

# Motion, Mass, Space and Time: An Emergent Vector Field Framework

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**Abstract:** The primary objective of this paper is to investigate the fundamental cause underlying the motion of a massive object. In other words, it seeks to elucidate the nature of momentum and how it originates. To achieve this, a comprehensive literature review on space, time, mass, and motion is presented, offering a novel perspective on these foundational concepts. The mathematical framework is constructed using the core principles and equations of classical mechanics and the special theory of relativity, drawing some direct and substantial indirect influences from continuum mechanics. To analyze physical phenomena within a four-dimensional space-time continuum, the Hodge decomposition theorem and tensor decomposition methods are employed. This paper derives a new set of governing equations for the state of motion of a massive object, providing an entirely new interpretation of its dynamics. Ultimately, this work establishes that mass-energy and momentum are manifested forms of the periodic change of a vector field defined to characterize the system's physics. Within this research paper, the Translational Gravitomagnetic Field Tensor is derived using an entirely novel method. Furthermore, the physical mechanism responsible for giving rise to space-time is explicitly detailed, thereby reinforcing the contemporary paradigm in physics that space-time is an emergent property rather than a fundamental entity of nature. Ultimately, the research paper appears to advocate for an absolute background throughout its entire exposition.

**Key Words:** Momentum conservation; Space-time; Classical field theory; Tensor calculus; Gravitomagnetic field tensor; Absolute background.

## 1. Introduction

### 1.1 Problem Statement

From a foundational perspective, classical mechanics originates with the study of the rectilinear motion of a massive object. Here, we approach the problem of motion from a deceptively simple question: why does an object possessing mass maintain a constant velocity in the absence of an external force? In contemporary physics, this phenomenon is explained by the principle of conservation of linear momentum. If one probes further into why momentum is conserved, Noether's theorem points to the homogeneity of space. However, the present framework challenges the sufficiency of this explanation. It is posited that further fundamental insights can be shed on this seemingly elementary phenomenon of inertial motion.

Concurrently, this paper addresses a deeper question: what constitutes mass? Tracing the conceptual evolution of mass from Galileo Galilei, we examine whether matter can ultimately be defined by treating leptons, quarks, or strings as irreducible fundamental entities, or whether an underlying mechanism—equivalent to the Higgs field—is fundamentally responsible for the manifestation of mass in material objects. Furthermore, since the dynamics of a massive object are formulated relative to temporal progression in space, space-time itself is scrutinized. We evaluate whether space-time serves as an absolute, fundamental background necessary for the occurrence of events, or if it emerges as a derived quantity from a deeper, more primary cause.

## **1.2 Background of the Subject**

At present, fundamental physics stands at a historic pinnacle of mathematical development. Classical mechanics, which began with Galileo's kinematics, now claims the potential to realize a unified field theory within the framework of string theory [1]. Under quantum field theory, three of the four fundamental forces of nature—the electromagnetic, weak, and strong nuclear forces—have been successfully quantized [2]. Notably, the electromagnetic and weak interactions have been unified into the electroweak framework [3, 4], a milestone rigorously validated by empirical tests [5]. The Higgs boson, a cornerstone of the Standard Model of particle physics, was experimentally confirmed in 2012 at the Large Hadron Collider [6]. Moving further, the Grand Unified Theory (GUT) offers a framework to unify the strong nuclear force with the electroweak force [7, 8], though experimental verification currently remains beyond our technological capabilities.

Similarly, various paradigms have been proposed for the quantization of gravity, even though their empirical validation remains inaccessible to current experimental setups. String theory provides a sophisticated mathematical framework for quantum gravity while simultaneously attempting the grand unification of all four fundamental forces. Developing continuously through the contributions of leading physicists and mathematicians since the 1970s, it stands as a high-level mathematical model for total unification [1]. Conversely, ‘Loop Quantum Gravity’ (LQG) focuses strictly on the non-perturbative quantization of the gravitational field itself [9], without making immediate claims toward unification. Experts in this domain suggest that just as the quantization of electromagnetism historically paved the way for electroweak unification, the formal quantization of geometry via LQG may similarly clear a path toward a complete unified

field theory [9]. Concurrently, in astrophysics, the ‘Standard Model of Cosmology’ ( $\Lambda$  CDM) has been robustly developed to explain the origin and macro-evolution of the universe [10], while ‘Quantum Cosmology’ emerges as a cutting-edge domain aiming to resolve the initial conditions and primordial causes behind the universe's birth [11] a success heavily contingent upon the ultimate quantization of gravity.

Since the inception of natural philosophy, defining the absolute nature of space and time has remained a persistent challenge. While Loop Quantum Gravity and M-theory currently represent the most sophisticated treatments of space-time architecture, this paper suggests that revisiting these foundations through the structural style of classical field theory can yield profound insights. By uncovering a novel, deeper relationship connecting mass and motion directly to space and time, the framework presented herein aims to contribute toward resolving outstanding critical crises in modern physics, including the dark matter dilemma, the problem of time, the existence of an absolute reference frame, the quantization of gravity, and the realization of a unified field theory.

### **1.3 Structure of the Paper**

The ‘Literature Review’ section provides a concise overview of the historical and contemporary theories propounded on space, time, mass, and motion, establishing the necessary contextual background for this work. Readers thoroughly familiar with these foundational debates may bypass this review and proceed directly to the core analysis. The primary body of this paper derives a new set of governing equations describing both the stationary and dynamic states of a massive object, organized into two main sections. Section A attempts to derive an equation for the relativistic increment of mass with velocity based on the novel conceptual framework introduced here. While the preliminary results in Section A indicate that the derivation moves in the correct conceptual direction, it falls short of fulfilling the primary objective. Consequently, Section B introduces additional fundamental concepts to comprehensively solve the governing equations and achieve the core thesis of the paper. The 'Results and Discussion' section highlights the physical implications of the conceived concepts and derived equations. Finally, the paper concludes by synthesizing the core findings and outlining potential avenues for future research on this basis.

