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RESEARCH ARTICLE

Matter–Energy Model without the Gravitational Constant: A Unified Approach to Gravitational and Nuclear Interactions

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Abstract: Newton's law of universal gravitation and Einstein's General Theory of Relativity (GTR) face limitations in explaining gravitational anomalies and unifying fundamental physical forces. This study proposes that the gravitational constant G is not constant but distance-dependent (G_{var}), establishing a unified theoretical framework for gravitational and nuclear interactions. We first derive the functional form of G_{var} calibrated by planetary perihelion shifts, then analyze its impact on the physical unit system, and finally construct a matter–energy model based on the Primordial Energy Matrix (PEM) composed of force points. The results show that G_{var} effectively explains gravitational anomalies (e.g., Pioneer anomaly, flyby anomalies) and achieves the unification of gravity with strong/weak nuclear and electromagnetic forces without introducing extra dimensions. The matter–energy model reveals that elementary particles (neutrons, protons, electrons) originate from vortices formed by PEM force points, and atomic/molecular structures are derived from the cascading combination of these vortices. This work provides a new perspective for understanding the nature of gravity and the origin of matter.

Keywords: variable gravitational constant, matter-energy model, unified fundamental forces, primordial energy matrix, gravitational anomalies

1 Introduction

Gravity is one of the four fundamental forces in nature, but its description remains incomplete. Newton's law of universal gravitation assumes a constant G, which fails to explain phenomena such as planetary perihelion shifts and the Pioneer anomaly (Newton, 1686). Although GTR partially corrects these deviations, it cannot unify gravity with the strong nuclear force and is invalid at scales below the Planck horizon or beyond the Solar System (Nojiri & Odintsov, 2007). Additionally, the existence of dark matter and the need for extra dimensions to unify forces have long been controversial in physics (Hees et al., 2014; Haug, 2016).

To address these issues, previous studies have hypothesized that G might be variable (Haug, 2020, 2022), but a consistent theoretical framework linking this variability to matter formation and force unification is lacking. This study aims to: (1) Derive the distance-dependent gravitational constant G_{var} and verify it with gravitational anomalies; (2) Analyze the impact of G_{var} on the physical unit system; (3) Construct a unified matter–energy model based on G_{var} to explain particle formation and force unification.

2 Theoretical Foundation of the Variable Gravitational Constant

2.1 Limitations of the Traditional Gravitational Constant

Newton's gravitational law $F = \frac{Gm_1m_2}{r^2}$ neglects the "fictitious extension" of gravitational force lines, leading to inaccuracies in force calculations (Newton, 1686). GTR compensates for these deviations through relativistic corrections but has inherent limitations: it cannot be applied below the Planck horizon (10^{-35} m) or beyond the Solar System, and fails to unify gravity with the strong nuclear force (Nojiri & Odintsov, 2007).

2.2 Derivation of G_{var}

We propose that G_{var} depends on the distance r between two masses, with no dependence on the masses themselves. The functional form is:

$$G_{var} = \frac{k_1}{r^{1/k_2}} \tag{1}$$

where $k_1 = 6.674296 \times 10^{-11} N \cdot m^2/kg^2$ (consistent with the order of the traditional G) and k_2 = 10,973,731.57 (Rydberg constant R_∞). The corrected gravitational law is:

$$F = \frac{G_{var} m_1 m_2}{r^2} = \frac{k_1 m_1 m_2}{r^{2+1/k_2}} \tag{2}$$

The constants k_1 and k_2 are calibrated using planetary perihelion shift data, ensuring consistency with observational results without relativistic corrections.

2.3 Verification with Gravitational Anomalies

2.3.1 Planetary Perihelion Shifts

Traditional Newtonian mechanics predicts perfect elliptical planetary orbits, but observational data show perihelion shifts. Relativistic calculations and G_{var}-based calculations both align with observations, but G_{var} avoids the complexity of relativistic corrections (Table 1). For planets beyond Saturn, G_{var} predicts negative shifts, which is consistent with the gravitational field distribution in the outer Solar System (Figure 1).

