Quantum Magnetodynamics of Gravity

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Abstract

In assessments of the *quasi*-magnetic monopoles, experimentally discovered in tetrahedral crystal structures of spin ices, show them to exhibit conformity with the theoretical particles that Paul Dirac theorised to retain duality symmetry between the electromagnetic unified fields. During deliberation into the magnetic force led to the serendipitous insight that the existence of gravitons would consist of magnetic monopole dual particles, which self-organise into theoretical 'Gravity Strands' – the *modus operandi* as to the *vera causa* of the gravitational force. A theoretical premise readily developed, from which evolved a solution for quantum gravity in perfect unity with *magnetic* and *electrical fundamental* forces, thereby forming a foundation for Quantum Magnetodynamics.

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1. Introduction

In 1931 Paul Dirac discovered, when using Maxwell's equations for electromagnetism, that removing the electrically charged particles from the calculations produced duality symmetry; the electric and magnetic fundamental fields could be interchanged without changing their forms. Reinstating the electrically charged particles in the equations destroyed the duality symmetry. Dirac theorised that the existence of magnetic monopole particles and, by their inclusion in the equations together with electrically charged particles, will reinstate the duality symmetry, which in this instance, must manifest in some topological form. The quantisation condition Dirac concluded stated that if theoretical magnetic monopole particles existed, they would justify electric charge. This charge would have to exist in certain quantised units and, due to the duality symmetry, the elementary magnetic charge of magnetic monopoles must be quantised in units inversely proportional to those of elementary electric charge [1].

[1] This work, originally conceived in May 2009, has been updated based on ongoing development and enhancements to openly and transparently communicate its evolving progress.

2. Theoretical premise

The theoretical premise is based on the reasoning 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 would be continuous streams of oppositely charged magnetic monopole *graviton* particles expelled from nucleons in opposite directions along the axes of spin. [1] The natural pairing of nucleons in up/down spin orientations enable their streams of gravitons to self-organise into *gravity strands* of alternating charged particles, thereby initiating a gravitational force (see figure 1.1). The force of attraction manifests due to continuous head-on attractions and annihilations of alternating pairs of oppositely charged gravitons. [2] Single/unpaired nucleons (or paired nucleons where protons' spin orientations readily invert in response to an electrical or magnetic field or magnetised state) produce gravitons with the same charge 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 would formalise in unification: in Gravitomagnetic unified fields.

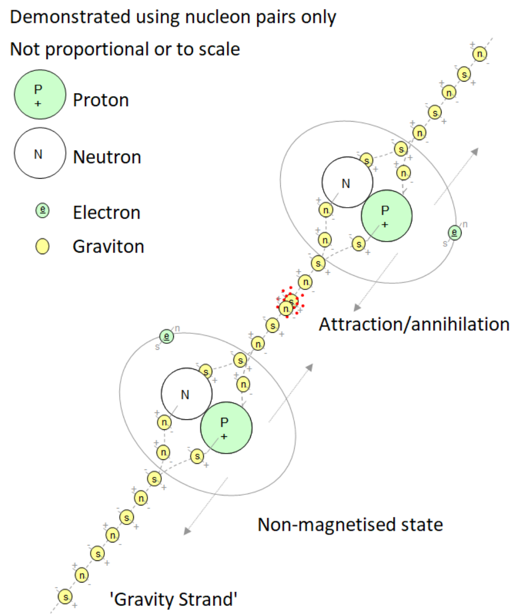

Figure 1.1: Gravitational force

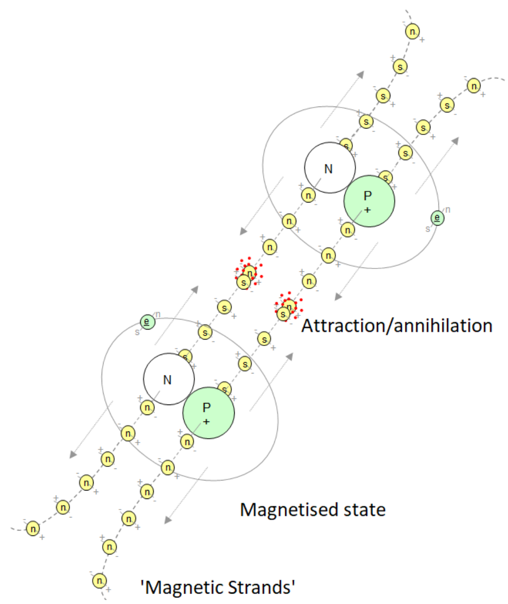

Figure 1.2: Magnetic force

[1] It defines all forms of hadronic matter as the only sources of gravitons. This would attribute the mass of black holes to extremely dense quark matter interiors. Correspondingly, neutron stars' sources of gravitons would originate from the neutron constituents of these stars. Gravitons' duality utilisation would thus explain both the very strong gravitational and magnetic fields of these compact cosmic objects. Regarding particles, only nucleons (as the only stable hadron particles) can have gravitational interactions to the exclusion of all other subatomic particles.

[2] It infers that gravitons are paired massless gauge bosons, comprising of monopoles and antimonopoles of opposite charges, which facilitates annihilation. Head-on attraction/annihilation of leading particles, in converging gravity strands, exposes the next pair of oppositely 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 produces plausibility that lines of magnetic flux, when made visible, are displaying monopoles with the same charge in traceable streams that curve progressively apart by their mutual repulsion (and where oppositely charged streams meet in head-on attraction/annihilation). It can be deduced that the magnetic monopole will have an electric moment, enabling interaction by the interconnection of fields between magnetic monopoles in magnetic strands and electrically charged subatomic particles. In gravity strands, the overall effects of electric moments and magnetic charges are neutralised throughout the length of each strand with only the leading particle retaining a net surplus magnetic charge.

[4] Exception arises within very powerful magnetic fields resulting in localise interference of gravity strand activity [3].

The disclosures by Richard Feynman were that the proton's magnetic moment, rather than being close to 1, was instead 2.79, and the neutral neutron, which should not have had any magnetic interaction, had a magnetic moment of 1.93 [4]. These magnetic moments are central to Nuclear Magnetic Resonance, where, in essence, spectra are produced in atomic nuclei that have at least one unpaired proton or neutron. The significance of these anomalous magnetic moments is potentially attributable to the emission of magnetic monopoles as posited.

3. Foundation for magnetodynamics

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

Today, the complexity of 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. This current complexity is potentially indicative of an incompleteness in current understanding and, as such, is 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 introduces magnetodynamics and the fundamental interactivity of quantum gravity is elucidated; the thermodynamic aspect of this force will become apparent. This underlying phenomenon will be consistent with the thermodynamic properties of matter.

3.1 Relative aspects of matter

External to matter, gravitational interactions correlate with the masses of *hadronic* objects. The mass of an object is the product of its volume and mass density. Internally, at the quantum level, the object properties of mass and volume become irrelevant. Thereby, it can be demonstrated that quantum gravitational interactions correlate with mass densities, in the requisite form of a relative equivalent Specific Density for individual elements and substances:

$$R_\rho = \frac{\rho}{uN} \quad \text{kg·m}^{-3}\text{·u}^{-1} \tag{3.10}$$

where ρ = mass density, u = atomic mass units and N = molecular element number (the number of atoms that form a molecular element, else 1). Precise molar volume is established from the reciprocal of specific density:

$$R_v = \frac{1}{R_\rho} \quad \text{kg}^{-1}\text{·m}^{3}\text{·u} \quad \text{or} \quad \text{m}^{3}\text{·mol}^{-1} \tag{3.11}$$

Statistically, there is a direct correlation between molar volume and the interactive strengths of electrical and gravitational forces. It is referred to as the Mean Interactive Molecular Distance:

$$\langle d \rangle = \sqrt{MR_v} \tag{3.12}$$

where constant $M = e^2/2\pi\varepsilon_0 G$ kg·m^{-1}·u^{-1} (see later quantum applicable derivation of G).