## 2. Literature Review

### 2.1 Space and Time

Across various global civilizations, the concepts of space and time have historically been utilized to communicate natural philosophy and investigate the physical world. From the pre-Socratic Greek philosopher Parmenides (500 BC) to Mark Van Raamsdonk (2010 AD), a long lineage of philosophers and physicists has analyzed the philosophical and mathematical structures of space and time. Remarkably, several foundational formulations proposed by early thinkers remain conceptually relevant to contemporary discourse. Long before the Common Era, Parmenides posited that empty space cannot exist [12], implying that space is not merely a void and that there is no basis for saying that space exists where there is nothing. Furthermore, Parmenides viewed time—in the forms of past and future—as an illusion, arguing that reality exists strictly within the continuous present [13]. Conversely, Democritus conceptualized space as an absolute, infinite void through which massive objects move entirely without resistance [14]. Plato later attributed the properties of homogeneity and isotropy to space, characterizing it not as an infinite void, but as a finite, formless substratum devoid of intrinsic physical properties, serving as the essential matrix for physical phenomena. According to Plato, the variability of events constitutes the underlying basis of time [15].

Aligning with Parmenides, Aristotle maintained that a true vacuum or empty space is non-existent. Moving a step further, Aristotle defined space relationally with respect to physical objects, asserting that the independent existence of space separate from matter is impossible. For Aristotle, time was fundamentally a metric for measuring change [16], making him the first natural philosopher to define time meaningfully from a physical perspective. This relational view of space was later supported by Ibn Sina (Avicenna). Similarly, within the rich history of the Indian knowledge system, cultivated by ancient sages and scholars, space (*Akasha*) is not treated as a mere empty void; rather, it is understood to originate from a metaphysical, non-physical, ultimate reality (*Brahman*) [17]. Within this tradition, the Vedas and Upanishads conceptualize time (*Kala*) as an eternal, cosmic truth equivalent to *Brahman* itself [18].

In the early modern era, René Descartes posited that space possesses no independent physical existence but is instead determined strictly by the mutual spatial configurations of physical

bodies. The Cartesian philosophy similarly treated time as an empirical measure of change and motion [19]. This stood in stark contrast to Isaac Newton, who propounded the doctrine of absolute space, characterizing it as an immovable, infinite, and independent entity. Newton likewise formulated time as an absolute, universal continuum flowing uniformly throughout the cosmos, entirely unaffected by external objects or physical events [20]. Beyond this philosophical interpretation, Newton—inspired by the pioneering kinematics of Galileo Galilei—defined time mathematically to systematically formulate the laws of motion. Historically, Galileo was the first to provide a sufficient experimental and conceptual foundation for treating time as a formal mathematical variable in the study of physical phenomena [21]. Gottfried Wilhelm Leibniz strongly opposed the Newtonian framework of absolute space and time. Leibniz viewed space relationally as an order of co-existing things, and time as a physical quantity determined by the sequential succession of changing states and their mutual interactions. Consequently, he rejected the notion that space and time serve as an independent, pre-existing background for physical events [22]. Immanuel Kant later proposed that space and time are not objective realities but rather intrinsic, *a priori* forms of human intuition and consciousness, possessing no independent existence outside perception [23].

Echoing the relational tradition of Leibniz, Ernst Mach conceptualized space strictly as the web of relationships among physical bodies. He maintained that time lacks an independent, absolute existence, viewing it instead as a relative, empirical construct that can only be meaningfully conceptualized through the observation of changes within physical systems [24]. Conversely, Hendrik Antoon Lorentz defended the Newtonian framework of absolute space and time, though he sought to contextualize it within the classical tradition by replacing absolute space with a hypothetical, all-pervading physical medium known as the ‘ether’. Although Lorentz’s profound mathematical framework—the Lorentz transformations—ultimately laid the groundwork for dismantling absolute space and time, he maintained that relativistic variations were physical distortions caused by interaction with the ether, asserting that an absolute reference frame must exist in the universe [25]. From a philosophical standpoint, Henri Poincaré’s view of space shared commonalities with Kantian conventionalism, treating geometry as a convenient construct of the human mind designed to systematically explain natural phenomena. Poincaré rejected the notion of time as an absolute, universal, or eternal entity, framing both space and time relationally as reflections of the interconnectedness of physical phenomena [26]. While Poincaré

supported the concept of the ether like Lorentz, he did not ascribe an absolute status to it; his mathematical insights profoundly reinforced the philosophical foundations of relativism [27].

Under the Special Theory of Relativity, Albert Einstein completely rejected the necessity of the luminiferous ether—a concept that had remained mainstream since Descartes and had been revived by Maxwell’s electrodynamics. Einstein replaced the independent, absolute status of space and time with a unified, dynamic construct known as space-time. According to relativity, space and time are inextricably linked; they exist together as a singular continuum that both influences and is influenced by physical phenomena [28]. Hermann Minkowski mathematically formalised this insight; building upon the work of Lorentz, Poincaré, and Einstein, he replaced independent three-dimensional space and Newtonian time with a unified four-dimensional space-time manifold, establishing the definitive mathematical foundation for modern relativistic physics [29].