Table 1 Perihelion Shifts (Pitjeva, 2006)

Values	Mercury	Venus	Earth	Icarus	Mars	Ceres	Jupiter	Saturn	Uranus	Neptune	Pluto
Observed Values	43.11 42.66 43.56	8.30 3.60 13.20	5.00 4.95 5.05	9.80 9.00 10.60	1.50 1.35 1.65						
Relativistic Values	42.99	8.63	3.84	10.06	1.35	0.30	0.062	0.014	0.0024	0.00035	0.00042
Values with Gnew	41.00	12.88	6.91	5.96	2.97	0.81	0.15	-0.004	-0.028	-0.01	-0.018

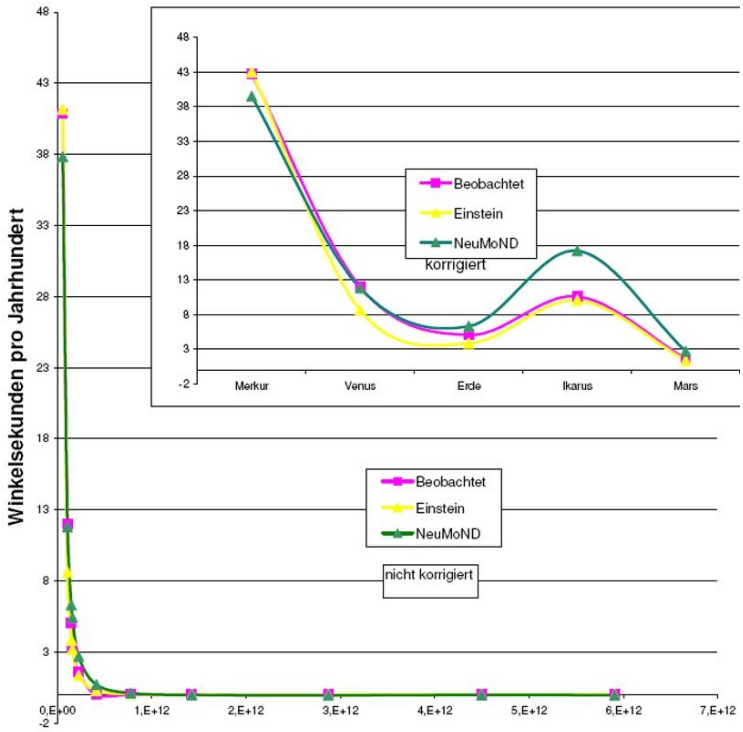

Figure 1 Perihelion Shifts: G_{new} Compared with Einstein's Relativistic Values and Observed Values (Iorio,2009; Weber, 2019, 2023, 2024)

2.3.2 Pioneer Anomaly

The anomalous acceleration of the Pioneer 10 probe is successfully simulated using G_{var}. At 7.4 AU, the anomalous acceleration is zero, and at 41.4 AU, the distance deviation from the calculated value is zero (Figure 2). This indicates that the Pioneer anomaly is not caused by solar radiation pressure alone but by the distance dependence of gravity.

