Theoretical quantum gravity at the atomic scale

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Abstract
Assessment was given to recent experimentally discovered quasi-magnetic monopoles, conforming functionally to the hypothetical particles as theorised by Paul Dirac in retaining the duality symmetry of the electromagnetic unified fields. This led to an association that these same hypothetical particles could also be participatory in mediating the gravitational force. This association readily developed, exhibiting a clear interchangeability between the magnetic force and a theoretical multi-vectorial gravitational force. These abstractions for the two forces remain distinct by retaining non-interaction.

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1. Introduction
In 1931 Paul Dirac discovered that when using Maxwell’s equations for electromagnetism, by removing the electrically charged particles from the equations, produced duality symmetry whereby the electric and magnetic fundamental fields can be interchanged without changing their form. Adding the electrically charged particles back into the equations destroyed the duality symmetry. Dirac proposed the existence of hypothetical magnetic monopole particles and their inclusion in the equations, together with electrically charged particles, reinstated the duality symmetry, which in this instance must manifest in some topological form. The quantization condition Dirac concluded was if hypothetical magnetic monopole particles existed would justify electric charge, which must be quantized in certain units and, due to the duality symmetry, the elementary magnetic charge of magnetic monopoles must be quantized in units inversely proportional to the elementary electric charge [1].
2. Hypothetical ‘Gravity Strands’

Premise: Rationalises that magnetic monopoles would emanate from non-confinement in QCD (in furtherance of [2]); as cause, the by-product of quark/gluon interactions. The effect will be continuous streams of polar charged magnetic monopole ‘graviton’ particles expelled, in opposite polar directions, from nucleons’ nuclei along their axes of spin.\(^1\) Nucleons will naturally pair together as a consequence of their continuous streams of gravitons self-organising into ‘strands’ of alternating charged particles, whereby initiating a gravitational force (see figure 1.1); hence the name ‘Gravity Strand’. The force of attraction manifests from continuum head-on attraction and annihilation of opposite charged gravitons.\(^2\) Single/unpaired nucleons (or paired nucleons where protons’ spin orientations readily invert in response to an electrical or magnetic field or magnetized state) will produce same charged gravitons flowing in the same direction, thereby instigating a magnetic force\(^3\) (see figure 1.2). The gravitational and magnetic forces are normally distinct in that they retain non-interaction\(^4\), whereas their interchangeability will formalize in unification: in Gravimagnetic unified fields.

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\(^1\) It defines all forms of hadronic matter to be the only sources of gravitons. It will quantify the masses of black holes to extremely dense quark-gluon plasma interiors. Correspondingly, neutron stars’ sources of gravitons are limited to the neutrons constituent in these stars. (Gravitons duality utilization will then go on to explain both the very strong gravitational and magnetic fields of these compact cosmic objects.) In regard to particles, only nucleons (as the only stable hadron particles) can have gravitational interactions to the exclusion of all other subatomic particles.

\(^2\) It infers monopole gravitons are massless gauge-bosons comprising of opposite charged particle and antiparticle, which facilitates annihilation. Head-on attraction/annihilation of leading particles, in opposite travelling gravity strands, exposes the next pair of opposite charged particles in continuation of the process. The pulling force generated by the leading particles, is transferred via each opposing strand formation to the source objects.

\(^3\) It is deduced that the magnetic monopole will have a electric moment, enabling interaction by interconnection of fields between magnetic monopoles, travelling in magnetic strands, and electrically charged subatomic particles. (In gravity strands, the overall affects of electric moments and magnetic charges are neutralized throughout the length of each strand with only the leading particle retaining a net surplus magnetic charge.) It is plausible that lines of magnetic flux, when made visible, are displaying same charged monopoles in traceable streams curved progressively apart by their mutual repulsion (and where opposite charged streams meet in head-on attraction/annihilation).

\(^4\) Exception arises within very powerful magnetic fields resulting in localize interference of gravity strand activity [3]
The disclosure by Richard Feynman is that the proton’s magnetic moment should be close to 1, but is instead 2.79, and the neutral neutron, which should not have any magnetic interaction, has a magnetic moment of 1.93 [4]. This is central to nuclear magnetic resonance where, in essence, spectra are produced in atomic nuclei that have at least one unpaired proton or neutron. These unexplained anomalies in the magnetic moments are significant and potentially attributable to the emission of magnetic monopoles as posited.

3. Foundation for magnetodynamics

In the past, Ptolemy’s geocentric model required increasing complexity in order to accurately describe astronomical observations and in predictive capabilities. The complexity was an indication of incompleteness in past understanding and confirmed in a paradigm shift by Copernicus’ heliocentric model, subsequently followed by Kepler’s planetary laws and Newton’s gravity [5].

Present day, the complexity involved in condensed matter physics and the inability to accurately compute many-body interactions beyond three particles [6] in describing the heterogeneity of matter, is analogous to the above. In that this present complexity is potentially indicative of incompleteness in current understanding and, as such, prime for a paradigm shift in exposition. The origin of this, like Ptolemy’s model, would predominantly centre on a false assumption.

The continuing discussion is an introduction to magnetodynamics in which the fundamental interactivity of quantum gravity is elucidated. It will become apparent as to the thermodynamic aspect of this force. This underlying phenomenon will be consistent with the thermodynamical properties of matter.

3.1 Relative aspects of matter

External to matter, gravitational interactions are directly related to the masses of hadronic objects. Mass major components are volume and density. Internally, at the atomic level, volumes, together with masses of objects, with respect to the gravitational force, become irrelevant and so, therefore, gravitational interactions will only be directly related to mass densities. In obtaining consistency between the different mass densities of individual elements and substances is achieved by conversion to a ‘Relative Matter Density’:

\[ R_\rho = \frac{\rho}{(uN)} \]  

(1.0)

where \( \rho \) = mass density, \( u \) = atomic mass units and \( N \) = molecular element factor (atoms forming an molecular element, else 1). Precise ‘Molar Relative Volume’ is established from the reciprocal of relative matter density:

\[ R_v = \frac{1}{R_\rho} \]  

(1.1)

Used statistically, there is proportionality between the square root of molar relative volume and the interactive strengths of electrical and gravitational forces, referred to as the ‘Mean Interactive Molecular Distance’:\n
\[ \langle r \rangle = M\sqrt{R_v} \]  

(1.2)

where ‘Transition Molecular Distance Constant’ \( M = \frac{\sqrt{e^2/(2\pi\varepsilon_0G)}}{\frac{e}{2\pi\varepsilon_0G}} \).

