactions of two similarly charged particles. The negative particles would be the down-quarks and the positive particles would be the up-quarks.

![Diagram](image2)

**Fig. 3.8:** The stacked and the electromagnetic interactions in a proton and a neutron.

**Note:** All quarks of the same family have the same orbital diameter and same direction of orbital motion. The different orbital diameters shown here serve to illustrate the stacked-interactions. The negative and negative particle interaction is the stacked-interaction of the down quarks. The positive and positive interaction is the stacked-interaction of the up quarks. The proton is formed by the stacked interaction of the up-quarks and the electromagnetic interaction between the stacked up-quarks and the down-quark. The neutron is formed by the stacked interaction of the down quarks and the electromagnetic interaction between the stacked down quarks and the up quark.

It is noteworthy to point out that the attractive stacked-interactions are effective only within a short distance of \(10^{-13} \text{ cm}\). At a greater distance than that the stacked-quarks exert a repulsive force on each other. This is the exact behavior of the nuclear strong force that we observed in the laboratory. Another peculiar property of the nuclear strong force is that it becomes stronger when the interacting particles are being pulled apart. This peculiar property is also predicted by Model Mechanics as follows: When the stacked particles are pulled apart the E-Strings surrounding them becomes more distorted. Therefore, the energy required to pull them further apart will be increased accordingly.
The Nuclear Weak Force
Quantum Mechanics describes this force as the force that causes the decaying processes of all the unstable particles through time. The quantum mechanical process for the weak force involves a process called the spontaneous breaking of symmetry. This process gives rise to the weak force messengers $W^+$, $W^-$ and $Z^0$. These are virtual particles whose brief existence is financed by the uncertainty of energy and time relationship. Also, this description of the nuclear weak force depends on the existence of yet another class of particles known as the Higgs Bosons. The Higgs Boson is necessary because it is the mechanism that imparts mass to all massless particles. Model Mechanics gives a much simpler description of the weak force. In the case of a heavy nucleus, such as a uranium nucleus, the decay is the result of the de-coupling of the stacked-interactions by a combination of neutron captures followed by the repulsive CRE force. The processes involved are as follows:

1. A free neutron is captured by a decaying nucleus
2. The stacked interactions at the site of neutron capture are weakened. This enables the repulsive CRE force to de-couple the weakened stacked-interactions and give rise to the nuclear weak force.

In the case of a subatomic particle, the decaying process is different. The best-known subatomic particle-decaying process is the neutron decay, also known as the beta decay. Quantum Mechanics does not specify when a free neutron will decay or why it will decay in about sixteen minutes. On the other hand, Model Mechanics is capable of describing the neutron decay process in detail. The following diagrams will help the reader to visualize the processes involved.

![Diagram of neutron decay process](image)

Fig. 3.9: Schematic diagrams for the neutron decay process.

a) The up-quark in an unbounded neutron exerts an attractive force on any free S-Particles that are traveling in the same direction as its S-Particle. When a free S-Particle follows the orbit of the orbiting S-Particle of the up quark, it becomes an up-quark. This new up-quark immediately forms a stacked interaction with the original up quark.

b) The down-quark between the two-stacked up-quarks is pulled closer to them because it feels the force from both of them.

c) This has the effect of moving the stacked down quarks laterally relative to each other. When the lateral movement is greater than the radius of the down quark, the force between the stacked down-quarks becomes repulsive. This causes the down-quark that feels less attractive force from the two stacked up-quarks to peel away. The peeled away down-quark will then interact with a free S-Particle to give an electron and an antineutrino.
The decaying process for a subatomic particle such as a muon is different from that for a neutron. It was found that a muon at a speed close to that of light would have a much longer decay length than that of a muon at the rest frame of the laboratory. When these decay lengths are converted to decay times they agree with the SRT time dilation equation. This led physicists to claim that the muon decaying process is a proof of the time dilation concept of SRT. The Model Mechanical explanation of the muon decay process is as follows:

1. The orbit of the muon’s S-Particle is unstable and it will decay into a stable orbit of the electron.

2. In the rest frame of the Lab, a muon decays in 2.2 microseconds. However, a muon moving with respect to the Lab will have a longer decay time of \((2.2 \times 10^{-6})(F_{aa} / F_{ab})\) seconds.

3. Therefore from the Lab point of view the decay length for a traveling muon is: \(v(2.2 \times 10^{-6})(F_{aa} / F_{ab})\) meters and \(v\) is the relative velocity between the Lab and the traveling muon. This Model Mechanical prediction for the decay length of a traveling muon agrees with experimental observations.

Conclusions:

The quantum field concept is overly complex and it failed to include gravity in its description. Therefore, it is not capable of unifying all the forces of nature. The physical model of the E-Matrix and Absolute Motions of the interacting objects in the E-Matrix gives valid description for all the forces, including a new theory of gravity called DTG and a new theory of relativity called IRT. Therefore, Model Mechanics is a valid candidate for a Theory of Everything.