In the first quarter of the twentieth century, quantum mechanics emerged, initially utilizing the Minkowski space-time manifold as a fixed, passive geometric background. By the mid-twentieth century, however, the successful formulations of Quantum Field Theory (QFT) demonstrated that this geometric background is not a quiescent physical structure, but is instead continuously permeated by infinitesimal vacuum fluctuations occurring within the respective underlying fields of fundamental particles [30]. In the subsequent decades, intense efforts were directed toward quantizing the gravitational force and unifying the four fundamental forces of nature. As a consequence, the spatial separation between massive objects came to be understood through the vibrations of space-time itself, which represent the gravitational field; in other words, the gravitational field and space-time were recognized as the same entity [31]. Within the paradigm of Loop Quantum Gravity (LQG), physicists such as Carlo Rovelli and Abhay Ashtekar argued that the space-time manifold is not continuous, but is instead composed of discrete, fundamental quanta of space-time [32]. Thus, in LQG, space-time is fundamentally a quantized physical quantity. Conversely, in the early frameworks of string theory, such as Bosonic String Theory, space-time initially retained the same smooth, geometric background profile utilized in conventional quantum field theories [31]. However, according to contemporary developments in advanced string theory, space-time is no longer viewed as a primary, fundamental physical

entity, but rather as an emergent property arising from deeper, non-geometric degrees of freedom [32, 33].

In the historical evolution of cosmology, empirical observations and experiments designed to test models of cosmic origins have robustly established that the universe began from a state of extremely high energy density and curvature, a phenomenon known as the Big Bang [34]. Space-time itself came into existence at this primordial singularity. Among all theories of space and time proposed over the last two and a half millennia, the General Theory of Relativity stands as the most outstanding milestone [35]. While established branches of quantum field theory treat space-time as a static, passive background—thereby leaving its deepest mysteries unresolved—advanced frontiers like Loop Quantum Gravity and string theory offer unprecedented insights into its microstructure, even though they currently remain beyond the limits of direct empirical verification.

Collectively, modern relativity has proven that space and time cannot be conceptualized independently of one another; they function as a single, integrated four-dimensional component. Space-time actively participates in the physics of the universe, acting upon matter and being acted upon in return. Space is not a vacant background for occurrences, nor is time merely a mathematical construct established to catalog change. Space is not an independent substance endowed with classical physical properties, nor is time an omnipresent entity flowing uniformly across the cosmos. Ultimately, space and time cannot be treated as eternal, irreducible building blocks of the universe; rather, contemporary physics dictates that they are emergent quantities derived from a more fundamental, underlying component of nature.

## **2.2 Mass and Motion**

What constitutes the underlying cause behind mass, the inherent property of matter? A systematic evaluation of this concept naturally begins with Galileo Galilei, whose pioneering experiments established the foundational concept of inertia [36]. Building upon this, Isaac Newton defined mass by the quantity of matter, framing it as the intrinsic physical property responsible for a body's resistance to any change in its state of rest or uniform motion. In Newtonian mechanics, mass serves strictly as a quantitative measure of an object's inertia [37]. Albert Einstein fundamentally transformed this paradigm by demonstrating that mass is a

manifested form of energy, establishing their mutual convertibility through the mass-energy equivalence principle [38]. Furthermore, special relativity showed that a body's relativistic mass increases as a function of velocity [28]. Based on this relativistic framework, mass must be understood as the measure of an object's inertia across both its stationary and dynamic states. In contemporary particle physics and advanced quantum mechanics, mass is treated as a secondary property of fundamental particles, arising directly from the dynamical interaction of these particles with the vacuum expectation value of the Higgs field [39].

The formal inception of physics as a structured discipline (classical mechanics) originated precisely with the study of the motion of a massive object. Ever since humanity began studying nature, the methodology for understanding the mass and motion of an object has progressively evolved in the following manner. René Descartes deserves primary historical credit for establishing the prerequisite mathematical framework necessary to define the motion of a massive object. Although he did not contribute directly to the underlying dynamics, his algebraic innovations provided succeeding physicists with the tools required to represent physical variables and constants within formal mathematical equations. His second major indirect contribution was the formulation of the Cartesian coordinate system, which provided the first systematic geometric representation of flat space [40]. Following Descartes, Galileo Galilei provided the first direct, systematic experimental study of the motion of massive objects in the history of physics. He laid the foundational groundwork for the equations of motion and the principle of non-relativistic relativity, which were subsequently codified into a rigorous mathematical architecture by Isaac Newton. It was precisely through the framework of the Cartesian coordinate system that Galileo's empirical observations of rectilinear motion under uniform acceleration were mapped into formal equations.

The true realization of dynamics governing the motion of massive objects occurred through the monumental work of Isaac Newton. Synthesizing the foundational insights of Descartes and Galileo, Newton constructed the bedrock of classical dynamics. Utilizing the Cartesian coordinate system, he expanded the treatment of rectilinear motion by defining time formally as an independent coordinate within this geometric system. By embedding his concepts of absolute space and uniformly flowing absolute time into this coordinate framework, Newton established an enduring tradition of expressing the motion of massive objects through differential equations.

His discovery of differential calculus revolutionized the field of mechanics, and his Second Law of Motion remains the definitive centerpiece of classical dynamics.

Later, Joseph-Louis Lagrange and William Rowan Hamilton extensively generalized and advanced Newton's formulation. While the Newtonian vector-based methodology encounters significant mathematical complexities when analyzing highly constrained or intricate physical systems, the analytical techniques of Lagrangian and Hamiltonian mechanics resolve these systems with elegant scalar formulations [41, 42, 43]. In modern physics frameworks where Newtonian laws cease to directly apply, Lagrangian and Hamiltonian formalisms provide the indispensable mathematical pathway to unraveling systemic complexities. Nevertheless, in the specific case of a massive object undergoing rectilinear motion in free space, the physical conclusions derived from Lagrangian and Hamiltonian techniques map identically to those of Newtonian mechanics.

In the twentieth century, revolutionary shifts occurred in the conceptualization of mass and the field of mechanics, credited to the monumental contributions of Hendrik Antoon Lorentz, Henri Poincaré, Hermann Minkowski, and Albert Einstein. Together, they formulated and fully established the Special Theory of Relativity. Phenomena such as the relativistic increment of mass with velocity and the mass-energy equivalence equation brought about a paradigm shift away from the foundational assumptions of Newtonian mechanics. In the domain of particle kinematics, Henri Poincaré formalized these relativistic coordinates under the Poincaré transformation group, which remains the most comprehensive mathematical framework for characterizing particle motion in modern relativistic physics [44].