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1 Has a similarity to but distinct from mean inter-particle separation, the distinction arises from molecular kinetic motion. (Molecular will, in addition, be used as a generic term referring to either atoms or molecules.)
3.2 Intermolecular forces

With all atomic nuclei the two electrons in the innermost orbital are strongly bound to the nucleus, and whose cloud originates nuclear screening. Their stability is central to the reasoning that they are the only two electrons effective in atomic negative charge electrostatic repulsion, and thereby determines the Coulomb interaction between two atoms:\(^1\)

\[
F_e = \frac{(2e)^2}{4\pi\varepsilon_0 \langle r \rangle^2}
\]  

(1.3)

As disclosed in the initial premise, the gravitational force is instigated by gravitons self-organising into gravity strands that culminate in distinct outward multi-vectorial radiation of gravity strands from atomic nuclei. The attraction/annihilation of gravitons in the mediation of the gravitational force, of single opposing gravity strands between two atomic nuclei, produces the resultant Gravitational interaction:

\[
F_g = 2GR \rho
\]  

(1.4)

where \(G\) is the gravitational constant. The opposing Coulomb and Gravitational interactions then attain equilibrium that will sustain the position of atoms and molecules within the heterogeneity (topology) of matter:\(^2\)

\[
F_e - F_g = 0
\]  

(1.5)

(Table in appendix A contains a list of Coulomb-Gravitational interactions in relation to different elements and sample substances at STP.) Beyond the exotic state of quark-gluon plasma, nucleons are the only stable hadron particles predicted to produce gravitons and, thereby, are the only particles able to interact gravitationally. Electrons, like all remaining subatomic particles, are posited not to produce gravitons and, therefore, are unbound to the gravitational force; electron retention is bound by electrostatics. In consequence, this will conclude that mass is not universally bound to the gravitational force. Moreover, application of Newton's classical gravitational law in equivalence to a quantum law has inherently been a false assumption.

Proposition 1: Atomically, solids are consolidated by continuous alignment of gravity strand interactions between atomic nuclei. Liquids are synthesized by distinguishable combinations of alignment and intermittent interaction of gravity strands. And gases are synthesized purely by intermittent interaction of gravity strands, due to the random kinetic motion and orientation of atomic nuclei. All gravity strand interactions will be inversely proportional to molecular kinetic motion/energy, which is dependent upon temperature.

The above proposition illustrates a crucial underlying dynamical phenomenon of the gravitational force whereby it is dependent upon temperature and, as such, relevant in respect of gravitational attribution to the thermodynamical properties of matter. Equivalence in interactions between these two opposing intermolecular forces will produce equilibrium of state within a closed system, equating to symmetry between the two forces, whereby, any loss of equilibrium will correspond to differential in force strengths arising from spontaneous symmetry-breaking.

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\(^1\) All remaining electrons of atomic nuclei occupy higher orbitals and, due to initial screening, are less stably bound to the nucleus. Hence these electrons are more fluid (and are instrumental in chemical dynamics instigated by outer orbital electron/s sharing or donation with adjoining atoms, or otherwise are prone to wander); and as such, due to this fluidity, these electrons are reasoned non-contributory to electrostatic repulsion between atoms.

\(^2\) Example: Diamond, in which all the carbon atoms forming the crystalline structure are uniformly spaced 0.154 nm apart, corroborates Dirac's duality symmetry: \(F_e = 3.9118743(77) \times 10^{-8}\) - \(F_g = 3.9118743(82) \times 10^{-8}\).
Asymmetry in these force strengths will be the cause of expansion or contraction in matter, until equilibrium of state is re-established, and any restricted asymmetry in the gaseous states, arising from change in initial temperature, will determine the pressure within a specific gas. This can be fundamentally demonstrated by the following example where volume is constant and pressure of the gas is in relation to atmospheric pressure:

\[ p = \frac{F_e}{F_g(T_i/T)} p_a \]  

(1.6)

Explanation for mean interactive molecular distance, as formulated in Eqn. 1.2, is encapsulated in proposition 1.

Graph 1: Mean Interactive Molecular Distance

Note: the mean interactive molecular distance tends towards but remains greater than zero, \( \langle r \rangle > 0 \), as molar relative volume decreases. At the Sun’s Tachocline Transition Region the temperature is greater than the critical point for the gas plasma to transform into a liquid state.

The magnetic field strength of each magnetically charged monopole will give gravity strands elastic ability, which is empirically evidential in certain materials, and is expository in the tensile strengths of solids.

### 3.3 Molecular thermodynamical processes

There is a distinction between two fundamental forms of pressure: accumulative and induced pressure. Accumulative pressure is the result of gravitational influence and which attributes to matter. It is consequential to atmospheric pressure and increasingly accumulating within matter where it can ultimately culminate, at the quantum scale, in the degeneracy pressure of electrons (or neutrons in the case of neutron stars). Induced pressure, however, is the result of thermodynamical or induced physical effects and, is later shown, does not attribute to matter but remains as a thermodynamic attribution.
Asymmetry in intermolecular force strengths within the gaseous state will be the cause of induced pressure, which then opposes the kinetic theory notion that pressure results from the accumulative kinetic energy of atoms or molecules striking the internal container’s surface/s. It will be consistently demonstrated that induced pressure is not a direct consequence of kinetic energy but constitutes to potential energy of a gaseous system in direct proportionality with the asymmetry in the intermolecular force strengths. The composition of Eqn. 1.6, for a fixed volume of a specific gas, is specifically expressed:

\[
p = \frac{(2e)^2}{4\pi\varepsilon_0(M\sqrt{1/R_p})^2} / \left[\frac{2GR_pT_i}{T}\right]p_a
\]

The left bracketed numerator of Eqn. 2.0 expresses the electrostatic repulsion force and, due to the fixed volume, remains constant in value. The right bracketed denominator of the equation expresses the gravitational attraction force and will alter in value depending upon change in temperature. Reduction of Eqn. 2.0 will represent an ideal gas at the quantum level:

\[
p = \frac{e^2T}{2\pi\varepsilon_0 M^2 GT_i}p_a
\]

The cancelling out, in Eqn. 2.1, of relative matter density equates to \(R_\rho = 1\), and correspondingly \(R_\nu = 1\) litre, which, within the bounds of a critical temperature and irrespective of pressure, momentary occurs at the approximate mean point during a phase transition involving vaporization/condensation or sublimation/deposition and is applicable for all elements and substances. (When, within the above bounds: \(R_\nu < 1\) for liquids and solids and \(R_\nu > 1\) for gases.) This is supported by the transition molecular distance constant \(M\) as corresponding to the mean interactive molecular distance for all elements and substances at this same transitional point and is presented in the duality symmetry of the coulomb-gravitational interactions:

\[
\frac{(2e)^2}{4\pi\varepsilon_0 M^2} - 2G = 0
\]

This forwards Rule 1: At or below a critical temperature and irrespective of pressure, the proximal phase transition between a liquid or sublimation of a solid to a gas or vice versa of an individual element or substance (or in their summing) occurs at the point when their molar relative volume transcends 1 litre.