3.2 Interatomic interactions of 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]

$$F_{\mathrm{e}} = \frac{(2e)^2}{4\pi\varepsilon_0\langle d\rangle^2} \tag{3.20}$$

As disclosed in the theoretical premise, the gravitational force is instigated by gravitons self-organising into gravity strands and culminate in their distinct multi-vectorial outward radiation from the nucleonics of atomic nuclei. The attraction/annihilation of gravitons in the mediation of the gravitational force, of individual opposing gravity strands between two atomic nuclei, produces the resultant Gravitational interaction: [2]

$$F_{\mathrm{g}} = 2GR_{\rho} \tag{3.21}$$

The opposing Coulomb and Gravitational interactions then attain equilibrium that will maintain the position of atoms and molecules within the heterogeneity (topology) of matter: [3]

$$F_{\mathrm{e}} - F_{\mathrm{g}} = 0 \tag{3.22}$$

Appendix B contains the full quantum applicable derivation of the gravitational constant, derived from Planck units, $G = F_{\mathrm{p}} l_{\mathrm{p}}^3 u_{\mathrm{p}} / m_{\mathrm{p}}$ $\mathrm{N{\cdot}kg^{-1}{\cdot}m^3{\cdot}u}$, where the Planck mass unit, u_{p}, is a further derived unit. In addition, it will be substantiated that thermal pressure is an exclusive property of R_v: a distinction that differentiates the Coulomb and Gravitational interactions.

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, as such, are unbound to the gravitational force; electron retention is bound by electrostatics. Furthermore, the application of Newton's classical gravitational law in equivalence to a quantum law has inherently been a false assumption.

3.3 Molecular thermodynamics

It is deduced that, atomically, solids are consolidated by the continuous alignment of gravity strand interactions between atomic nuclei. Gases are synthesised purely by continual intermittent interaction of gravity strands, consequential of molecular kinetic motion, and liquids are synthesised by distinguishable combinations of alignment and intermittent interaction of gravity strands. The strengths of all gravity strand interactions are concluded to be inversely proportional to molecular kinetic energy, which is dependent upon temperature.

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

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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 due to this fluidity, the reasoning is furthered in that they exert no repulsive force on adjoining atoms.

[2] External to matter, where mass and volume become physically distinguishable, force transforms to $F = VuNR_{\rho}g$.

[3] Example: For diamond, in which all the carbon atoms forming the crystalline structure are uniformly spaced 0.154 nm apart, $\langle d\rangle$, corroborates Dirac's duality symmetry: $F_{\mathrm{e}} = 3.9120901966 \times 10^{-8}$ - $F_{\mathrm{g}} = 3.9120901966 \times 10^{-8}$.

The previous deduction reveals a crucial underlying dynamical phenomenon of the gravitational force, which is its dependence on temperature and, as such, will be participatory in the thermodynamic properties of matter. Equivalence in interactions between these two opposing intermolecular forces will produce an equilibrium state within a closed system, equating to symmetry between the two forces, whereby, any loss of equilibrium will correspond to the differential in force strengths arising from spontaneous symmetry-breaking. Asymmetry in these force strengths will be the cause of expansion or contraction in matter until an equilibrium state is reinstated, and any restricted asymmetry in the gaseous state will be the cause of thermal pressure.

It brings forth an important distinction between two fundamental forms of pressure: accumulative and thermal pressure. Accumulative pressure is the result of gravitational influence, and is a contractive pressure that contributes to the density of matter. It is consequential to atmospheric pressure and this influence increasingly accumulates within matter until ultimately it can overcome the electron degeneracy pressure (or neutron degeneracy pressure in the case of neutron stars). Thermal pressure however, is purely attributable to thermodynamics and is a repulsive pressure which is, as shown later, non-contributory to mass matter.

Within the bounds of critical temperatures and regardless of pressure, $R_v < 1$ for all liquids and solids and $R_v > 1$ for all gases. Furthermore, there will be a divergent state when $R_v = 1$, as momentarily occurring at the approximate mean point during a phase transition involving vaporisation/condensation or sublimation/deposition. This is endorsed by the square root of the constant M, as corresponding to the mean interactive molecular distance for all elements and substances at this same transition point, and is presented in the duality symmetry of the Coulomb-Gravitational interactions:

$$\frac{(2e)^2}{4\pi\varepsilon_0\langle M\rangle} - 2G = 0 \tag{3.30}$$

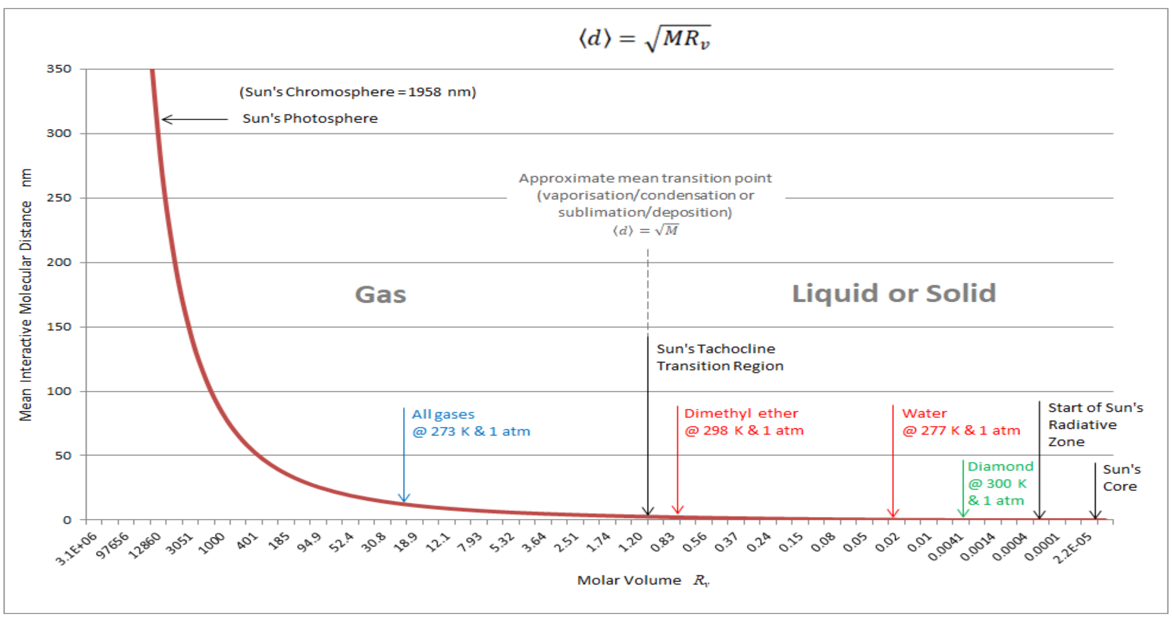

Illustration 1: Mean interactive molecular distance [1]

[1] Descending at the Sun's tachocline transition region, the gas plasma exceeds the critical temperature where, conversely, would transform into a liquid state.