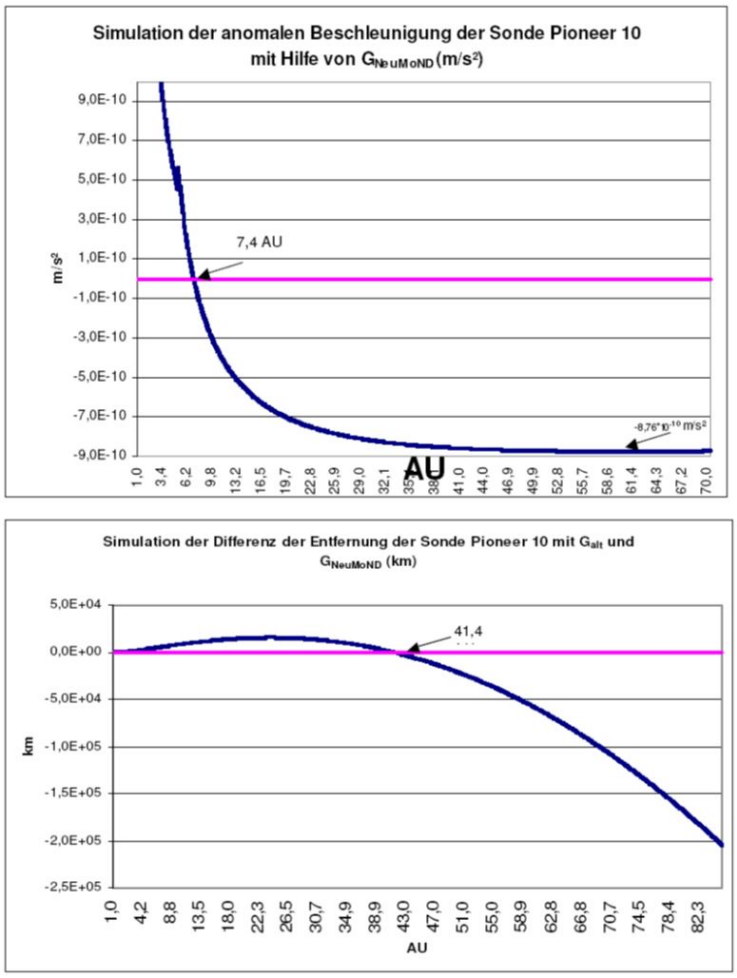

Figure 2 Anomalous Acceleration and Distance of Probe Pioneer 10 Simulated with G_{new}

2.3.3 Flyby Anomalies

The flyby velocity deviation of celestial bodies is composed of two components: the deviation from G_{var} and atmospheric drag. Simulations with G_{var} (Figure 3) accurately reproduce the observed deviations under different flyby altitudes and approach angles.

2.3.4 Dark Matter Explanation

Calculations using G_{var} show that the deviation in galactic rotational speeds is only ˜0.00005% for the Milky Way (Figure 4), indicating that dark matter cannot be fully explained by G_{var} alone. Thus, the search for dark matter remains necessary.

2.4 Force Unification via G_{var}

The exponential curve of G_{var} leads to a significant increase in gravitational strength at extremely small distances:

(1) At $10^{-275,000,000}$ m, gravity equals the weak nuclear force;
(2) At $10^{-395,000,000}$ m, gravity equals the electromagnetic force;
(3) At $10^{-417,000,000}$ m, gravity equals the strong nuclear force (Figure 5).

This achieves the unification of fundamental forces without extra dimensions.