Eqns. 2.0 & 2.1 presents induced pressure within a fixed volume of a gas. In considering variable volume of a fixed quantity of a specific gas that ranges from compressed to unsuppressed volume as a result of change in absolute temperature and/or induced pressure is presented, without reduction, to demonstrate the precise processes taking place:

\[
V = \left[\frac{(2e)^2nR_\nu(T/T_i)p_a}{4\pi\varepsilon_0(M\sqrt{R_\nu(T/T_i)})p_a} \right] / \left[\frac{2GR_\rho T_i}{T}\right]
\]

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1 The relative matter aspects are, in addition, dependent upon atmospheric pressure, i.e. \(R_\nu(p_a/p_\nu)\) & \(R_\rho(p_\nu/p_a)\), and so, to minimize complexity, \(p_a\) will remain constant throughout.
where \( n = V_i / R_v \) moles. The right side of the equation expresses change in relative matter density; equating to dynamical change in the gravitational force strength that then establishes change in mass density: \( \rho = uNR_v(T_i/T) \). On the left side of the equation, taking into account any change in induced pressure (formed from restriction in the electrostatic repulsion force pursuance of equilibrium), potential change in the mean interactive molecular distance is expressed by the denominators and the numerators express corresponding potential change in molar relative volume. (The \( R_v \) potentials are inversely proportional to the induced pressure: \( R_v[(T/T_i)(p_a/p)] \).) Reduction of Eqn. 2.3 fully develops Eqn. 2.1, for an ideal gas, to that of a specific gas as presented at the quantum level (recalling: \( R_v = 1/R_p \)):

\[
pV = \frac{e^2 n R_v T}{2\pi \epsilon_0 M^2 G T_i} p_a
\]

The coulomb and gravitational attributes are equivalent, and as such, are consonant with the duality symmetry of their interactions:

\[
\frac{e^2}{2\pi \epsilon_0 M^2 G} = 1
\]

The equivalence produced in Eqn. 2.5 will further reduce Eqn. 2.4 and, as a consequence, will reconcile the quantum aspect with the classical; in giving rise to a new classical equation of state for gases and, in the omission of a gas constant, is then specific for any given gas:

\[
pV = nR_v(T/T_i)p_a
\]

**Law 1:** *In relation to atmospheric pressure, the product of induced pressure and volume of a given gas is directly proportional to its molar relative volume in which is proportional to any change in absolute temperature.*

Thus far, the heterogeneous state of gases has been the simplest state to analyse with regard to the duality symmetry of the coulomb-gravitational interactions. As to heterogeneous states of liquids and solids, they atomically differ in structures and hence respond by different extents to change in temperature. This underlying complexity is currently resolved by use of relevant thermal expansion coefficients at the classical scale and where exposition, at the quantum scale, of these coefficients will correlate with differentiated asymmetries in the coulomb-gravitational interactions; and where symmetry, in all instances, concludes in equilibrium of state.

The above outline in complexity is exemplified with regard to negative thermal expansion in which certain materials expand on cooling; ice is an example. In explanation, not all magnetic monopoles radiating from atomic nuclei integrate by self-organising into gravity strands i.e. nuclei that have at least one unpaired proton or neutron or where paired nucleon spins are not inversely orientated. Non-integrated magnetic monopoles form individual magnetic strands that mediate the magnetic force. Hydrogen is a prominent example. Whereas molecular hydrogen (H\(_2\)) form gravity strands and interact gravitationally, atomic hydrogen (H) only emit magnetic strands (see figure 1.2 with respect to a single proton) and therefore can only interact magnetically. The forming of hydrogen bonds will arise from Coulomb-Magnetic interactions in which short bonds are attraction alignment of magnetic strand interactions between the hydrogen’s proton and an unpaired proton or neutron within the nucleus of the atom, or between atoms, it is bonded to.
The Coulomb interaction will result from the negative charge of the single electron of the hydrogen atom in a repulsion interaction with the two innermost orbital electrons of the bonded atom/s. These duality symmetrical bond/s are maintained by electron sharing between the bonded atoms. Long bonds by inference will be autonomous attraction or repulsion alignment of magnetic strand interactions between atomic nuclei. This in furtherance will posit that negative thermal expansion is where reducing temperature and hence reducing molecular kinetic motion allows increasing sustainment between atomic nuclei (rigidity) by continuous alignment of gravity strand interactions (evolving from intermittent interactions) and, as a consequence, results in proportional increase in autonomously opposing repulsion alignment of magnetic strand interactions that effectuate expansion.

3.4 Correlation of mass density with equilibrium of state

Eqn. 2.0 is re-presented to reconcile an apparent paradox in the mass density ratio of mass and volume:

\[
p = \left\{\left(\frac{2e}{4\pi \varepsilon_0 r^2}\right) / \left(\frac{2GR_0T_i}{T}\right)\right\}pa
\]  

(2.7)

If volume for a specific gas, as expressed by the left side of the equation, remains constant then mass and mean interactive molecular distance of the gas will also remain constant, whereas, mass density, as expressed by the right side of the equation, will fluctuate with change in temperature; hence the paradox. Fixed volume equates to a fixed quantity of a given gas of constant mass and will extend to variable volume where, in such instances, the mean interactive molecular distance alters accordingly with volume. Eqn. 2.7 can be expressed in the following form:

\[
\frac{m p_a}{V_p} = \rho
\]

(2.8)

Eqn. 2.8 forms Proposition 2, whereby, for volumetric mass density to remain consistent as a ratio between mass and volume then variability in mass density is accounted for in the following theorem:

Theorem 1: In relation to atmospheric pressure, mass density of a given gas is proportional to the mass of the gas and inversely proportional to the product of volume and induced pressure.

Lemma 1: In the case of unsuppressed volume of a gas, change in temperature will cause change in volume but pressure remains constant to atmospheric pressure; in conformity with Charles law [7]. Resultant change in mass density of Eqn. 2.8 is consistent with theorem 1.

Lemma 2: In the case of fixed volume of a gas, change in temperature will cause change in pressure but volume remains constant; in conformity with Gay-Lussac (Amontons) Law [8-9]. Resultant change in mass density of Eqn. 2.8 is consistent with theorem 1.