The above R_v conformities conclude in Rule 1: *At or below a critical temperature and regardless of pressure, the approximate mean point during a 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 volume traverses the unitarity volume.*

3.3.1 Molecular thermodynamics of the gaseous state

Asymmetry within a gaseous system, at constant volume and atmospheric pressure p_a, the resulting thermal pressure p can be fundamentally expressed:

$$p = \frac{F_{\mathrm{e}}}{F_{\mathrm{g}}(T/T')} p_a \tag{3.31}$$

The composition of Eqn. 3.31 is thus specifically extended:

$$p = \left\{ \left[\frac{(2e)^2}{4\pi\varepsilon_0 \langle M\, 1/R_\rho \rangle} \right] \Big/ \left[\frac{2GR_\rho T}{T'} \right] \right\} p_a \tag{3.32}$$

The left square bracketed numerator of Eqn. 3.32 expresses the electrostatic repulsion force and, due to the fixed volume, remains constant in value. Whereas, the right square bracketed denominator of the equation expresses the gravitational attraction force and will alter in value depending on a change in temperature. Reduction of Eqn. 3.32 represents an ideal gas at the quantum level:

$$p = \frac{e^2 T'}{2\pi\varepsilon_0 MGT} p_a \tag{3.33}$$

Eqns. 3.31 to 3.33 present thermal pressure within a fixed volume of a gas. In considering variable volume of a fixed quantity of a given gas, ranging from compressed through to unsuppressed volume as a result of a change in absolute temperature and with or without change in thermal pressure is presented, without reduction, to demonstrate the precise processes taking place: [1]

$$V = \underbrace{\left[\frac{(2e)^2 nR_v(T'/T)p_a}{4\pi\varepsilon_0 \langle MR_v(T'/T) \rangle p} \right]}_{\textit{volume}} \Big/ \underbrace{\left[\frac{2GR_\rho T}{T'} \right]}_{\textit{density}} \tag{3.34}$$

where $n = V_i/R_v$ moles. The right side of the equation expresses the change in specific density, equating to dynamical change in the gravitational force strength that then establishes a change in mass density: $\rho = uNR_\rho(T/T')$. On the left side of the equation, the molar volume and temperature aspects cancel out and, thereby, it becomes apparent it is the fundamental pressures that modulates volume.

Thus far, the conclusions originating from Eqn. 3.31 are: a) The consistency of the electrostatic force strength is unaffected by temperature whereas the gravitational force strength is inversely affected. b) The electrostatic repulsion force divergence from an equilibrium state, manifest proportionally in thermal pressure. c) In an equilibrium state, thermal pressure is equipoise to accumulative pressure.

[1] The molar aspects are, in addition, dependent upon atmospheric pressure, i.e. $R_v(p_a/p'_a)$ & $R_\rho(p'_a/p_a)$, and, so to minimise complexity, $p'_a = p_a$ and will remain constant throughout.

Reduction of Eqn. 3.34 (recalling $R_v = 1/R_\rho$) fully develops Eqn. 3.33, for an ideal gas, to that of a specific gas, as derived at the quantum level:

$$pV = \frac{e^2 n R_v T'}{2\pi\varepsilon_0 MGT} p_a \tag{3.35}$$

The reconcilability of the Coulomb-Gravitational elements further realises duality symmetry:

$$\frac{e^2}{2\pi\varepsilon_0 MG} = 1 \qquad \frac{\cancel{C^2}\,\cancel{N}\,\cancel{m^2}}{\cancel{C^2}}\;\frac{\cancel{m}\,\cancel{u}}{\cancel{kg}}\;\frac{\cancel{kg}}{\cancel{N}\,\cancel{m^3}\,\cancel{u}} \tag{3.36}$$

The above equivalence will further reduce Eqn. 3.35 and subsequently the reduction will reconcile the quantum aspect with the classical, by giving rise to a new classical equation of state for gases and, in the omission of a gas constant, is specific for any given gas:

$$pV = nR_v(T'/T)p_a \tag{3.37}$$

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

3.4 Interatomic Coulomb-Magnetic interactions

Thus far, the gaseous state 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 cohere into different atomic structures and hence respond to a change in temperature by differing extents. This underlying complexity is epitomised by negative thermal expansion in which certain materials expand on cooling; ice is an example.

In explanation of negative thermal expansion, 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. Atomic hydrogen (H) is a prominent example, emitting only magnetic strands (see figure 1.2 with respect to a single proton) therefore, only able to interact magnetically, whereas molecular hydrogen (H_2) forms gravity strands and interacts gravitationally. The formation of atomic hydrogen bonds will arise from Coulomb-Magnetic interactions in which short bonds are attraction alignments 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. Such duality symmetrical bond/s are maintained by electron sharing between the bonded atoms.

Beyond electron sharing, the apparent long bonds form with either attraction or repulsion alignments of magnetic strand interactions between atomic nuclei, according to the spin alignments in atomic structures. With this consideration, will posit that negative thermal expansion is where temperature reduction and the subsequent reduction in molecular kinetic motion allows increasing sustainment between atomic nuclei (rigidity) by the continuous alignment of gravity strand interactions, evolving from intermittent interactions. As a consequence, the sustainment results in a proportional increase in repulsion alignment of magnetic strand interactions that effectuate the expansion.

3.5 Correlation of mass density with an equilibrium state

Eqn. 3.32 is re-presented to reconcile an apparent paradox in the mass density ratio of mass and volume:

$$p = \left\{ \left[\frac{(2e)^2}{4\pi\varepsilon_0 \langle d \rangle^2} \right] \Big/ \left[\frac{2GR_\rho T}{T'} \right] \right\} p_a \tag{3.50}$$

If the volume for a given gas, as expressed by the left side of the equation, remains constant then mass and the volumetric 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 a change in temperature — hence the paradox. The constant mass of a given gas within a fixed volume will extend to variable volume where, in such instances, the mean interactive molecular distance will alter accordingly with volume. Eqn. 3.50 can be explicitly stated in the following form:

$$\rho = \frac{m\, p_a}{Vp} \tag{3.51}$$

where mass *m* and atmospheric pressure p_a remain constant. Eqn. 3.51 forms Proposition 1. In addition to the well-established relationships between volume and pressure, variability in mass density is accounted for in the following theorem:

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

Lemma 1: In the case of an unsuppressed volume of gas, a change in temperature will cause a change in volume, but thermal pressure remains constant with atmospheric pressure, in conformity with Charles' law [7]. The resultant change in the mass density of Eqn. 3.51 is consistent with Theorem 1.

Lemma 2: In the case of a fixed volume of gas, a change in temperature will cause a change in thermal pressure, but volume will remain constant, in conformity with Gay–Lussac's (Amontons') law [8–9]. The resultant change in the mass density of Eqn. 3.51 is consistent with Theorem 1.

Lemma 3: In the case of a compressed volume of gas, where the initial constant temperature is re-obtained, this will cause a change in thermal pressure and volume, in conformity with Boyle–Mariotte's law [10]. The resultant mass density of Eqn. 3.51 remains constant and is consistent with Theorem 1.

Volume	Mass of Gas kg	Initial Temperature K	*Specimen* Temperature K	Initial Volume m^3	Resultant/ *Specimen* Volume m^3	Resultant Thermal Pressure atm	Initial Mass Density kg m^{-3}	Resultant Mass Density kg m^{-3}	Constant $\rho' T'$
Lemma 1: Unsuppressed	**83.8**	273	***400***	22.347	**32.742**	**1**	3.75	**2.559**	**1023.750**
Lemma 2: Fixed	**83.8**	273	***400***	22.347	**22.347**	**1.465**	3.75	**2.559**	**1023.750**
Lemma 3: Compressed	**83.8**	273	**273**	22.347	***10***	**2.235**	3.75	**3.750**	**1023.750**

Table 1: Mass density of a gas [1]

[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.