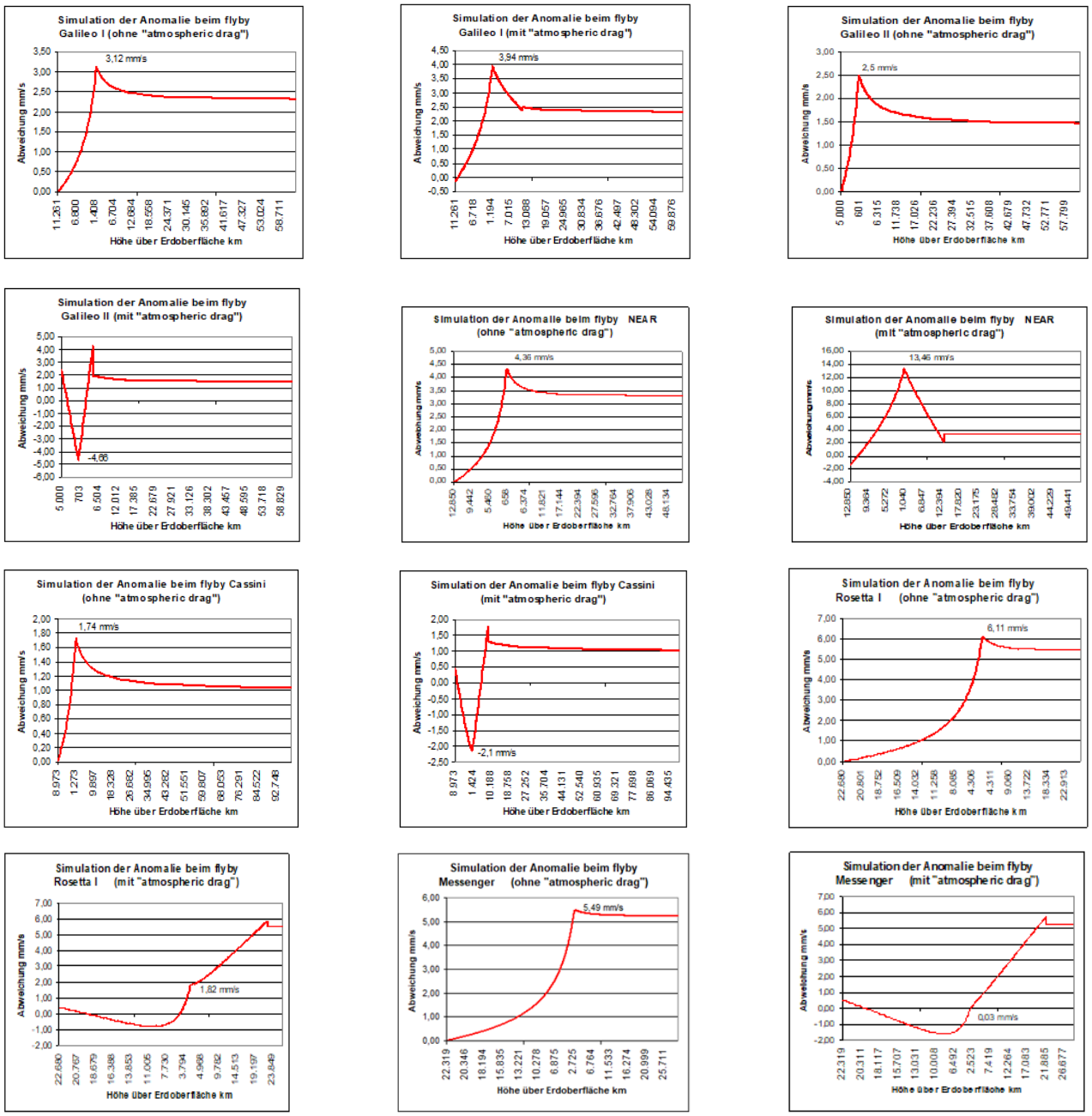

Figure 3 Simulated Deviations During Earth Flybys with and without "Atmospheric Drag" Using G_{new}

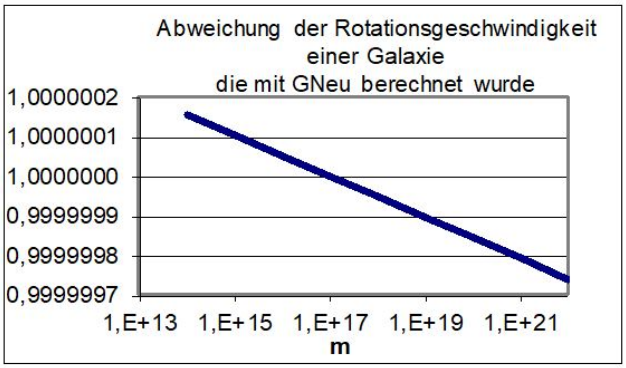

Figure 4 Possible share of dark matter that can be explained with G_{new} (%)

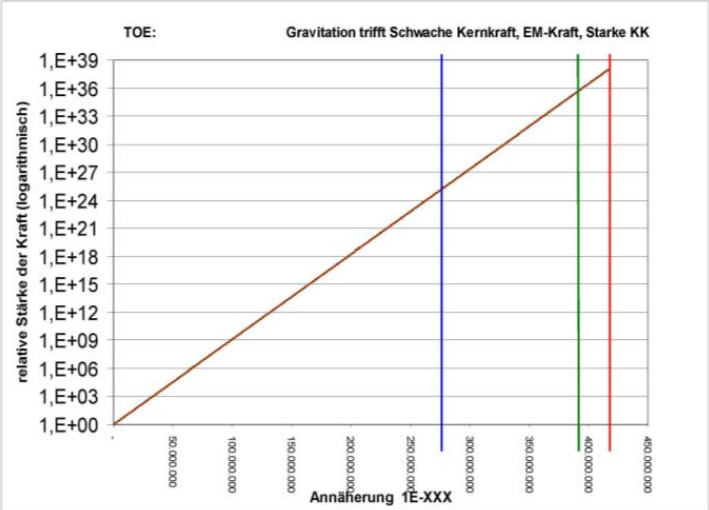

Figure 5 Unification of the Fundamental Physical Forces

3 Impact of G_{var} on the Physical Unit System

3.1 Planck Units with G_{var}

Planck units are traditionally defined by c (speed of light), $\hbar$ (reduced Planck constant), and G (constant). By treating G as G_{var}, we iteratively adjust 17 Planck units (mass, momentum, energy, etc.) to 1, forming a matrix of equivalence relationships. The key findings are:

(1) A new constant K' = 1.173927 is embedded in all adjusted Planck units;

(2) The equivalence relationship E = mc^2 is naturally derived, consistent with Einstein's mass-energy equivalence;

(3) The unit system is independent of traditional Planck formulas but retains their derivation framework.