Another profound revolution regarding the motion of massive objects emerged during the first half of the twentieth century via the doctrine of wave-particle duality, which catalyzed the birth of quantum mechanics. According to this paradigm, moving bodies exhibit intrinsic wave-like characteristics. The concept of duality was first introduced by Albert Einstein to explain the photoelectric effect, which linked the particle-like behavior of photons to electromagnetic waves [45]. Louis de Broglie subsequently generalized this concept, demonstrating its universal applicability to massive particles [46]. By integrating de Broglie's generalized wave-particle duality with Einstein's relativistic frameworks, Erwin Schrödinger, Oskar Klein, and Walter Gordon formulated the definitive equations of motion for quantum particles, known as the

relativistic and non-relativistic energy-wave equations [47, 48, 49]. This marked a historic epoch in physics, wherein research converged toward a singular conceptual framework to unify the treatment of the motion and existence of both particles and waves, establishing modern quantum mechanics.

According to quantum mechanics and its advanced extensions, a moving massive particle behaves as a localized wave packet. Consequently, just as a classical wave packet propagates through a physical medium, a moving massive object must similarly propagate through an underlying physical background. String theory extends this quantum field paradigm by replacing zero-dimensional point particles with one-dimensional vibrating strings, and in its higher-dimensional extensions—such as D-brane physics—with multidimensional extended objects known as branes. Here, physical phenomena are explained via the vibrational modes of strings and branes executing motion within spaces of higher dimensionality ( $D > 4$ , comprising 3 spatial dimensions, 1 temporal dimension, and extra compactified spatial dimensions). For example, in Bosonic String Theory, the fundamental unit of matter is a string whose vibrational excitations in a 26-dimensional spacetime (25 spatial dimensions and 1 temporal dimension) characterize the effective motion and properties of a particle [51].

Finally, Loop Quantum Gravity grounds its mechanics directly upon the dynamic space-time concept of General Relativity. Unlike other branches of physics, LQG features no fixed, static background or steady external flow of time to parameterize motion. Instead, time itself is a dynamical variable intimately coupled to and affected by physical events. According to loop quantum gravity, the local space-time fabric associated with any physical occurrence is composed of discrete, fundamental granules or nodes. Within this framework, motion is rigorously explained as the sequential transformation and evolution of the microscopic quantum geometry of space-time, mathematically modeled through physical constructs such as spin networks and spin foams [52].

### **3. Main part**

#### **3.1 Section A**

The literature review conducted on space, time, mass, and motion is merely a scientific wordplay done so far. This does not prove the actual purpose of the research paper. Lacking the necessary

mathematical analysis, it is nothing more than mere intellectual nourishment. So, let's begin the mathematical analysis. But where do we begin? Instead of starting with the phenomenon responsible for the beginning of the universe, it would be more convenient to begin with a physical phenomenon occurring around us. In its early stages, the universe was an extremely high-energy system, and the state of the universe we live in is a low-energy system. We can attempt to move from a low-energy physical phenomenon around us, such as the 'rectilinear motion of an ordinary massive object' to extremely high-energy state (the beginning of the universe). Physics has evolved in this way over its nearly two and a half thousand years of development, leading to the era of modern physics.

To simplify the necessary mathematical analysis, a hypothetical operational absolute reference frame may be temporarily defined and established to investigate the kinematic state of a massive body. Let us assume this reference system is situated at a symmetrical cosmic location within the universe. In accordance with large-scale observations, the universe as a whole possesses no baseline for collective translational or rotational motion; rather, it undergoes continuous cosmic expansion, where galaxy clusters and super-clusters recede from one another [53]. This persistent cosmological expansion inherently reduces the mean energy density of the universe over time, which dynamically influences the geometric and physical properties of the underlying background coordinates. However, by treating these large-scale cosmological variations as negligible over localized intervals or specific boundary conditions, this coordinate system can be operatively utilized as a stable, absolute background framework for structural derivations.

Suppose an object of mass  $m$  is moving with a velocity  $v_i$  relative to a system of absolute inertial frame. The question is why the object continues to move forward in a fixed direction with a constant magnitude of speed unless an external force is applied. According to classical mechanics, since the external force is zero, resulting in conservation of momentum, the velocity of the object remains constant.

$$F_i = \frac{dP_i}{dt} = 0 \Rightarrow P_i = C_i, \quad P_i = mv_i \Rightarrow v_i = \frac{C_i}{m}$$

Here we rephrase the question and ask, why is the momentum of a moving massive object conserved? Classical mechanics' answer to this is that the background (space) in which the object is moving is homogeneous, so momentum is conserved due to this property of space. In the

special theory of relativity, momentum and energy conservation are discussed simultaneously; the homogeneity of space-time is the main reason for momentum-energy conservation. In quantum mechanics, the symmetry of space is also responsible for momentum conservation. In relativistic quantum mechanics and quantum field theory, the momentum conservation of particles is explained using the Poincaré transformation. In string theory, the same mathematical technique, known in a modified form as ‘Emmy Noether's theorem’, is used to explain the momentum conservation of particles [54]. In both classical mechanics and modern physics, the homogeneity of space is considered responsible for the conservation of momentum. Although the answer to the question is correct from the perspective of classical mechanics and modern physics, the research paper is not satisfied with this answer. The question is rephrased to ask, in the above situation, what physical interaction occurs between the massive object and its background (the medium in which the object moves) that causes the object to continue moving in the same direction with the same speed.