Lemma 3: In the case of compressed volume of a gas, in which initial constant temperature is reattained, will cause change in pressure and volume; in conformity with Boyle–Mariotte law [10]. Resultant mass density of Eqn. 2.8 remains constant and is consistent with theorem 1.
Table 1: Mass Density of a Gas

From the above lemmas it can be obtained from deduction that change in density only occurs when there is change in temperature:

$$\frac{1}{V_i} \left( \frac{\partial V}{\partial T} \right)_p = \frac{1}{p_i} \left( \frac{\partial p}{\partial T} \right)_V = -\frac{1}{\rho} \left( \frac{\partial \rho}{\partial T} \right)_m$$  (2.9)

Lemma 1    Lemma 2    Lemmas 1 & 2

The deduction is further substantiated by the fact that for a given gas of constant mass the product of density and temperature remain constant. In addition to the accumulation pressure, mass density is dependent upon temperature:

$$\rho_1 T_1 = \rho_2 T_2$$  (3.0)

Theorem 1 has been validated and is furthered by the fact that the product of volume and induced pressure is consistent with the unsuppressed volume of a gas. Although the cause is shown to be a consequence of quantum gravity, nevertheless the effect is manifested at the classical level, as presented in proposition 2, and hence validation of theorem 1 concludes in the following classical laws:

Law 2: In relation to atmospheric pressure, mass density of a given gas remains proportional to the mass and inversely proportional to the unsuppressed volume of the gas irrespective of change in volume and/or induced pressure.

Law 3: For a given gas of constant mass, mass density is inversely proportional to change in absolute temperature and in which the product of density and temperature remain constant.

Table 2: Critical Point of Gases

1 Accuracy in computation will entail the use of a higher degree of precision i.e. $V_i = m/\rho_i$. Calculated results are displayed rounded to three decimal places.
Data for the critical point of gases is used to further substantiate Eqn. 2.7 (for variable volume), proposition 2 and law 3. Constant mass for a given gas is uniformly expressed by its molar ‘relative’ mass:

\[ R_m = uN m_u N_A \]  

where \( m_u = \) atomic mass constant in grams and \( N_A = \) Avogadro constant. Molar relative volume, initially established at STP in table of appendix A where \( T_l = 273.15 \) K (Steam: \( T_l = 373.15 \) K) and \( p_a = 1 \) atm, is updated to include critical temperature and critical pressure:

\[ R'_v = R_v \left( \frac{T_c}{T_l} \right) \left( \frac{p_a}{p_c} \right) \]  

From proposition 2:

\[ \rho = \frac{R_m p_a}{R'_v p_c} \]  

Equivalent mass density is derived from relative matter density, updated from table A, using critical temperature only:

\[ \rho = uN R_p \left( \frac{T_l}{T_c} \right) \]  

(By rearrangement of proposition 2: \( p_c = (R_m p_a) / (R'_v \rho) \).) Eqn. 3.4 reaffirms that induced pressure does not attribute to relative matter density, and, consequentially, mass density, which is only attributable to gravitational interactions where force strength, being inversely proportional to molecular kinetic motion/energy, is dependent upon temperature. This asserts that deviation from expected to actual mass density correlates to deviation from restricted to natural volume and both emanate from, and correlates to, asymmetry in strengths of the electrostatic repulsion force that determines volume, and the gravitational attraction force that determines mass density.

Table 2 shows that molar relative volume has transcended the 1 litre threshold, as stated in Rule 1, at a transitional critical point, as in the above examples, where the gas transforms into a liquid (in compliance with critical temperature: \( R_v < 1 \) for liquids and solids and \( R_v > 1 \) for gases).

Equilibrium of state manifests in unsuppressed volume; in relation to accumulative pressure, is the product of volume and induced pressure. This in conjunction with law 2 asserts that volumetric mass density is not just a straightforward ratio of mass and volume but is a representation of a true ratio when heterogeneous states of matter are in equilibrium of state. This paradigm shift is comprehensibly demonstrated by the sudden increase in temperature produced in an exothermic reaction, as in an explosive combustion, that will cause spontaneous drop in mass density, as the result of spontaneous increase in molecular kinetic motion and proportional decrease in molecular gravitational force strength, which allows rapid expansion in volume generated by the accumulative electrostatic repulsion force of each atom or molecule, till equilibrium of state is reinstated. This quantum gravity effect is then explicable for the work produced in heat engines and in chemical explosions.

Proposition 3: Within the heterogeneity of matter, invariant consistency of the electrostatic force determines volume, whereas variable dynamics of the gravitational force determines density.
3.5 Unification of fundamental forces

The above proposition realizes importance, not only relating to the major components of mass, in the same way interactions between electrical and magnetic fundamental forces formalize in unification, the presented unity of interactions between electrical and gravitational fundamental forces would infer a more integrated unification.¹

![Diagram of fundamental forces]

Figure 2: Integrated Unification

4. From the quantum to the classical scale

4.1 A fundamental principle of mass

Taking Einstein's famous equation for mass-energy in relating to particles and breaking down the mass element into its components of volume and density:

\[ E = mc^2 = V\pi c^4 \] (4.0)

where the mass element is:²

\[ m = V\pi c^2 \] (4.1)

and therefore density is:

\[ \rho = \pi c^2 \quad (4.2a) \]

or alternatively:

\[ \rho = \frac{\pi}{\mu_0 \epsilon_0} \quad (4.2b) \]

It establishes particle density is relativistically constant. Volumetric size, distinct or relativistic variant, of particles is then determined by the energy carried as verified by the Einstein-Planck formulation:

\[ Vf\pi c^4 = hf \] (4.3)

where \( h = \) Planck constant and \( f = \) wave frequency. (This would question the notion of massless particles, but is not the purpose of this topic.) What is important is the densities of particles are identical and invariant, thereby inferring density has reached a finite universal limit: an absolute density or, in other words, the limit to which energy can be concentrated, where, as a consequence, energy has condensed into the manifestation of mass. The significance of Eqn. 4.2b would deduce that, as energy cannot be created or destroyed and therefore must have an origin, the origin to energy is in the vacuum wherein vacuum energy density = \( 1/c^2 \) J/m³ and, as such, must be eternal and infinite: profoundly, it will be the genesis to everything that exists.

¹ Conceptual realization arose naturally after development of initial premise. A concept investigated, without success, by Faraday then Einstein, where in the later case, endeavoured to unify general relativity with electromagnetism.
² Used to ascertain electron radius = \( 9.166 \times 10^{-17} \) m and proton radius = \( 1.122 \times 10^{-15} \) m.
4.2 **Black holes**

When a dying star collapses in a supernova and the mass density of the remnant core exceeds the Tolman-Oppenheimer-Volkoff limit for degeneracy pressure of neutrons, the object left is a stellar black hole, which is currently assumed a singularity; an infinitesimal dense volume. If considered logically, singularities present implausible entities where Nature’s physical laws would break down and all known forces in their current form will be prohibited including gravity.

It is defined in the initial premise that all forms of hadronic matter will be the only sources of gravitons. It can be rationalized that for black holes to emit gravitons then consistency of their interiors must allow quark/gluon interactions and, therefore, the most plausible explanation for their interiors would be the existence of extremely dense quark-gluon plasma. As to how dense the quark-gluon plasma is, then the notion of absolute density is assumed, and together with the established mass, will ascertain a black hole’s volume and surface radius.