From the above lemmas, it can be seen from the deduction that change in density only occurs when there is a change in temperature. Therefore, *mass density is dependent on temperature*. The deduction establishes that for a given gas, of constant mass, the product of density and temperature remains constant:

$$\rho_1 T_1 = \rho_2 T_2 \tag{3.52}$$

Eqn. 3.52 forms Proposition 2, which is affirmed by the corresponding coefficients:

$$\frac{1}{V_i}\left(\frac{\partial V}{\partial T}\right)_p = \frac{1}{p_i}\left(\frac{\partial p}{\partial T}\right)_V = -\frac{1}{\rho}\left(\frac{\partial \rho}{\partial T}\right)_m \tag{3.53}$$

Lemma 1 Lemma 2 Lemmas 1 & 2

3.5.1 Critical points of gases

		Data					Eqn. 3.50			Proposition 1				Proposition 2	
Element (gases)		Atomic Mass Units u	Molecular Element Number N	Critical Pressure p_c (atm)	Critical Temperature T_c K	Mean Interactive Molecular Distance $\langle d \rangle = \sqrt{MR'_v}$ (nm)	Specific Density R'_ρ @ T_c (kg m^{-3} u^{-1})	Reaffirms Critical Pressure p_c (atm)	Molar Mass R_m (kg mol^{-1})	Molar Volume R'_v (m^3 mol^{-1})	Mass Density ρ @ T_c (kg m^{-3})	Reaffirms Critical Pressure p_c (atm)	Constant $\rho_i T_i$	= $\rho_c T_c$	
Hydrogen	H_2	1.007941	2	12.80	33.2	1.213	0.36691	12.80	2.01588	0.21293	0.73964	12.80	24.5562	24.5562	
Helium	He	4.002602	1	2.24	5.19	1.147	2.34709	2.24	4.0026	0.19021	9.39447	2.24	48.7573	48.7573	
Nitrogen	N_2	14.006743	2	33.50	126.2	1.461	0.09666	33.50	28.0135	0.30883	2.70769	33.50	341.711	341.711	
Oxygen	O_2	15.999405	2	49.80	154.6	1.326	0.07890	49.80	31.9988	0.25450	2.52478	49.80	390.331	390.331	
Fluorine	F_2	18.998403	2	51.50	144.3	1.260	0.08449	51.50	37.9968	0.22982	3.21041	51.50	463.262	463.262	
Neon	Ne	20.180046	1	27.20	44.4	0.962	0.27437	27.20	20.18	0.13400	5.53682	27.20	245.835	245.835	
Chlorine	Cl_2	35.452539	2	76.00	416.9	1.750	0.02970	76.00	70.9051	0.44305	2.10579	76.00	877.904	877.904	
Argon	Ar	39.947677	1	48.10	150.8	1.333	0.08089	48.10	39.9477	0.25701	3.23143	48.10	487.300	487.300	
Krypton	Kr	83.799325	1	54.30	209.3	1.477	0.05840	54.30	83.7993	0.31534	4.89399	54.30	1024.31	1024.31	
Xenon	Xe	131.292481	1	57.60	289.8	1.683	0.04236	57.60	131.292	0.40989	5.56103	57.60	1611.59	1611.59	
Radon	Rn	222.017570	1	61.98	377	1.874	0.03175	61.98	222.018	0.50813	7.04973	61.98	2657.75	2657.75	
Substance (sample gases)															
Methane	CH_4	16.042500	1	45.79	190.8	1.537	0.06389	45.79	16.0425	0.34179	1.02503	45.79	195.575	195.575	
Ammonia	NH_3	17.030566	1	111.30	405.5	1.428	0.03046	111.30	17.0306	0.29501	0.51868	111.30	210.326	210.326	
Steam (373.15 K)	H_2O	18.015287	1	217.70	647.096	1.286	0.01921	217.70	18.0153	0.23918	0.34599	217.70	223.890	223.890	
Carbon dioxide	CO_2	44.009546	1	72.80	304.19	1.533	0.04040	72.80	44.0095	0.34001	1.77796	72.80	540.837	540.837	

Table 2: Critical points of gases

Data for the critical points of gases are used to further substantiate Eqn. 3.50 (for variable volume) and Propositions 1 and 2. Constant mass for a given gas is uniformly expressed by its molar mass:

$$R_m = uNm_\mathrm{u}N_\mathrm{A} \tag{3.54}$$

where m_u = atomic mass constant and N_A = Avogadro constant (for m^3). Molar volume, initially established at standard temperature and pressure (STP) in table A of Appendix A, in that T = 273.15 K (Steam: T = 373.15 K) and p_a = 1 atm, is updated to include critical temperature and critical pressure:

$$R'_v = R_v[(T_c/T)(p_a/p_c)] \tag{3.35}$$

From Proposition 1:

$$\rho = \frac{R_m \, p_a}{R_v' \, p_c} \tag{3.56}$$

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

$$\rho = uNR_\rho(T/T_c) \tag{3.57}$$

A rearrangement of Proposition 1 is $p_c = (R_m \, p_a)/(R_v' \, \rho)$. Eqn. 3.57 reaffirms that specific density, and, consequentially, mass density is not dependent on thermal pressure but is instead dependant on the interactional strength of the gravitational force. This force being inversely proportional to molecular kinetic motion/energy, is dependent upon temperature. Eqn. 3.57 also substantiates Proposition 1 and, in addition to the results presented in table 2, will further substantiate Proposition 2; mass density is dependent on temperature.

Table 2 shows that molar volumes have traversed the 1 m^3 threshold as declared in Rule 1, where, in the above examples, at a critical transition point each gas has transformed into a liquid state (in compliance with critical temperature: R_v < 1 for liquids and solids and R_v > 1 for gases).

The substantiation of Propositions 1 and 2 validates Theorem 1 and is furthered by the fact that pV/p_a is consistent with the unsuppressed volume of a gas. Although the cause in Theorem 1 is shown to be as a consequence of quantum gravity, the effect manifests at the classical level and, thereby, validation of Theorem 1 results in the following classical laws:

Law 2: *In relation to atmospheric pressure, the 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 thermal pressure.*

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

Thermal pressure has been established as an exclusive property of volume and is not a property of mass density, which is only dependent on the properties of accumulative pressure and temperature. In addition, it has been substantiated that mass density remains consistent with unsuppressed volume, which is a manifestation of an equilibrium state. This will be a significant paradigm shift in our understanding of mass density in that it is not just a straightforward ratio of mass and volume, but it is a representation of a true ratio when substances are in an equilibrium state, and this will be applicable to all heterogeneous states of matter.

This paradigm can be comprehensively demonstrated in the processes within an explosive combustion. The sudden increase in temperature produced in the exothermic reaction causes a spontaneous drop in mass density. This is a result of the spontaneous increase in molecular kinetic motion and proportional decrease in molecular gravitational force strength, allowing the rapid increase in volume generated by the accumulative electrostatic repulsion of each atom or molecule (constituting thermal pressure), till an equilibrium state is reinstated. This quantum gravitational effect will then be explicable for the work produced in heat engines and in chemical explosions.

It has also been established within the heterogeneity of matter, volume derives from the *static* consistency of the electrostatic repulsion force and in equipollence, mass density derives from the *dynamic* gravitational attraction force.