Various branches of modern physics, such as quantum field theory, string theory, and loop quantum gravity, provide insights into the physical interaction between material object and background [55, 56, 57]. This paper attempts to explain the state of motion of a massive body by considering some kind of interaction between body and background, which is responsible for the conservation of momentum. Assume that the center of mass of a massive object is located at origin of the absolute reference frame. If an external force is applied to change the object's position over time, the object opposes this. Why does an object oppose the change in its position? According to classical mechanics, because of the inertia and the combined conclusions of several branches of modern physics, a massive object exhibits inertia due to its interaction with background, which has a specific field or quantum structure. The research paper advances the mathematical analysis by considering the interaction between body and background as the cause of the steady state inertia of the massive object.

According to the special theory of relativity, mass is a form of energy. Given that a body is at rest relative to the absolute reference frame, the rest-mass-energy inherent to the object represents the object's potential energy relative to the rest of the universe. The basic physical interpretation behind this concept is not presented here; an attempt is made to explain it in the next section of this paper.

According to the special theory of relativity the mass-energy equivalence equation

$$E^2 = P_i^2 c^2 + m^2 c^4$$

In the above equation, the symbol  $m$  is used instead of the conventional symbol  $m_0$  for rest mass. The reason for this will become clear later in the research paper.

In state of rest  $P_i = 0$ , hence from the above equation

$$E^2 = m^2 c^4, \quad E = \pm mc^2$$

According to the research paper, the potential energy of a mass containing body relative to the entire universe

$$U = \pm mc^2 \tag{1}$$

Since we assume that an object interacts with the background or, in other words, object interacts with the entire universe through some unknown, undefined physical interaction, when an external force is applied to change its position, the object opposes it. The phenomenon of change in position relative to an absolute reference frame due to an applied external force can be represented by the following equation of classical mechanics.

$$F_i = - \frac{\partial U}{\partial x_i} \tag{2}$$

If the massive object acquires momentum due to a change in position, then according to Newton's second law of motion

$$F_i = \frac{dP_i}{dt} \tag{3}$$

From equations (2) and (3)

$$\frac{dP_i}{dt} = - \frac{\partial U}{\partial x_i} \tag{4}$$

When the classical momentum  $P_i$  and the potential energy  $U$  defined in the paper are substituted into the above equation, we obtain

$$\begin{aligned}\frac{d(mv_i)}{dt} &= -\frac{\partial(\pm mc^2)}{\partial x_i} \\ \frac{d(mv_i)}{dt} &= \mp \frac{\partial(mc^2)}{\partial x_i}\end{aligned}\tag{5}$$

According to the Special Theory of Relativity, mass is a function of velocity; however, according to this research paper, the mass of a body is a periodic function of the coordinates—position and time—of the corresponding reference system. Writing the above equation in one-dimensional space, gives

$$\frac{d(mv_1)}{dt} = \mp \frac{d(mc^2)}{dx_1}\tag{6}$$

Before solving the above equation, let us reiterate the central question: how does an object continue moving at a constant speed in the same direction after a force is applied, even though it is surrounded by an infinite background that may have physical properties? This infinite background suggests that bringing the object from rest into motion should generate resistance, which would oppose its continued uniform motion. While contemporary physics explains this using the conservation of momentum and the homogeneity of space, the question persists: how does an object maintain a constant velocity after a single application of force within an infinite background that possesses physical attributes?

On the basis of equation (6), certain conditions are required to the object to remain in a continuous state of motion. An underlying action-reaction mechanism must govern the state of uniform motion. For the occurrence of action-reaction a background as a base is required at every possible point during the course of motion. The state of motion is possible only when the mass  $m$  of massive object is a periodic function of the coordinates, position  $x_1$  and time  $t$  of the related reference frame. Equation (6) is solved based on these concepts. According to the principle of action-reaction, equation (6) should be written with a negative value of momentum even for an infinitely extended background. It will be discussed latter in the paper. Now writing the equation for an object with a positive value of momentum gives

$$\begin{aligned}m \frac{dv_1}{dt} + v_1 \frac{dm}{dt} &= \mp c^2 \frac{dm}{dx_1} \\ m \frac{dv_1}{dt} + v_1 \frac{dm}{dt} \frac{dx_1}{dx_1} &= \mp c^2 \frac{dm}{dx_1}\end{aligned}$$

$$m \frac{dv_1}{dt} + v_1^2 \frac{dm}{dx_1} = \mp c^2 \frac{dm}{dx_1}$$

The solution of the above equation gives the following two equations for the limits of  $v_1$  (from 0 to  $v_1$ ) and the limits of  $m$  (from  $m_0$  to  $m$ ). *The decision to use  $m$  instead of  $m_0$  in the former was taken to avoid inconvenience related to symbols during integration.*

In case of  $U = -mc^2$

$$m = \frac{m_0}{\sqrt{\left(1 - \frac{v_1^2}{c^2}\right)}} \quad (7)$$

In case of  $U = +mc^2$

$$m = \frac{m_0}{\sqrt{\left(1 + \frac{v_1^2}{c^2}\right)}} \quad (8)$$

Taking the negative potential energy of the massive object, the solution to equation (6) is equation (7), which is equivalent to the transverse component of the mass increment with velocity. Taking the positive potential energy of the object, the solution is equation (8), which violates the principle of special theory of relativity. Solving equation (6) for the negative value of equation (1) in three-dimensional space gives the following equation in place of equation (7).

$$m = \frac{m_0}{\sqrt{\left(1 - \frac{v_i^2}{3c^2}\right)}} \quad (9)$$

According to the above equation, the maximum velocity  $\sqrt{3}c$  a massive object can attain is a violation of the special theory of relativity. I believe that if we consider the mass-energy of a body as a second-order tensor (dyad) instead of a zero-order tensor (scalar), the above discrepancy can be resolved. Another point worth considering about the equation (7) is that this equation is equivalent to the transverse component of the mass increment with velocity equation. According to the situation depicted in relation to the body's motion, the solution of equation (6) should have yielded the longitudinal component of the equation for the mass increment with

velocity, which does not happen. Both components can be obtained by solving equation (6), but for this, it is necessary to solve equation (4) by redefining the mass-energy equivalence relation.