3.2 Natural Units and Fine-Structure Constant

Adjusting Planck units to match electron-related natural units (electron mass, energy, Compton wavelength) reveals two critical G_{var} values:

(1) G_{var1} = 3.80994675 $\times$ 10^{34}: Gravity equals the strong nuclear force;

(2) G_{var2} = 2.0288479 $\times$ 10^{30}: Gravity equals the electromagnetic force.

The ratio $\sqrt{G_{var2}/G_{var1}} = 0.007297351923$, which matches the Sommerfeld fine-structure constant α. The difference between α and a new factor α' = 0.00759967158 (related to c) explains the 4.143% discrepancy in proton radius measurements using electrons and muons.

3.3 Universal Equation

All physical units can be expressed using the universal equation derived from G_{var}:

$$Unit = c^x \cdot K'^y \tag{3}$$

where c = 299792457 m/s, K′ = 1.17392682724814, and x, y are exponents from the unit matrix. This equation provides a unified framework for unit conversion and calibration.

4 Matter–Energy Model Based on G_{var}

4.1 Primordial Energy Matrix (PEM)

The PEM is defined as an infinite, homogeneous distribution of force points (Quasi-Nothing Objects, QuNOs) in absolute empty space. Key properties:

(1) Force points are infinitely small, exerting attractive (gravity) and repulsive (sinusoidal force) forces;

(2) Zero crossings exist where attractive and repulsive forces balance, forming a stable matrix structure (Figure 6–7);

(3) Space and time emerge from the motion of force points, with time as a derived quantity (rhythm of motion) and space as the medium for force transmission.

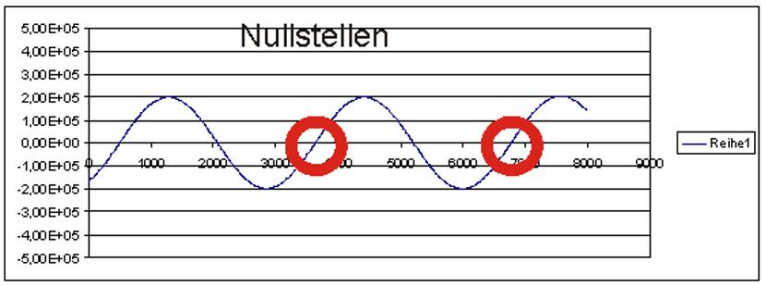

Figure 6 Zero crossings as resting positions for the force points

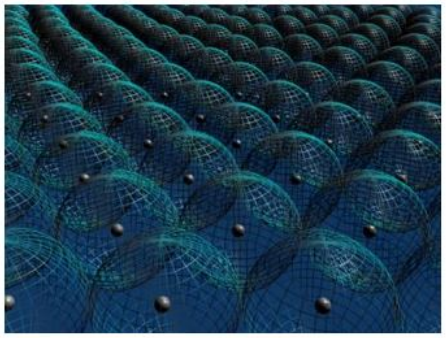

Figure 7 A “layer” of force points in the primordial energy matrix

4.2 Catastrophe Mechanism and Vortex Formation

A ”catastrophe” occurs when external forces push force points beyond the repulsive barrier. This leads to:

(1) Force points rotating stably in a self-generated ”primordial black hole” (Figure 8–9), with centrifugal force counteracting gravity;

(2) Rotating force point pairs behave as single units, cascading into larger rotational structures (Figure 8–9);

(3) Vortex formation (Figure 10) marks the transition from submatter to matter, with vortices exhibiting all fundamental forces:

A. Weak attraction → gravity;

B. Suction/expulsion of PEM elements → electromagnetic force;

C. Vortex spiral stability → strong nuclear force;

D. Inflow/outflow coupling stability → weak nuclear force.

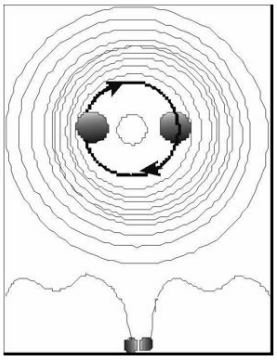

Figure 8 Two points rotate stably within the attraction funnel

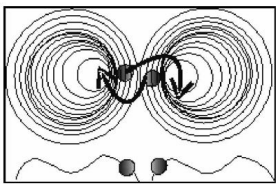

Figure 9 Two points begin to rotate

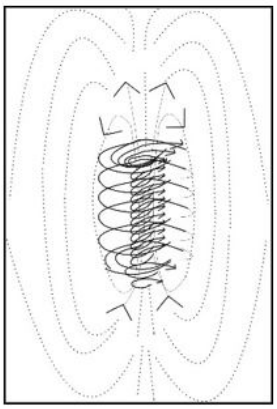

Figure 10 A vortex of matrix elements (schematic)

4.3 Elementary Particles and Atomic Structures

4.3.1 Particle Formation

(1) Four vortices form a ring: All same-direction vortices → dark matter (neutral, no electromagnetic field);

(2) One reversed vortex → neutron (three centers of mass, "quarks" as illusions; Figure 11–Figure 13);

(3) Two reversed vortices → proton (three centers of mass, emits/reabsorbs electron vortices; Figure 11–13);

(4) Electron: External vortex emitted by protons, with a magnetic field formed by short-circuited charge flow.

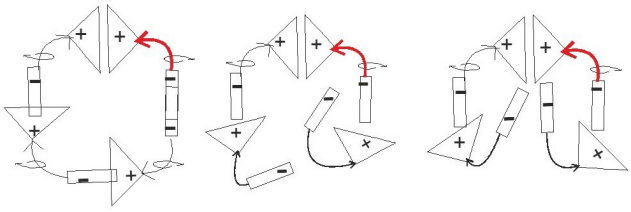

Figure 11 Reorganization of a "Quadruple Accident"

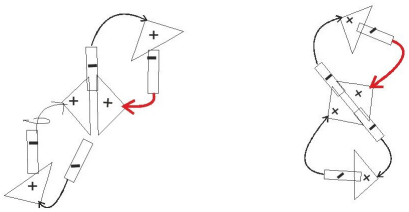

Figure 12 Formation of a Neutron

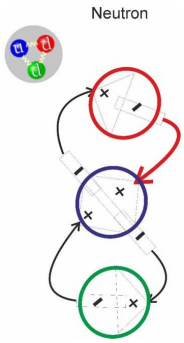

Figure 13 Neutron with Three Centers of Gravity

4.3.2 Atomic and Molecular Formation

(1) Atoms form via vortex exchange between protons and neutrons (Figure 14–24), with nuclear binding energy released as PEM energy;

(2) The periodic table is constructed based on shell/subshell filling of proton-neutron vortex structures (Figure 19–28);

(3) Molecules form via electron vortex coupling between atoms (e.g., methane, Figure 29), with chemical bonds mediated by electromagnetic forces.

4.4 Field Hierarchy

(1) 0th-order field: PEM (scalar field, gravity + repulsive force);

(2) 1st-order field: Vortex internal field (vector field, strong/weak nuclear force);

(3) 2nd-order field: Electromagnetic field (electron + magnetic field);

(4) 3rd-order field: Intermolecular force field (solid/liquid/gas states);

(5) 4th-order field: Social bond field (residual electromagnetic field, relevant for living matter).