The event horizon of a black hole is established by Schwarzschild radius:

\[
    r_s = \frac{(2Gm)}{c^2}
\]

(4.4)

If the mass of a stellar black hole is less than 8.0786 solar masses then the event horizon will be below the surface and, therefore, the black hole and its surface will be observable.

It forwards a supposition that all black holes are ultimately composite particles: superfluid quark-gluon plasma at absolute density. Technically, they will be quark stars. It is disclosed in a paper by Jinfeng Liao and Edward Shuryak [11] that magnetic monopoles play an essential role within quark-gluon plasma. It is presented in the initial premise that magnetic monopoles stem from the by-product of quark/gluon interactions within the strong nuclear force and, as predicted, extend beyond.

4.3 **Gravitational radiation**

The external gravitational field of a hadronic object will consist of high concentrations of unconfined free radiating gravity strands in an outward gravitational radiation\(^1\) and, including gravitational radiation from all hadronic matter within the universe, would make gravitons among the most numerous of any particle. Their substantial non-annihilated accumulative surplus would advance an explanation as to the unexplained existence and amount of Dark Matter; the explanation becomes resolved by the continuing existence of a Cumulative Gravitational force (clarification given later). Furthering substantiation by deduction, magnetic monopole graviton massless gauge-bosons do not couple to the quanta of light, therein, leaving photon-coupling only with electrically charged particles.\(^2\)

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\(^1\) The density of gravity strands in gravitational radiation, which decreases inversely proportional to the square of the distance from a hadronic object, arises proportional to the mass of that object and will fluctuate in degree from any variability in mass densities within the mass. This last facet is in agreement with data coming from the ESA GOCE geoid project [12]. Consequence of gravitational radiation (relativistic) has been observed with binary pulsar PSR 1913+16 [13]. (General relativity predicts that accelerating masses should emit ‘gravitational radiation’ in the same way that accelerating charged particles emit electromagnetic radiation.) Radiation is conveyed by particles.

\(^2\) In similarity with neutrinos, it would forward an explanation why magnetic monopoles remain undetected by the fact of their apparent ‘invisibility’, whereas unlike neutrinos, magnetic monopoles are not free radical particles but have precise functionality.
4.4 Compact cosmic objects associated with powerful magnetic fields

Gravitons duality utilization that culminate in Gravitomagnetic unified fields, as forwarded in the initial premise, will realize a correlation with gravitational field strengths in relation to compact cosmic objects containing powerful magnetic fields. The stronger the magnetic field of an object will inversely affect the strength of its gravitational field. The explanation would derive from the fact that, during the instigating stage when the object forms, a higher proportion of gravitons, instead of self-organising into gravity strands, are remaining as magnetic strands responsible for the magnetic force, therein, explaining the origins to such strong magnetic fields.

Magnetars with extremely powerful magnetic fields of $10^8$-$10^{11}$ tesla are up to a 1000 times more powerful than the magnetic fields of neutron stars. The powerful magnetic field of a magnetar rapidly decays over a period of approximately 10,000 years [14-15] to that of a regular neutron star. A hydrodynamic dynamo process from rapid rotation of magnetars, as a postulated source for the magnetic field, cannot then be explanatory to this rapid decay as, over this time period, rotation conversely increases in rate, from the 5-12 seconds for most magnetars [15], to less than one second for typical neutron stars [16].

It is from reasoning, that as the magnetic field of a magnetar decays over a period of time, its gravitational field will progressively become stronger as magnetic strands become more organised into gravity strands; thus explaining the inversely declining magnetic field strength. The intensifying density of gravity strands, and with it increasing gravitational field strength, will proportionally increase the mass density of the magnetar; evidential in starquakes and glitches as the internal structure contracts. (Magnetars increasing rate of rotation is then explained by conservation of angular momentum due to increasing mass density and contracting volume.) It is predicted that a magnetars, starting out at an upper limit in mass, will transmute into a black hole during its period of magnetic field decay where increasing mass density eventually overcomes the Tolman-Oppenheimer-Volkoff limit for degeneracy pressure of neutrons; as potentially proceeding initial supernova of DES14X3taz [17] and in the disappearance of N6946-BH1 [18].

The above can also be considered for super-Chandrasekhar mass supernovae where the mass of white dwarf stars can achieve singularly up to 2.8 solar masses before exploding in these supernovae thereby breaking the Chandrasekhar limit of 1.44 solar masses maximum for a white dwarf star. It has been identified in a paper by Upasana Das and Banibrata Mukhopadhyay, ‘Violation of Chandrasekhar Mass Limit: The Exciting Potential of Strongly Magnetized White Dwarfs’ [19], as a plausible connection to this phenomenon. This again would associate compact cosmic objects and powerful magnetic fields. A white dwarf star formed with a powerful magnetic field (with a surface magnetic field of up to $10^5$ tesla [19]) would give rise to a weaker than expected gravitational field where the internal gravitational force attributes to reduced electron degeneracy pressure that results in greater than expected volume and lower mass density. This would allow extra mass to be accreted before its mass density grows to a critical $2 \times 10^{12}$ kg/m$^3$, thereby, the weaker internal gravitational strength allowing the mass of the white dwarf star to grow beyond the Chandrasekhar limit before resulting in a supernova explosion.

The above occurrences provide opportunities to test for quantum gravity. With regard to compact cosmic objects associated with powerful magnetic fields, any deviation in an object’s expected gravitational field strength being inversely proportional to its magnetic field strength, and detectable in unexpected larger object volume and lower mass density, would be attributable to quantum magnetodynamical processes as presented.
4.5 Dark Matter

Image 1: Galaxies, Galactic Clusters and Superclusters

The cumulative mass of the galactic supercluster, at the centre of image 1, should cause curvature in space-time where surrounding structural material manifest, to some degree, in a spiral or orbital motion around the supercluster, which is non-evidential. The conglomeration of the overall megastructure is fibrous in characteristic which, on the grand scale presented by the image, emphasizes the heterogeneous nature that would, predicatively, emanate from gravity strand activity radiating from all cosmic hadronic matter where their substantial non-annihilated surplus, over substantial distances, ultimately accumulates into a Cumulative gravitational force\(^1\) (formerly known as dark matter). This heterogeneous nature of the cumulative gravitational force attributes to the participating factor in the formation of galaxies.\(^2\) (This is covered in a more explanatory account in appendix C: The early quantum universe.)

The image produces an analogy that reflects, as a manifestation at the macroscopic scale, the multi-vectorial interactions of gravity strands occurring at the microscopic scale.