### **3.2 Section B**

The solution to equation (4) that the present paper seeks to achieve its objective is not equation (7). The derivation of equation (7) merely indicates that we may be applying Newton's second and third laws of motion in right direction. To solve equation (4) in the way we want, we first need to understand the relationship between the mass-energy of a massive object at state of rest and in state of motion, with the coordinates (position and time) of the absolute reference frame. The previous section explored this relationship and attempted to derive the equation for the mass increment with velocity. This section analyzes it in detail and redefines it in a more sophisticated mathematical way. The main subject of the paper is the motion of an ordinary massive object, such as a piece of stone or a meteorite.

Under the derivation process of equation (7) in Section A, according to the law of action and reaction, the motion of an object requires a background that can push the object in the intended direction while itself moving in the opposite direction. Whether an infinitely extended background can translate in the opposite direction in this manner is doubtful; therefore, for the massive object to be able to translate in the intended direction, two reasons are necessary. The first is that for the force required to bring the body from a state of rest to a state of motion, a base capable of exerting force is needed, which can be matter or radiation. The second is the generation of a deformation within the infinite background due to the motion of the object.

The universe came into existence from the primary event Big Bang. Suppose Big Bang is an extremely high energy level of unstable oscillation in specific primordial field, which is progressing itself in a particular orderly manner, transforming into the space, time, waves, fundamental particles of matter, etc., due to its own properties. The question of how and for what reasons this primary field transforms other components of the universe is the subject of the Unified Field Theory. In this research paper, we are seeking answers to some other common questions around a main question, what is the fundamental cause behind the uniform motion of a massive body? as mentioned at the beginning of the paper.

What is matter? Where does it get its mass? What is the fundamental reason behind inertia? Is it composed of leptons, quarks, and their binding field particles: photons,  $W^\pm$ ,  $Z$  bosons, and gluons? According to different branches of quantum mechanics, it is supposed that matter is an oscillation, or a set of oscillations, of ‘all possible related fields’. Overall, an ordinary massive object is a unified oscillation of all these associated fields. This unified oscillation, as an ordinary massive object is a complex physical phenomenon, which can be visualized as a simplified model as follows.

Suppose a massive object of mass  $m$  is spherical. According to the research paper, the energy contained within the body due to its rest-mass is called ‘the potential energy of body relative to the entire universe’. This energy connects the body to the material objects present in the entire universe. You can also understand this as a ball placed in a chamber, tied to the walls of the chamber in all possible directions by countless threads. Here, instead of the ball, we can imagine spherically symmetric radial oscillation, instead of the walls, material objects distributed throughout the infinite universe, and instead of threads, we can imagine the progressive or stationary waves. Perhaps, this relationship of the massive body to the material objects, present in the entire universe is responsible behind the origin of the inertia of rest. Here we proceed with an assumption that the resultant integrated oscillation of the oscillations of the constituent fundamental particles of the object, is oscillating in isotropic spherical manner.

I would like to reiterate that the representation of a massive object into a spherically symmetric radial oscillation is a mathematical artifact. It is a simplification of the actual phenomenon (massive object), which is definitely a complex physical structure. It is important to clarify one more point here: the spherically symmetric radial oscillation conceived as a representative of a massive object is not a mechanical oscillation. It can be understood as the oscillation of a specific field related to the mass of the object. The spherically symmetric radial oscillation represents a massive object. Finally, according to the research paper, the object interacts to the rest of the universe through its rest-mass-energy.

We have just defined the absolute state of rest of an object as a spherically symmetric radial oscillation, but the absolute state of motion of an object needs to be incorporated into the framework of this research paper. When an external force is applied to bring an object from rest to motion, the work done on the object due to the force and the associated displacement is

converted into kinetic energy. According to the special theory of relativity, this energy is responsible for the increase in mass due to motion. On this basis, it is understood that the isotropic spherical oscillation representing rest-mass-energy, under the influence of an external force represents the total energy as an asymmetric spherical oscillation. Where, in the state of rest of an object, mass-energy behaves like a zero-order tensor (scalar), in the state of motion, it must have a second-order tensor (dyad). The physical information related to the asymmetry of the spherical oscillations produced in the direction of the external force due to the state of motion can be mathematically written through a second order tensor.

Here, ‘the external force  $F_i$  applied to the object,’ ‘the potential energy  $U$  of the body with respect to the rest of the universe’ and momentum  $P_i$  of equation (4) from the previous section are redefined. Based on the analysis of the object’s motion in the previous section, the concept is strengthened that the mass of the object and the background in which the object moves do not exist independently of each other. Both are two separate parts of the same phenomenon occurring with the same entity. This is very much equivalent to the phenomenon in continuum mechanics in which, when a spherical part of an infinitely extended elastic medium oscillates, the associated progressive or stationary waves are transmitted to the rest of the medium. The spherically symmetric radial oscillation represents the massive object in rest. Based on this, the physical conditions related to the object's state of motion are analyzed using a very simple mathematical method related to the continuum mechanics.