3.6 Unification of fundamental forces

The above declaration culminates in realising importance not only relating to the construct of matter but also, in the same way interactions between *electrical* and *magnetic fundamental* forces formalise in unification, the presented unity of interactions between electrical and gravitational fundamental forces would infer a more integrated unification.

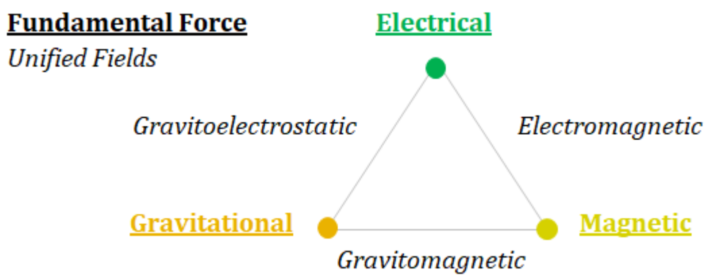

Figure 2: Integrated unification (3D)

This conceptual realisation arose naturally following development of the theoretical premise. A concept investigated, without success, by Faraday then Einstein — who endeavoured to unify general relativity with electromagnetism.

If this theoretical presentation for quantum gravity were substantiated, the import would ultimately give rise to Quantum Magnetodynamics and, in placing it between the well-established quantum field theories of QCD and QED, would advance the potential to realise further integrated unifications, and validity to Nature's optimum formation and utilisation of fundamental forces.

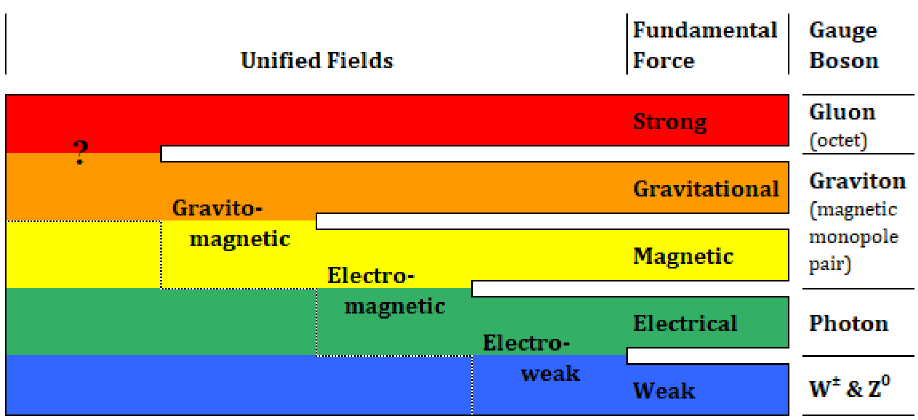

Figure 3: Fundamental model of forces (2D)

Annotation to figure 3: The unification between the strong and gravitational forces, implied from extrapolation, specifically emerges from the theoretical premise in which magnetic monopoles emanate from non-confinement in QCD — as a by-product of quark/gluon interactions, which optimises in the strong nuclear, gravitational and magnetic forces.