\(^1\) Whereas the affect of the cumulative gravitational force over a large scale is heterogeneous in that propagation is non-uniform, the gravitational force in a local region is homogeneous and propagates uniformly. This infers there will be a dynamical transition from a gravitational force to a cumulative gravitational force relating to the change from homogeneous to heterogeneous; a consequence of the differentiation in scale that gives rise to two different aspects of the same force. (Magnetic monopole gravitons, intrinsic to all discrete scales of the gravitational force, would eliminate the need for any other non-evidential hypothetical exotic particles attributed to ‘Dark Matter’, which would need to be hadronic; matter/particles constituting of quarks.)

\(^2\) This is in addition to the established activity of dark matter, now referred to as the cumulative gravitational force, involvement in the confinement of cosmic matter within galaxies.
5. Conclusion

In establishing the principle of relative matter densities was fundamental to realizing the duality symmetry of Coulomb-Gravitational interactions, as explicable in the molecular synthesis of matter. The principle further ascertain that mass density is a direct consequence of and dynamically related to the gravitational force, and volume, as the equipollent component of matter, is determined by the invariant consistency of electrostatics. Heterogeneity in the mass of condensed matter arises from the product of this complementarity.

It is inferred that hypothetical gravitons will constitute to the existence of magnetic monopoles; as massless gauge-bosons comprising of, as a quantum stipulation, opposite charged particle-antiparticle pairs, which facilitates continuum head-on attraction and annihilation of the opposite charged monopoles. From rationalisation presented in the initial premise, magnetic monopoles, emanate from the by-product of hadronic quark/gluon interactions and form into two distinct strand configurations of monopoles that culminate in the gravitational and magnetic forces. In the distinct forms where paired nucleons produce alternating charged monopoles in self-organised gravity strands that mediate the gravitational force or single/unpaired nucleons produce same charged monopoles in magnetic strands that mediate the magnetic force. The interchangeability of these strand configurations formalizes in unification: in Gravimagnetic unified fields.

It is deduced that magnetically charged monopoles will have an electric dipole moment across their axes of spin congruent with the established magnetic dipole moment of electrically charged particles, which enables interaction by interconnection of fields between magnetic monopoles, travelling in magnetic strands, and electrically charged particles. Field strengths of electrical charge and magnetic moment of electrically charged particles primarily perpetuate within atomic confines, whereas magnetic and gravitational fundamental forces, mediated by the strand configurations of monopoles, both perpetuate beyond this confine. (This is emphasized with respect to the magnetic force: the described configuration of magnetic strands will be explanatory as to the mediation and propagation of the extensive magnetic fields emanating from cosmic objects.)

The reality of magnetodynamical processes would ultimately unite the extreme classical scale of the universe, with its structural formations and containment, to a process originating at the utmost quantum scale, and as such, would reconcile the microscopic scale with the macroscopic scale. The import from the experimental discovery of magnetic monopoles and in the substantiation of Quantum Magnetodynamics will further its ultimate development, and in consequence, place it between the well established quantum dynamic theories of Chromodynamics and Electrodynamics. Fulfilment will then broaden potential to realize further integrated unification: as indication of Nature’s ultimate economic utilization of fundamental forces.
### Appendix A

#### Table A: Coulomb-Gravitational Interactions

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<th>Element</th>
<th>Periodic Table</th>
<th>Symbol</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th>Mass Units</th>
<th>Mass Density (g/L or kg/m³)</th>
<th>Relative Density</th>
<th>Molar Volume (L/mol)</th>
<th>Mean Molecular Distance (Å)</th>
<th>Mean Molecular Force (N)</th>
<th>Mean Interatomic Distance (Å)</th>
<th>Coulomb Interaction (e²/4πε₀r³) (N)</th>
<th>Gravitational Interaction (2GMc²/r²) (N)</th>
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### Matter Properties

#### Mass Density @ 300 K (gases @ 273.15 K) and 1 atm.

**Mean Interactive Molecular Distance:** Constant $M = 2.629 \times 10^9 \text{ m}^2/\text{mol}$

| Substance (samples) | Periodic Table | Symbol | Protons (Element: Atomic number) | Neutrons | Nucleon Number | Atomic Mass | Molecular Element Factor | Mass Density $\rho$ ($\text{g}/\text{l}$ or $\text{kg}/\text{m}^3$) | Relative Density (Molar Relative Volume $R_v = V/\langle R_p \rangle$ (l/mol)) | Relative Matter $R_p/\langle R_p \rangle$ (% of Diamond) | Mean Interactive Molecular Distance $\langle 2\epsilon/\pi \rangle^{1/2}$ (nm) | Coulomb Interaction $2\epsilon/\pi R_v x$ | Gravitational Interaction $-2GM\rho x$ |
|---------------------|----------------|--------|----------------------------------|----------|----------------|-------------|------------------------|-----------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Ice                 | H2O            | 18     | 8                                | 10       | 20             | 18.01500    | 1                      | 18.01500                                      | 1                                               | 18.01500                                       | 1                                              | 1.00700                                       | 2                                              | 1.00700                                       |
| Water               | H2O            | 18     | 8                                | 10       | 20             | 18.01500    | 1                      | 18.01500                                      | 1                                               | 18.01500                                       | 1                                              | 1.00700                                       | 2                                              | 1.00700                                       |
| Steam (373 K)       | H2O            | 18     | 8                                | 10       | 20             | 18.01500    | 1                      | 18.01500                                      | 1                                               | 18.01500                                       | 1                                              | 1.00700                                       | 2                                              | 1.00700                                       |
| Air ($4N_2 + O_2$) (Approx.) | H2O | 18 | 8 | 10 | 20 | 18.01500 | 1 | 18.01500 | 1 | 18.01500 | 1 | 1.00700 | 2 | 1.00700 |
| Ozone ($O_3$)       | O3             | 24     | 16                               | 8        | 24             | 6.12000     | 1                      | 6.12000                                       | 1                                               | 6.12000                                       | 1                                              | 1.95800                                       | 2.5                                           | 5.58600                                       |
| Methane             | CH4            | 16     | 10                               | 6        | 16             | 16.04270    | 1                      | 16.04270                                      | 1                                               | 16.04270                                      | 1                                              | 1.71600                                       | 2.4                                           | 5.58600                                       |
| Ammonia             | NH3            | 17     | 10                               | 7        | 17             | 17.03502    | 1                      | 17.03502                                      | 1                                               | 17.03502                                      | 1                                              | 1.95800                                       | 2.5                                           | 5.58600                                       |
| Carbon dioxide      | CO2            | 22     | 16                               | 11       | 22             | 44.09800    | 1                      | 44.09800                                      | 1                                               | 44.09800                                      | 1                                              | 1.95800                                       | 2.5                                           | 5.58600                                       |
| Dimethyl ether      | CH3OCH3        | 46     | 26                               | 20       | 46             | 46.06904    | 1                      | 46.06904                                      | 1                                               | 46.06904                                      | 1                                              | 1.95800                                       | 2.5                                           | 5.58600                                       |