According to the research paper, the object is connected to the rest of the universe. According to the laws of general physics, in the case of spherically symmetric radial oscillations, the following relationship exists between pressure  $P$ , surface area  $A$ , and force  $F_0$  at a distance  $r$  from the center of the object which is supposed as spherically shaped.

$$\begin{aligned}
 \frac{F_0}{A} &= P \\
 \frac{dF_0}{dA} &= P \\
 dF_0 &= PdA
 \end{aligned}
 \tag{10}$$

Suppose an external force  $F_i$  is applied to bring the object from rest to motion. The external force  $F_i$  applied to bring the object into motion will break the symmetry of the isotropic spherical oscillation and make it asymmetric. Therefore, equation (10) is written as follows.

$$\begin{aligned} dF_0 + dF_i &= \sigma_{ij}n_j dA \\ d(F_0 + F_i) &= \sigma_{ij}n_j dA \end{aligned}$$

Here,  $\sigma_{ij}$  represents the stress tensor. Before proceeding further, it is necessary to consider  $F_0 + F_i$ . In the above equation, we can replace  $F_0 + F_i$  with  $\mathcal{F}_i$ .  $F_0$  is responsible for the existence of rest-mass of the object. According to the special theory of relativity, the mass increases due to the motion. It is clear that the external force  $F_i$  is responsible for the increase in mass with the state of motion. The total force  $\mathcal{F}_i = F_0 + F_i$  must be responsible for the total mass of the object during the motion. Therefore, by substituting  $\mathcal{F}_i = F_0 + F_i$  in the above equation and integrating both sides of the equation,

$$\mathcal{F}_i = \int \sigma_{ij}n_j dA$$

According to Gauss's divergence theorem

$$\mathcal{F}_i = \int \frac{\partial \sigma_{ij}}{\partial x_j} dV \quad (11)$$

As was suggested at the end of Section A, it is likely that the mass-energy of the body should be of the second order tensor. However, a physical situation does not arise in which the mass-energy defined in equation (04) can be directly replaced by the second order tensor. Although the physical conditions for directly replacing the mass-energy defined in Equation (4) with a second-order tensor do not exist. The system allows the sum of ‘the force responsible for the existence of the object in rest’ and ‘the external force applied to set the object in motion’ to be written together in terms of the second-order stress tensor, as shown in Equation (11).

From Newton's second law of motion

$$\mathcal{F}_i = \frac{d\mathcal{P}_i}{dt} = \frac{d}{dt} \int p_i dV = \int \frac{dp_i}{dt} dV \quad (12)$$

where,  $\mathcal{P}_i = \int p_i dV$ . If  $\mathcal{F}_i = \int f_i dV$ , then from both the above equations (11) and (12)

$$\frac{dp_i}{dt} = \frac{\partial \sigma_{ij}}{\partial x_j} \quad (13)$$

Here,  $p_i$  is momentum density and  $f_i$  force density.

I would like to draw an attention toward a particular point: here, the force  $F_i$  and momentum  $P_i$  described in Section A are different from force  $\mathcal{F}_i$  and momentum  $\mathcal{P}_i$  those described in Section B. In Section A, they are responsible only for the motion of the massive object, but in Section B, they are responsible for both the motion of the object as well as its existence in rest, and this is why the symbols used for them are different in both the sections.

According to the research paper, any massive object, whether at rest or in motion, is an oscillation of a specific field. According to the special theory of relativity, these oscillations should, in their original form, be devoid of rest-mass.

The following relationship exists between the pressure generated by electromagnetic radiation and the momentum density and velocity of the radiation.

$$P = p_i \cdot c_i$$

According to the research paper, the above equation written for electromagnetic radiation can be applied to spherically symmetric radial oscillations conceived massive object in rest. The above equation for the state of motion of a massive object can be written in terms of the stress tensor as follows.

$$\sigma_{ij} = p_i \otimes c_j \quad (14)$$

Here, outer product is taken between momentum density  $p_i$  and the velocity of light  $c_j$ . Inner product with  $c_j$  on both sides of the above equation gives

$$\begin{aligned} \sigma_{ij} \cdot c_j &= p_i \otimes c_j \cdot c_j \\ \sigma_{ij} \cdot c_j &= p_i c^2 \\ \frac{\sigma_{ij} \cdot c_j}{c^2} &= p_i \\ p_i &= \frac{\sigma_{ij}}{c} \cdot \frac{c_j}{c} \\ p_i &= \frac{\sigma_{ij}}{c} \cdot \hat{c}_j \end{aligned} \quad (15)$$

On substituting the momentum density  $p_i$  from the above equation in equation (13) we get

$$\begin{aligned}\frac{\partial}{\partial t} \left( \frac{\sigma_{ij}}{c} \cdot \hat{c}_j \right) &= \frac{\partial \sigma_{ij}}{\partial x_j} \\ \frac{\partial(\sigma_{ij} \cdot \hat{c}_j)}{\partial(ct)} &= \frac{\partial \sigma_{ij}}{\partial x_j}\end{aligned}\tag{16}$$

Before proceeding further, it is necessary to interpret the term on the left side of the above equation. Let us write the relevant term in the following possible mathematical ways to help in its analysis.

$$\begin{aligned}\frac{\partial(\sigma_{ij} \cdot \hat{c}_j)}{\partial(ct)} &= \frac{\partial}{\partial(ct)} \left( \frac{\sigma_{ij} \cdot \mathbf{c}_j}{c} \right) = \frac{\partial}{\partial(ct)} \left( \frac{\sigma_{ij} \cdot \mathbf{c}_j t}{ct} \right) = \frac{\partial \sigma_{ij}}{\partial x_0} \left( \frac{\sigma_{ij} \cdot \mathbf{x}_0}{x_0} \right) = \frac{\partial(\sigma_{ij} \cdot \hat{x}_0)}{\partial x_0} = \frac{\partial \sigma}{\partial x_0} \hat{x}_i \otimes \hat{x}_j \cdot \hat{x}_0 \\ &= \frac{\partial \sigma}{\partial(ct)} \hat{x}_i \otimes \hat{x}_j \cdot \hat{c}_j = \frac{\partial \sigma}{\partial(ct)} \hat{x}_i \otimes \hat{x}_j \cdot \left( \frac{c_j}{c} \right) \hat{x}_j = \frac{\partial \sigma}{\partial(ct)} \left( \frac{c_j}{c} \right) \hat{x}_i\end{aligned}\tag{17}$$