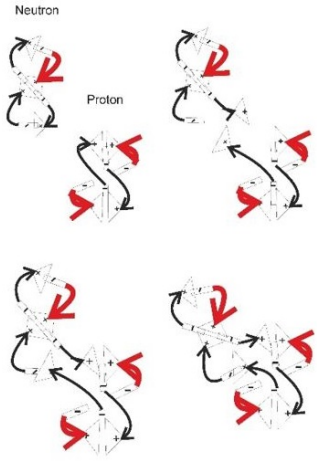

Figure 14 Formation of New Elements or Isotopes

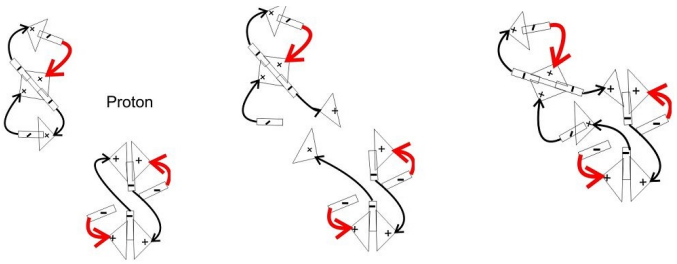

Figure 15 Formation of Deuterium (Hydrogen Isotope)

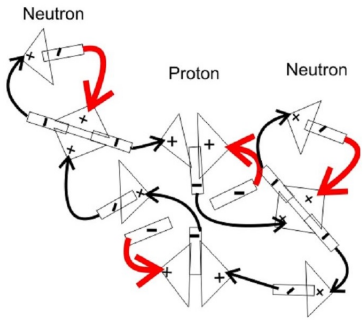

Figure 16 Tritium (Hydrogen Isotope)