**Liquids (samples):**

- **Oxygen (90 K):** $O_2$
- **Methane (109 K):** CH4

**Solid (samples):**

- **Diamond:** Carbon
- **Synthetic:** Synthetic solids

**Gases (samples):**

- **Ice:** 273 K
- **Water:** 273 K
- **Steam:** 373 K
- **Air:** $4N_2 + O_2$
- **Ozone:** $O_3$
- **Methane:** CH4
- **Ammonia:** NH3
- **Carbon dioxide:** CO2
- **Dimethyl ether:** CH3OCH3

**Key:**
- **Non-metal**
- **Semi-metal**
- **Metal**
- **Lanthanide**
- **Actinide**

**Gas**

**Liquid**

**Solid**

**Synthetic**

**Mass Density @ 300 K (gases @ 273.15 K) and 1 atm.**

**Mean Interactive Molecular Distance:** Constant $M = 2.629 \times 10^9 \text{ m}^2/\text{mol}$

**Criterion:** Accuracy of computation entails high precision

**Source of Data:** Cross-checked from various sources
**Appendix B: Gravitational coupling strength**

In determining the precise coupling strength of the gravitational force, as comparison in relative magnitude of force strengths, it is essential to present gravitational interactions as magnetic interactions, by reason of magnetic monopoles interactions occurring between opposing gravity strands. This requires determining the elementary magnetic charge of a magnetic monopole:

\[
\frac{e^2}{\varepsilon_0} = \mu_0 \eta^2
\]  

(B.0)

therefore, it can be taken that the elementary unit of magnetic charge in SI base units is:

\[
\eta = \sqrt{\frac{e^2}{\varepsilon_0 \mu_0}} = 4.803 \, 204 \, 671 \times 10^{-11} \text{ A} \cdot \text{m}
\]  

(B.1)

and is consistent with Maxwell’s conclusion:

\[
\frac{\eta}{e} = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} = c
\]  

(B.2)

Magnetic charge will be comparable with electrical charge where, in both instances, field strength will decrease in magnitude with increasing distance from the point charge in accordance with the inverse-square law. This accordance applies to the gravitational interaction of Eqn. 1.4 when presented as a magnetic interaction and in retaining the duality symmetry in relation to the coulomb interaction:

\[
\frac{(2e)^2}{4\pi \varepsilon_0 R^2} - \frac{\mu_0 \eta^2}{2\pi R^2} = 0
\]  

(B.3)

As previously stated in a topic of subsection 3.3, not all magnetic monopoles radiating from atomic nuclei integrate by self-organising into gravity strands, but, instead remain as magnetic strands which give rise to Coulomb-Magnetic interactions. Using the prominent example of atomic hydrogen, bonds are formed by attraction alignment of magnetic strand interactions between atomic nuclei. The Coulomb interaction result from the negative charge of the single electron of the hydrogen atom in a repulsion interaction with the two innermost orbital electrons of the bonded atom, with respect to the separation of both nuclei:

\[
\frac{2e^2}{4\pi \varepsilon_0 R^2} - \frac{\mu_0 \eta^2}{2\pi R^2} = 0
\]  

(B.4)

The magnetic interactional term of the above equation expresses the quantum equivalence to Ampere’s law and, furthermore, will determine the coupling strength for the magnetic force:

\[
\frac{e^2}{2\varepsilon_0 hc} = \frac{\mu_0 \eta^2}{2hc} = \alpha
\]  

(B.5)

where \( h = \text{Planck constant}, \ c = \text{speed of light} \) and \( \alpha = \text{fine-structure constant} \). The gravitational coupling strength is determined by:

\[
\frac{\mu_0 \eta^2}{hc} = 2\alpha
\]  

(B.6)

---

1 Coulomb interactions are denoted as: repulsion is positive and attraction is negative. This is also applicable to magnetic strand interactions. Correspondingly, gravity strand interactions are always negative.
Elementary units of charge are then derived from:

\[ e = N \sqrt{2 \varepsilon_0 h c a} \quad \text{(B.7a)} \]

\[ m_j = N \sqrt{\frac{2 h c a}{\mu_0}} \quad \text{(B.7b)} \]

where, in the above, \( N = \text{integer: } (\neq 0) \pm 1, \pm 2, \pm 3, \ldots \text{ etc.} \) Together with Eqn. B.2, Eqns. B.7a & B.7b complies with the Dirac quantization condition. Eqn. B.5 ascertains magnetic and electrical force coupling strengths are equivalent, whereas Eqn. B.6 ascertains the gravitational force coupling strength is twice as strong and is an manifestation of the ‘Strong-gravitational unified fields’; the outcome of unification between the strong and gravitational forces that emerges from QCD coupling in which magnetic monopole gravitons emanate from non-confinement in QCD (in furtherance of [2]) as a by-product of quark/gluon interactions within the strong nuclear force. The significance of the gravitational force coupling strength, in the strength of the gravitational force at the quantum scale, is also tenable by the fact of the difference in configurations of magnetic monopoles in magnetic and gravity strands, where in the later the magnetic monopoles are in a stronger configuration and hence reflected in the coupling strength. Also, the significance is prevalent in the collapse of massive stars, in that it explains gravity’s accumulative ability to overcome the accumulative degeneracy pressure of electrons in the formation of neutron stars, and again will be instrumental in ultimately overcoming the accumulative degeneracy pressure of neutrons in the formation of black holes.
Appendix C: The early quantum universe

The conceptual foundation for quantum gravity is applied to the early universe succeeding the Big Bang event to ascertain the conditions arising from magnetodynamical processes. The period to be considered is from after the universe was one second old, the juncture at which quark-gluon plasma condensed into protons and neutrons, to the universe at 400 million years old when the onslaught of the first stars formed, which ultimately led to the formation of the first galaxies at approximately one billion years.

Within the first few minutes after the Big Bang followed a limited period involving a nucleosynthesis process when helium and trace of lithium formed. With helium nuclei in which opposite spin orientations of the two pairs of nucleons will produce, outwardly, four monopole strands that combine by self-organising into two directional opposite radiating gravity strands. Whereas, the close confines of the inwardly directed monopole strands, being four individual magnetic strands, interact as attracting pairs of magnetic interactions that assist, to some degree, nuclear binding (as produced by the strong nuclear force in the exchange of pions between nucleons). In addition, it would form explanation to the pronounced stability of helium nuclei. This primordial element accounted for 25% of all baryonic matter and would primarily have been the only source effectuating a gravitational force, which remain the case until the recombination epoch.