Appendix A

Table A: Quantum coulomb-gravitational interactions at STP

Element	Periodic Table Symbol	Protons (Element: Atomic number)	Neutrons	Nucleon Number	Atomic Mass Units u	Molecular Element Number N	Mass Density ρ (kg m^{-3})	Specific Density $R_\rho = \rho/(uN)$ (kg m^{-3} u^{-1})	$R\rho$ % of Diamond	Molar Volume $R_v = 1/R_\rho$ (m^3 mol^{-1})	Mean Interactive Molecular Distance $\langle d\rangle = \sqrt[3]{MR_v}$ (nm)	Coulomb Interaction $\frac{(2e)^2}{4\pi\varepsilon_0\langle d\rangle^2}$ (N)	Gravitational Interaction $-2GR_\rho$ (N)
Hydrogen (H_2)	H	1	0	1	1.007941	2	0.0899	0.045	0.015%	22.424	12.451	5.95E-12	-5.95E-12
Helium	He	2	2	4	4.002602	1	0.1785	0.045	0.015%	22.424	12.451	5.95E-12	-5.95E-12
Lithium	Li	3	4	7	6.940037	1	530	76.368	26%	0.0131	0.301	1.02E-08	-1.02E-08
Beryllium	Be	4	5	9	9.012182	1	1850	205.278	70%	0.0049	0.184	2.74E-08	-2.74E-08
Boron	B	5	6	11	10.811028	1	2340	216.446	74%	0.0046	0.179	2.89E-08	-2.89E-08
Carbon	C	6	6	12	12.010736	1	2260	188.165	64%	0.0053	0.192	2.51E-08	-2.51E-08
Diamond		6	6	12	12.010736	1	3520	293.071	100%	0.0034	0.154	3.91E-08	-3.91E-08
Graphene		6	6	12	12.010736	1	4120	343.026	117%	0.0029	0.142	4.58E-08	-4.58E-08
Nitrogen (N_2)	N	7	7	14	14.006743	2	1.251	0.045	0.015%	22.393	12.442	5.96E-12	-5.96E-12
Oxygen (O_2)	O	8	8	16	15.999405	2	1.429	0.045	0.015%	22.392	12.442	5.96E-12	-5.96E-12
Fluorine (F_2)	F	9	10	19	18.998403	2	1.696	0.045	0.015%	22.404	12.445	5.96E-12	-5.96E-12
Neon	Ne	10	10	20	20.180046	1	0.900	0.045	0.015%	22.422	12.451	5.95E-12	-5.95E-12
Sodium	Na	11	12	23	22.989770	1	970	42.193	14%	0.0237	0.405	5.63E-09	-5.63E-09
Magnesium	Mg	12	12	24	24.305052	1	1740	71.590	24%	0.0140	0.311	9.56E-09	-9.56E-09
Aluminium	Al	13	14	27	26.981538	1	2700	100.068	34%	0.0100	0.263	1.34E-08	-1.34E-08
Silicon	Si	14	14	28	28.085413	1	2330	82.961	28%	0.0121	0.289	1.11E-08	-1.11E-08
Phosphorus (White)	P	15	16	31	30.973762	1	1820	58.759	20%	0.0170	0.343	7.84E-09	-7.84E-09
Phosphorus (Red)	P	15	16	31	30.973762	1	2200	71.028	24%	0.0141	0.312	9.48E-09	-9.48E-09
Phosphorus (Black)	P	15	16	31	30.973762	1	2700	87.171	30%	0.0115	0.282	1.16E-08	-1.16E-08
Sulphur	S	16	16	32	32.066085	1	2070	64.554	22%	0.0155	0.327	8.62E-09	-8.62E-09
Chlorine (Cl_2)	Cl	17	18	35	35.452539	2	3.214	0.045	0.015%	22.061	12.350	6.05E-12	-6.05E-12
Argon	Ar	18	22	40	39.947677	1	1.784	0.045	0.015%	22.392	12.442	5.96E-12	-5.96E-12
Potassium	K	19	20	39	39.098301	1	860	21.996	8%	0.0455	0.561	2.94E-09	-2.94E-09
Calcium	Ca	20	20	40	40.078023	1	1550	38.675	13%	0.0259	0.423	5.16E-09	-5.16E-09
Scandium	Sc	21	24	45	44.955910	1	2990	66.510	23%	0.0150	0.322	8.88E-09	-8.88E-09
Titanium	Ti	22	26	48	47.866750	1	4540	94.847	32%	0.0105	0.270	1.27E-08	-1.27E-08
Vanadium	V	23	28	51	50.941472	1	6110	119.942	41%	0.0083	0.240	1.60E-08	-1.60E-08
Chromium	Cr	24	28	52	51.996138	1	7190	138.280	47%	0.0072	0.224	1.85E-08	-1.85E-08
Manganese	Mn	25	30	55	54.938050	1	7440	135.425	46%	0.0074	0.226	1.81E-08	-1.81E-08
Iron	Fe	26	30	56	55.845150	1	7874	140.997	48%	0.0071	0.221	1.88E-08	-1.88E-08
Cobalt	Co	27	32	59	58.933200	1	8900	151.018	52%	0.0066	0.214	2.02E-08	-2.02E-08
Nickel	Ni	28	31	59	58.693356	1	8900	151.636	52%	0.0066	0.214	2.02E-08	-2.02E-08
Copper	Cu	29	35	64	63.545644	1	8960	141.001	48%	0.0071	0.221	1.88E-08	-1.88E-08
Zinc	Zn	30	35	65	65.395567	1	7130	109.029	37%	0.0092	0.252	1.46E-08	-1.46E-08
Gallium	Ga	31	39	70	69.723072	1	5910	84.764	29%	0.0118	0.286	1.13E-08	-1.13E-08
Germanium	Ge	32	41	73	72.612759	1	5320	73.265	25%	0.0136	0.307	9.78E-09	-9.78E-09
Arsenic	As	33	42	75	74.921596	1	5780	77.147	26%	0.0130	0.299	1.03E-08	-1.03E-08
ά-Arsenic	As	33	42	75	74.921596	1	2000	26.695	9%	0.0375	0.509	3.56E-09	-3.56E-09
Selenium	Se	34	45	79	78.959389	1	4790	60.664	21%	0.0165	0.338	8.10E-09	-8.10E-09
Bromine (Br_2)	Br	35	45	80	79.903529	2	3120	19.524	7%	0.0512	0.595	2.61E-09	-2.61E-09
Krypton	Kr	36	48	84	83.799325	1	3.75	0.045	0.015%	22.346	12.430	5.97E-12	-5.97E-12
Rubidium	Rb	37	48	85	85.467664	1	1532	17.925	6%	0.0558	0.621	2.39E-09	-2.39E-09
Strontium	Sr	38	50	88	87.616646	1	2540	28.990	10%	0.0345	0.488	3.87E-09	-3.87E-09
Yttrium	Y	39	50	89	88.905848	1	4470	50.278	17%	0.0199	0.371	6.71E-09	-6.71E-09
Zirconium	Zr	40	51	91	91.223647	1	6510	71.363	24%	0.0140	0.311	9.53E-09	-9.53E-09
Niobium	Nb	41	52	93	92.906378	1	8570	92.243	31%	0.0108	0.274	1.23E-08	-1.23E-08
Molybdenum	Mo	42	54	96	95.931292	1	10220	106.535	36%	0.0094	0.255	1.42E-08	-1.42E-08
Technetium	Tc	43	55	98	97.907216	1	11500	117.458	40%	0.0085	0.243	1.57E-08	-1.57E-08
Ruthenium	Ru	44	57	101	101.064945	1	12370	122.397	42%	0.0082	0.238	1.63E-08	-1.63E-08
Rhodium	Rh	45	58	103	102.905504	1	12410	120.596	41%	0.0083	0.239	1.61E-08	-1.61E-08
Palladium	Pd	46	60	106	106.415328	1	12000	112.766	38%	0.0089	0.248	1.51E-08	-1.51E-08
Silver	Ag	47	61	108	107.868151	1	10500	97.341	33%	0.0103	0.267	1.30E-08	-1.30E-08
Cadmium	Cd	48	64	112	112.411553	1	8650	76.949	26%	0.0130	0.300	1.03E-08	-1.03E-08
Indium	In	49	66	115	114.818086	1	7310	63.666	22%	0.0157	0.330	8.50E-09	-8.50E-09
Tin (White)	Sn	50	69	119	118.710111	1	7310	61.579	21%	0.0162	0.335	8.22E-09	-8.22E-09
Tin (Grey)	Sn	50	69	119	118.710111	1	5800	48.859	17%	0.0205	0.376	6.52E-09	-6.52E-09
Antimony	Sb	51	71	122	121.759788	1	6690	54.944	19%	0.0182	0.355	7.33E-09	-7.33E-09
Tellurium	Te	52	76	128	127.603125	1	6240	48.902	17%	0.0204	0.376	6.53E-09	-6.53E-09
Iodine	I	53	74	127	126.904468	1	4930	38.848	13%	0.0257	0.422	5.19E-09	-5.19E-09
Xenon	Xe	54	77	131	131.292481	1	5.9	0.045	0.015%	22.253	12.404	6.00E-12	-6.00E-12
Caesium	Cs	55	78	133	132.905447	1	1870	14.070	5%	0.0711	0.701	1.88E-09	-1.88E-09
Barium	Ba	56	81	137	137.326886	1	3590	26.142	9%	0.0383	0.514	3.49E-09	-3.49E-09