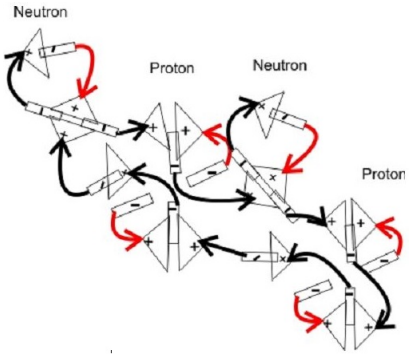

Figure 17 Helium Atom

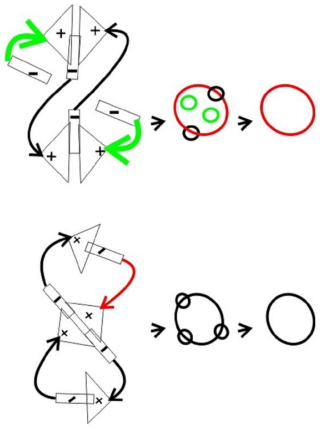

Figure 18 Simplified Particle Diagrams

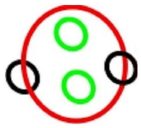

Figure 19 Hydrogen Atom

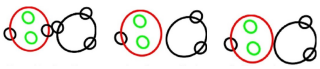

Figure 20 Deuterium Atom

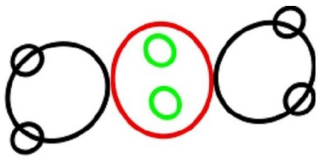

Figure 21 Tritium Atom

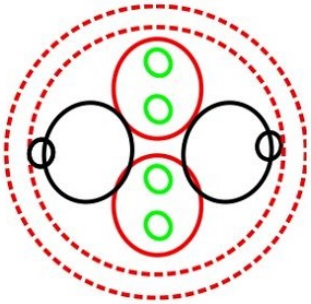

Figure 22 Helium Atom

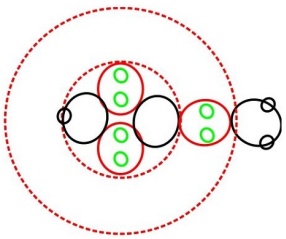

Figure 23 Lithium Atom

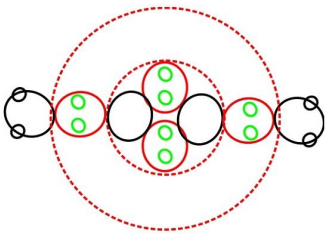

Figure 24 Beryllium Atom

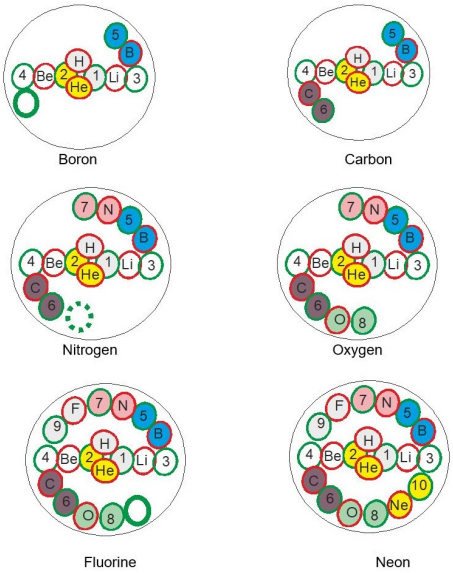

Figure 25 Filling the "2p" Subshell

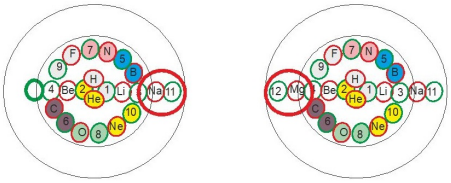

Figure 26 Sodium and Magnesium Atoms

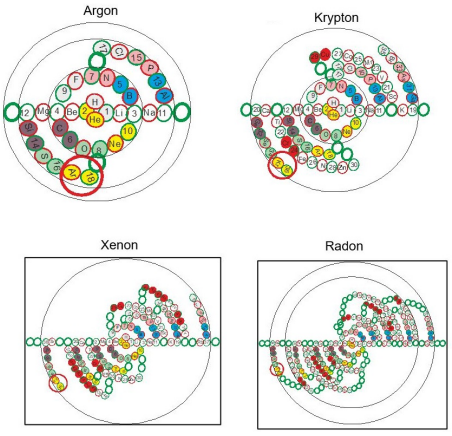

Figure 27 Noble Gases in Orbital Representation

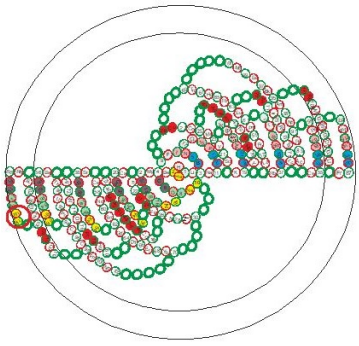

Figure 28 Oganesson Atom

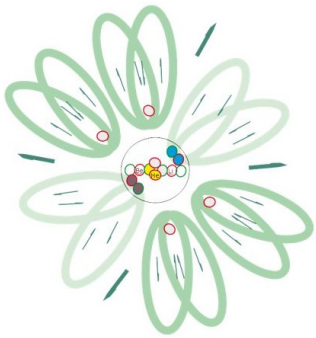

Figure 29 Formation of a Methane Molecule from a Carbon Atom and Four Hydrogen Atoms

5 Results and Discussion

5.1 Validation of G_{var}

G_{var} successfully explains multiple gravitational anomalies without relativistic corrections, achieving force unification at extreme small distances. The calibration via planetary perihelion shifts ensures its accuracy in the Solar System, while simulations of the Pioneer and flyby anomalies confirm its validity at interplanetary scales.

5.2 Innovation of the Matter–Energy Model

(1) Quarks are not independent particles but illusions of vortex center-of-mass intersections, resolving the confinement problem;

(2) Dark matter is identified as symmetric four-vortex rings, providing a new candidate for dark matter particles;

(3) The model unifies gravity with nuclear/electromagnetic forces, avoiding extra dimensions and simplifying relativistic calculations.

5.3 Limitations and Future Work

(1) G_{var} cannot fully explain dark matter, requiring further research on PEM dynamics;

(2) Experimental verification of K' and vortex structures is needed (e.g., high-precision proton radius measurements);

(3) The 4th-order field (social bonds) requires empirical validation in biological systems.

6 Conclusion

This study proposes a distance-dependent gravitational constant G_{var} and constructs a unified matter–energy model based on the Primordial Energy Matrix. Key conclusions are:

(1) $G_{var} = k_1/r^{1/k_2}$ explains gravitational anomalies and unifies fundamental forces;

(2) G_{var} modifies the physical unit system, deriving a universal equation and confirming $E = mc^2$;

(3) Matter originates from PEM force point vortices, with elementary particles, atoms, and molecules formed via cascading vortex interactions.

This framework resolves long-standing problems in gravity and particle physics, providing a new foundation for understanding the universe's fundamental structure. Future work will focus on experimental verification of G_{var} and PEM dynamics.

Conflicts of Interest

The author declares no conflict of interest.

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