The prevailing seventy-five percent of baryonic matter consisted of ionized atomic hydrogen each producing directional opposite radiation of magnetic strands of opposite charged magnetic monopoles (see Figure 1.2 with consideration to a single proton’s magnetic monopole radiation). The accumulative effect of the predominant atomic hydrogen magnetic strand radiation would result in the magnetic force being the dominant force during the first 379,000 year period, between the nucleosynthesis and recombination epochs of the early universe. The dominance of magnetism would have produced very strong turbulent magnetic forces which changed the homogeneous and isotropic distribution of matter resulting in localized perturbation in densities. It is predicted that this period of magnetic turbulence will eventually become evidential in the CMB with achievement in finer resolution; as resembling the surface of the Sun but at a vastly greater scale.

At the recombination epoch, when the early universe had cooled sufficiently, matter decoupled from energy (photon radiation) allowing electrons to combine with atomic nuclei to form atoms. It is at this moment atomic hydrogen, in close proximity, will naturally combine to form molecular hydrogen H2. Magnetic moment field strength within H2 molecules will align the two proton’s spin in opposite up/down orientations (in accordance with the Pauli Exclusion Principle whereby two identical adjoining fermions cannot simultaneously be in the same quantum state). Although the two protons remain repelled apart, their continuous streams of magnetic monopole gravitons will still self-organise into two directional opposite radiating gravity strands. Once bound, stability as H2 molecules is inversely proportional to energy levels. Formation of molecular hydrogen would increasingly attribute to overall gravitational potential. Over the next 400 million years the dominant magnetic force greatly diminishes to present day level, as evidential in intergalactic and interstellar gas/dust clouds. The gravitational force inversely increases to become the predominant governing force and, at this early stage in the universe’s development and without any significant structures for the gravitational force to interact with, the substantial non-annihilated surplus of gravity strands would rapidly accumulate in a Cumulative Gravitational force (formerly referred to as Dark Matter).
(Conceptualism of Modified Newtonian Dynamics – MOND – or in some other modified form is considered as, potentially, a necessary approach when dealing with the presents of Dark Matter, or as referred to the cumulative gravitational force, which must also take into account the complexity of such a force, as over large scales is heterogeneous; propagation of the force is non-uniform.)

Manifestation of a cumulative gravitational force within large scale regions would initiate the attraction process of drawing material together allowing localized perturbation in densities to grow. At first the process will be slow but will proceed to accelerate, eventually creating a voracious onset in an abrupt eruption of star formation at an unprecedented rate. (This is supported by analysis of Hubble Space Telescope deep sky images; that the first stars in the universe appeared in an abrupt eruption of star formation, rather than at a gradual pace, and is also evidential that localized regions were in the midst of rapidly accelerating gravitational contraction.) Those regions experiencing accelerating gravitational contraction would have continued, developing into a localized runaway process where all available regional material finalizes in a supermassive black hole. It therefore indicates the existence of some counterbalancing mechanism which prevented total collapse.

In my subsequent paper, ‘Formulation of a Principle Model of Forces’ [20], where a methodological use of extrapolations, from a recursive pattern relating to unified fields’ and to previously unrealised periodic structures, deduced there was an additional fundamental inflationary force in unity with the weak nuclear force. The major sources of this inflationary force emanate from a by-product of nucleosynthetic processes taking place in active stars. The repulsive aspect of this force only interacts with other nucleosynthetic active stars establishing why the greatest majority of effectual stars within galaxies naturally stay or move apart and do not collide or combine. This inflationary force is also attributed to the force responsible for the current accelerating expansion of the universe (formerly known as Dark Energy).

It would take the presents of this inflationary force to stop potential regional gravitational collapse. As regional stars formed, their activation attributes to the repulsive aspect of a localized inflationary force. This results in a self-regulatory counterbalancing process with the regional cumulative gravitational force and thus initiating the preconditions to allow formation of galaxies. Within galaxies, this self-regulatory counterbalancing process will be dependent upon the ratio between matter densities to star densities. In the initial abrupt eruption of star formation, the formation of black holes was still at the infancy stage. As a consequence, the first galaxies to form were dwarf galaxies and, in a large number of cases, their matter to star density was insufficient to overcome the dominance of the local cumulative gravitational force In such cases, they finalize in total collapse thus accounting for, as an explanation, the large deficit in the current expected existence of dwarf galaxies and the mechanism, over a relative short timescale, in the significant leap from the infancy stage in the formation of black holes to the existence of supermassive black holes; the seeds in the same early abrupt evolution of large galaxies.

The conclusion is that the gravitational force gradually developed over the first 400 million years of the universe existence. Within approximately the first 400,000 years, total gravitation potential was just 25% of current potential. During this same period the magnetic force prevailed as the dominate force that effectuated disturbances in the distribution of matter. The introduction of the inflationary force, although appearing more speculative, is conceptually an essential precondition in the formation of galaxies.
Appendix D: Loop Quantum Gravity

Carlo Rovelli’s informative account of the development and meaning of Loop Quantum Gravity, or referred to as Loop Theory, is presented in his book ‘Reality Is Not What It Seems: The Journey To Quantum Gravity’. In which, at the quantum level, the gravitational field is described by Faraday’s field lines. These imaginary lines represent the field emanating from a source where separation between the lines reflects the magnitude of the field. They are usually presented 2-dimentionially but are to be envisaged as 3-dimentionial representations. Illustrated below is the negative charged electrical field of an electron and the magnetic field surrounding a magnet:

![Electron's Field Lines and Magnetic Field Lines](image)

The following narrative by Carlo Rovelli on an early stage in the development of loop quantum gravity is extracted from his above mention book:

“.... I remember a period of intense discussions and burning intellectual fervour. [Abhay] Ashtekar had rewritten the Wheeler-De Witt equation in a simpler form; and [Lee] Smolin, together with Ted Jacobson of the University of Maryland in Washington, had been the first to find some of the strange solutions of the equation. The solutions had a curious peculiarity: they depended on closed lines in space. A closed line is a ‘loop’....”

“.... Remember Faraday’s [field] lines – the lines which carry the electric force and which, in Faraday’s vision, fill space? Well, the closed lines that appear in the solutions of the Wheeler-De Witt equation are Faraday lines of the gravitational field.” [21]

Interpretation of the loops, as presented in Loop Theory, concluded in quantum foam of space-time. In argument, as an alternative interpretation: for Faraday’s field lines to loop on themselves is illustrated by the example of the magnetic field in (b) of figure D1. The field lines of an individual magnetic monopole will be identical to the field lines of an electron as illustrated by (a) in figure D1, but with consideration, the size of a magnetic monopole is anticipated to be extremely small in comparison to the size of an electron. In the case of gravity strands the field lines produced, in an individual strand, by the alternating charged magnetic monopoles will be loops and where the centres of the loops are at discrete distances apart:

![Gravity Strand (section of) Field Lines](image)
Acknowledgment

Image 1 is with permission and courtesy of Prof. Volker Springel et al./Virgo Consortium in association with The Millennium Simulation Project at the Max Planck Institute for Astrophysics: http://www.mpa-garching.mpg.de/galform/virgo/millennium/

Applied constants


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