Element	Periodic Table Symbol	Protons (Element: Atomic number)	Neutrons	Nucleon Number	Atomic Mass Units u	Molecular Element Number N	Mass Density ρ (kg m^{-3})	Specific Density $R_\rho = \rho/(uN)$ (kg m^{-3} u^{-1})	$R\rho$ % of Diamond	Molar Volume $R_v = 1/R_\rho$ (m^3 mol^{-1})	Mean Interactive Molecular Distance $\langle d \rangle = \sqrt{MR_v}$ (nm)	Coulomb Interaction $\frac{(2e)^2}{4\pi\varepsilon_0 \langle d \rangle^2}$ (N)	Gravitational Interaction $-2GR_\rho$ (N)
Lanthanum	La	57	82	139	138.905449	1	6150	44.275	*15%*	0.0226	0.395	5.91E-09	-5.91E-09
Cerium	Ce	58	82	140	140.115722	1	6770	48.317	*16%*	0.0207	0.378	6.45E-09	-6.45E-09
Praseodymium	Pr	59	82	141	140.907648	1	6770	48.046	*16%*	0.0208	0.379	6.41E-09	-6.41E-09
Neodymium	Nd	60	84	144	144.236127	1	7010	48.601	*17%*	0.0206	0.377	6.49E-09	-6.49E-09
Promethium	Pm	61	84	145	144.912744	1	7220	49.823	*17%*	0.0201	0.373	6.65E-09	-6.65E-09
Samarium	Sm	62	88	150	150.366344	1	7520	50.011	*17%*	0.0200	0.372	6.68E-09	-6.68E-09
Europium	Eu	63	89	152	151.964336	1	5240	34.482	*12%*	0.0290	0.448	4.60E-09	-4.60E-09
Gadolinium	Gd	64	93	157	157.252119	1	7900	50.238	*17%*	0.0199	0.371	6.71E-09	-6.71E-09
Terbium	Tb	65	94	159	158.925343	1	8230	51.785	*18%*	0.0193	0.365	6.91E-09	-6.91E-09
Dysprosium	Dy	66	97	163	162.497030	1	8550	52.616	*18%*	0.0190	0.362	7.02E-09	-7.02E-09
Holmium	Ho	67	98	165	164.930319	1	8800	53.356	*18%*	0.0187	0.360	7.12E-09	-7.12E-09
Erbium	Er	68	99	167	167.256301	1	9070	54.228	*19%*	0.0184	0.357	7.24E-09	-7.24E-09
Thulium	Tm	69	100	169	168.934211	1	9320	55.169	*19%*	0.0181	0.354	7.36E-09	-7.36E-09
Ytterbium	Yb	70	103	173	173.037692	1	6970	40.280	*14%*	0.0248	0.414	5.38E-09	-5.38E-09
Lutetium	Lu	71	104	175	174.966718	1	9840	56.239	*19%*	0.0178	0.351	7.51E-09	-7.51E-09
Hafnium	Hf	72	106	178	178.484971	1	13310	74.572	*25%*	0.0134	0.304	9.95E-09	-9.95E-09
Tantalum	Ta	73	108	181	180.947876	1	16650	92.015	*31%*	0.0109	0.274	1.23E-08	-1.23E-08
Tungsten	W	74	110	184	183.841779	1	19300	104.982	*36%*	0.0095	0.257	1.40E-08	-1.40E-08
Rhenium	Re	75	111	186	186.206706	1	21000	112.778	*38%*	0.0089	0.248	1.51E-08	-1.51E-08
Osmium	Os	76	114	190	190.224861	1	22600	118.807	*41%*	0.0084	0.241	1.59E-08	-1.59E-08
Iridium	Ir	77	115	192	192.216054	1	22600	117.576	*40%*	0.0085	0.242	1.57E-08	-1.57E-08
Platinum	Pt	78	117	195	195.077791	1	21450	109.956	*38%*	0.0091	0.251	1.47E-08	-1.47E-08
Gold	Au	79	118	197	196.966552	1	19300	97.986	*33%*	0.0102	0.266	1.31E-08	-1.31E-08
Mercury	Hg	80	121	201	200.599149	1	13550	67.548	*23%*	0.0148	0.320	9.02E-09	-9.02E-09
Thallium	Ti	81	123	204	204.383317	1	11850	57.979	*20%*	0.0172	0.345	7.74E-09	-7.74E-09
Lead	Pb	82	125	207	207.216892	1	11350	54.774	*19%*	0.0183	0.355	7.31E-09	-7.31E-09
Bismuth	Bi	83	126	209	208.980383	1	9750	46.655	*16%*	0.0214	0.385	6.23E-09	-6.23E-09
Polonium	Po	84	125	209	208.982416	1	9300	44.501	*15%*	0.0225	0.394	5.94E-09	-5.94E-09
Astatine	At	85	125	210	209.987131	1	7000	33.335	*11%*	0.0300	0.455	4.45E-09	-4.45E-09
Radon	Rn	86	136	222	222.017570	1	9.73	0.044	*0.015%*	22.818	12.560	5.85E-12	-5.85E-12
Francium	Fr	87	136	223	223.019731	1	1870	8.385	*3%*	0.1193	0.908	1.12E-09	-1.12E-09
Radium	Ra	88	138	226	226.025403	1	5000	22.121	*8%*	0.0452	0.559	2.95E-09	-2.95E-09
Actinium	Ac	89	138	227	227.027747	1	10070	44.356	*15%*	0.0225	0.395	5.92E-09	-5.92E-09
Thorium	Th	90	142	232	232.038050	1	11720	50.509	*17%*	0.0198	0.370	6.74E-09	-6.74E-09
Protactinium	Pa	91	140	231	231.035879	1	15400	66.656	*23%*	0.0150	0.322	8.90E-09	-8.90E-09
Uranium	U	92	146	238	238.028913	1	18950	79.612	*27%*	0.0126	0.295	1.06E-08	-1.06E-08
Neptunium	Np	93	144	237	237.048167	1	20200	85.215	*29%*	0.0117	0.285	1.14E-08	-1.14E-08
Plutonium	Pu	94	150	244	244.064198	1	19840	81.290	*28%*	0.0123	0.292	1.09E-08	-1.09E-08
Americium	Am	95	148	243	243.061373	1	13700	56.364	*19%*	0.0177	0.350	7.52E-09	-7.52E-09
Curium	Cm	96	151	247	247.070347	1	13500	54.640	*19%*	0.0183	0.356	7.29E-09	-7.29E-09

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 = 6.913 315 355 x 10^{-18} kg·m^{-1}·u^{-1}

Criterion: Accuracy of computation entails high precision

Source of Data: Cross-checked from various sources

Substance (samples)

Substance	Periodic Table Symbol	Protons	Neutrons	Nucleon Number	Atomic Mass Units u	Molecular Element Number N	Mass Density ρ	Specific Density R_ρ	$R\rho$ % of Diamond	Molar Volume R_v	Mean Interactive Molecular Distance	Coulomb Interaction	Gravitational Interaction
Ice (273 K)	H_2O	10	8	18	18.015287	1	917	50.901	*17%*	0.0196	0.369	6.79E-09	-6.79E-09
Water (277 K)	H_2O	10	8	18	18.015287	1	999.973	55.507	*19%*	0.0180	0.353	7.41E-09	-7.41E-09
Steam (373.15 K)	H_2O	10	8	18	18.015287	1	0.60	0.033	*0.011%*	30.025	14.408	4.45E-12	-4.45E-12
Air ($4N_2 + O_2$)	(Approx.)				14.405000	2	1.29	0.045	*0.015%*	22.333	12.426	5.98E-12	-5.98E-12
Ozone (O_3)		8	8	16	15.999405	3	2.144	0.045	*0.015%*	22.387	12.441	5.96E-12	-5.96E-12
Methane	CH_4	10	6	16	16.042500	1	0.716	0.045	*0.015%*	22.406	12.446	5.96E-12	-5.96E-12
Ammonia	NH_3	10	7	17	17.030566	1	0.77	0.045	*0.015%*	22.118	12.366	6.04E-12	-6.04E-12
Carbon dioxide	CO_2	22	22	44	44.009546	1	1.98	0.045	*0.015%*	22.227	12.396	6.01E-12	-6.01E-12
Dimethyl ether (298 K)	CH_3OCH_3	26	20	46	46.068518	1	72.72	1.579	*0.539%*	0.6335	2.093	2.11E-10	-2.11E-10

Liquid Gas (samples)

Substance	Periodic Table Symbol	Protons	Neutrons	Nucleon Number	Atomic Mass Units u	Molecular Element Number N	Mass Density ρ	Specific Density R_ρ	$R\rho$ % of Diamond	Molar Volume R_v	Mean Interactive Molecular Distance	Coulomb Interaction	Gravitational Interaction
Oxygen (90 K) (O_2)	O	8	8	16	15.999405	2	1140	35.626	*12%*	0.0281	0.441	4.76E-09	-4.76E-09
Methane (109 K)	CH_4	10	6	16	16.042500	1	464.54	28.957	*10%*	0.0345	0.489	3.87E-09	-3.87E-09

Appendix B: Gravitational constant (derivation)

Planck length	l_{p}	1.61619997 x 10^{-35}	m
Planck mass	m_{p}	2.17651130 x 10^{-8}	kg
Planck time	t_{p}	5.39106320 x 10^{-44}	s
Planck force	F_{p}	1.21034164 x 10^{44}	N
Planck density	ρ_{p}	5.15555760 x 10^{96}	$\mathrm{kg{\cdot}m^{-3}}$

Table B1: *ad rem* Planck units

The current Newtonian derivations of the gravitational constant are:

$$G = \frac{F_{\mathrm{p}} l_{\mathrm{p}}^2}{m_{\mathrm{p}}^2} = 6.673848 \text{ x } 10^{-11} \qquad \mathrm{N{\cdot}kg^{-2}{\cdot}m^2} \qquad \text{(B.1a)}$$

$$G = \frac{l_{\mathrm{p}}^3}{m_{\mathrm{p}} t_{\mathrm{p}}^2} = 6.673857 \text{ x } 10^{-11} \qquad \mathrm{kg^{-1}{\cdot}m^3{\cdot}s^{-2}} \qquad \text{(B.1b)}$$

In a quantum applicable derivation of the gravitational constant, the force element from Eqn. B.1a is to be utilised in combination with the inverse mass density element from Eqn. B.1b. A dimensionless unit, u, was assigned to atomic mass units in order to notate a distinction between mass density and specific density. Correspondingly, to represent mass density as specific density, the derivation will need to include a 'mass units' element in the form of Planck Mass Units, which at present does not exist and must be derived from first principles. The value for this required Planck mass units is to be derived from existing Planck units independent of G:

$$f_1 = \frac{m_{\mathrm{p}}^2}{l_{\mathrm{p}}^2} = 1.8135589 \text{ x } 10^{54} \qquad \mathrm{kg^2{\cdot}m^{-2}} \qquad \text{(B.2a)}$$

$$f_2 = \frac{m_{\mathrm{p}}}{l_{\mathrm{p}}^3 u_{\mathrm{p}}} \qquad \mathrm{kg{\cdot}m^{-3}{\cdot}u^{-1}} \qquad \text{(B.2b)}$$

The quantifying stipulation for Eqns. B.2a and B.2b is they are equivalent, i.e. f_2 must equal f_1. Therefore, u_{p}, Planck mass units, can be derived from using the value of f_1, inversely with Planck density, with the units of f_2:

$$u_{\mathrm{p}} = \frac{\rho_{\mathrm{p}}}{f_1} = 2.84278477 \text{ x } 10^{42} \qquad \frac{\cancel{\mathrm{kg}}}{\cancel{\mathrm{m^3}}} \; \frac{\cancel{\mathrm{m^3}}\,\mathrm{u}}{\cancel{\mathrm{kg}}} \qquad \text{(B.3)}$$

From the now known value for Planck mass units, further new Planck components can be determined in the form of Planck specific density, $P_\rho = \rho_{\mathrm{p}}/u_{\mathrm{p}}$, and Planck molar volume, $P_v = 1/P_\rho$.

Planck mass units	u_{p}	2.84278477 x 10^{42}	u
Planck specific density	P_ρ	1.81355890 x 10^{54}	$\mathrm{kg{\cdot}m^{-3}{\cdot}u^{-1}}$
Planck molar volume	P_v	5.51401999 x 10^{-55}	$\mathrm{m^3{\cdot}mol^{-1}}$

Table B2: New Planck components

A quantum derivation of the gravitational constant is then derived from Planck units:

$$G = \frac{F_{\mathrm{p}} l_{\mathrm{p}}^3 u_{\mathrm{p}}}{m_{\mathrm{p}}} = \frac{F_{\mathrm{p}}}{P_\rho} = 6.673848 \text{ x } 10^{-11} \qquad \mathrm{N{\cdot}kg^{-1}{\cdot}m^3{\cdot}u} \qquad \text{(B.4)}$$

Appendix C: Gravitational coupling strength

In determining the precise coupling strength of the gravitational force, as a comparison in the relative magnitudes of force strengths, it will be essential to present gravitational interactions as magnetic interactions due to the interactions of magnetic monopoles in gravity strands. This requires determining the elementary magnetic charge of a magnetic monopole:

$$\frac{e^2}{\varepsilon_0} = \mu_0 \mathcal{m}^2 \tag{C.1}$$

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

$$\mathcal{m} = \sqrt{\frac{e^2}{\varepsilon_0 \mu_0}} = 4.803\ 204\ 671 \text{ x } 10^{-11} \ \text{A·m} \tag{C.2}$$

and is consistent with Maxwell's conclusion:

$$\frac{\mathcal{m}}{e} = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} = c \qquad \text{m·s}^{-1} \tag{C.3}$$

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 accordingly applies to the gravitational interaction of opposing gravity strands between two atomic nuclei, as presented in Eqn. 3.21. In retaining the duality symmetry:

$$\frac{(2e)^2}{4\pi\varepsilon_0 \langle d \rangle^2} - \frac{\mu_0 \mathcal{m}^2}{\pi \langle d \rangle^2} = 0 \tag{C.4}$$

As previously stated in subsection 3.4, 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. In using atomic hydrogen as a prominent example, bonds are formed by attraction alignments of magnetic strand interactions between atomic nuclei. The Coulomb interaction results from the negative charge of the hydrogen atom's single electron, engaging in a repulsion interaction with the two innermost orbital electrons of the bonded atom. With respect to the separation of both nuclei: [1]

$$\frac{2e^2}{4\pi\varepsilon_0 D^2} - \frac{\mu_0 \mathcal{m}^2}{2\pi D^2} = 0 \tag{C.5}$$

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:

$$\frac{e^2}{2\varepsilon_0 hc} = \frac{\mu_0 \mathcal{m}^2}{2hc} = \alpha \tag{C.6}$$

where h = Planck constant, c = speed of light and α = fine-structure constant. The gravitational coupling strength is determined by:

$$\frac{\mu_0 \mathcal{m}^2}{hc} = 2\alpha \tag{C.7}$$

[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:

$$m = N\sqrt{\frac{2hc\alpha}{\mu_0}} \qquad \text{A·m} \tag{C.8a}$$

$$e = N\sqrt{2\varepsilon_0 hc\alpha} \qquad \text{A·s} \tag{C.8b}$$

where, in the above, N = integer: ($\neq 0$) ±1, ±2, ±3.... etc. Together with Eqn. C.3, Eqns. C.8a and C.8b complies with the Dirac quantisation condition. Eqn. C.6 determines the physical coherent equivalence of the magnetic and electrical force coupling strengths, whereas Eqn. C.7 identifies the significance of the gravitational force coupling strength as being twice as strong. This reaffirms the false assumption in the application of Newton's classical gravitational law at the quantum scale, which has accordingly derived the present accepted ultra-weak coupling strength of 10^{-43} for the gravitational force. In relation to the strong nuclear force coupling strength of 1, the significance of the gravitational force coupling strength is realistic, given that the gravitational force emerges from QCD and, as such, the strong and gravitational forces must ultimately formalise in unification. Further justification to the gravitational force coupling strength is reflected in the accumulative effects produced by individual interactions within matter; demonstrated by ever increasing mass of objects, are invariably dominated by the gravitation force. As in the collapse of massive stars, gravity's dominance is demonstrated by overcoming the accumulative effect of the electron degeneracy pressure in the formation of neutron stars, and again in overcoming the accumulative effect of the neutron degeneracy pressure in the formation of black holes — the ultimate depiction of the strength of gravity. Although, second in strength to the ultra-dominant strong nuclear force, which, seemingly, stops gravity's progression in forming singularities; as, without the presents of quarks and gluons, gravity is negated. Essentially, gravity is the product, and therefore is the extension, of the potential and kinetic energies in the dynamic activity of quarks and gluons [1] — in effect, are the perpetual engines, within nucleons, that drives the existence of the cosmos and where their by-product extends to the governance of the cosmos.

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[1] It is anticipated that the potential and kinetic energy, not only verified as accounting for the mass of a composite nucleon, but also produces a vortex within that draws in vacuum energy, which is the source in fuelling the activity of quarks and gluons and, this influx of energy, is conserved in the production of magnetic monopole gravitons expelled from the nucleon.