Where,  $\mathbf{c}_j t = \mathbf{x}_0$ ,  $ct = x_0$ ,  $\|\sigma_{ij}\| = \sigma$ ,  $\mathbf{c}_j$  is vector and  $c_j$  the corresponding scalar component. The magnitude of  $\mathbf{c}_j$  is equal to the magnitude of the velocity of light, but as it is clear from the discussion in the research paper, this quantity is not the velocity of light; it is the velocity of waves generated due to spherical oscillations. Based on the system in question, it is clear that these waves do not travel in only one direction. If the object is in rest, then they travel in all possible directions from the center of the object. In the case where object is in motion, the waves created due to the work done on the object for its motion travel in all possible directions from the center of the object in the half-space opposite to the direction of motion.

If we assume that the right-hand side of Equation (16) represents the cause of the action, then the left-hand side represents the reaction. Both occupy three-dimensional space in opposite directions. The direction of  $\hat{x}_0$  is actually the direction of  $c$ , here time  $t$  is a variable established by thinkers like Galileo and Newton, whose magnitude depends on the distance traveled by the waves. According to the above analysis, the direction of  $c$  comes into existence only by occupying three-dimensional space. Therefore, from the window of human brain, time as a dimension is not as real as space. The human mind perceives three-dimensional space as real, while time is a mathematical construct used to understand changes in physical phenomena. The primary reason for establishing time in the early stages of human civilization may have been the need to define changes, as can be understood from a literature review. In the early stages of the

development of physics, time was considered immutable. The theory of relativity revealed the secret that time is dynamic, meaning that time is affected by events. The current paper seeks to take a step further and address the underlying reason behind the origin of time. The primary reason behind the mathematical construction of time must be the reaction endowed into the inherent occurrence of action-reaction behind the phenomenon. In the above discussion, the fourth dimension, ‘time’, created by reaction, appears to be affected by the phenomenon in question. The human mind perceives time as not as real as three-dimensional space. However, if we attempt to look beyond the senses of human brain at the phenomenon of the rest and motion of massive object, as discussed in the current paper, then three-dimensional space must also not be real. This can be understood as follows.

From equations (16) and (17)

$$\frac{\partial \sigma}{\partial x_0} \hat{x}_i \otimes \hat{x}_j \cdot \hat{x}_0 = \frac{\partial \sigma}{\partial x_j} \hat{x}_i \otimes \hat{x}_j \cdot \hat{x}_j \quad (18)$$

Solving an equation like equation (18) in three-dimensional space by substituting any term from the equation (17) into equation (16) does not provide an expected way to study the system in question. Establishing time as the fourth dimension is a successful method for studying physical phenomena in four-dimensional space-time. Therefore, equation (18) is written in the following way to take this approach.

$$\frac{\partial \sigma}{\partial x_0} \hat{x}_i \otimes \hat{x}_j \cdot \hat{x}_0 = f_0 \quad (19)$$

$$\frac{\partial \sigma}{\partial x_j} \hat{x}_i \otimes \hat{x}_j \cdot \hat{x}_j = f_i \quad (20)$$

Therefore

$$\begin{aligned} f_0 - f_i &= f_\mu \\ f_\mu &= 0 \end{aligned} \quad (21)$$

Here, the component of three-dimensional space is represented by the action-force  $f_i$ , and the component of the fourth dimension, time, is represented by the reaction-force  $f_0$ . Since the fundamental phenomenon behind any physical existence is action-reaction, equation (21) must be the fundamental equation. Space and time are not required for action and reaction to occur;

the human brain needs space and time to understand action and reaction. If human civilization had first known equation (21) and had the mathematical techniques to decompose equation (21) into terms of physical quantities understandable to the human brain, such as space (position), time, mass, energy, momentum, etc., human civilization would have progressed in the following manner.

If we look at the above equation, then the covariant force vector  $f_\mu$  in four-dimensional space-time is there, which, when decomposed using the Hodge decomposition theorem gives

$$f_\mu = -\nabla_\mu \phi + \nabla^\nu B_{\nu\mu} = 0 \quad (22)$$

Here,  $\nabla^\nu = g^{\alpha\nu} \nabla_\alpha$ ,  $\phi$  is the mass-energy density and  $B_{\nu\mu}$  is a second-order asymmetric tensor. We will see further that equation (22) based on equation (21) paves the way for constructing physical quantities such as space (position), time, mass, energy, momentum, etc. For the subsequent mathematical analysis in this research paper, we assume that the action responsible for the existence of a phenomenon, such as a massive body or its motion, mathematically causes the creation of space, while the corresponding reaction permits the formation of time. The above analysis also supports the fact of modern physics that both space and time act together as a single entity, space-time.

Taking the divergence of both sides of equation (22) gives the four-dimensional Laplacian of the mass-energy density  $\phi$ .

$$\nabla^\mu f_\mu = -\nabla^\mu \nabla_\mu \phi + \nabla^\mu \nabla^\nu B_{\nu\mu} = 0$$

Since,  $\nabla^\mu \nabla^\nu B_{\nu\mu} = 0$ , therefore

$$\nabla^\mu \nabla_\mu \phi = 0 \quad (23)$$

Taking the curl of both sides of equation (22) to obtain the four-dimensional Laplacian of  $B_{\nu\mu}$ .

$$f_\lambda = -\nabla_\lambda \phi + \nabla^\nu B_{\nu\lambda} \quad (24)$$

$$\nabla_\lambda f_\mu = -\nabla_\lambda \nabla_\mu \phi + \nabla_\lambda \nabla^\nu B_{\nu\mu} \quad (25)$$

$$\nabla_\mu f_\lambda = -\nabla_\mu \nabla_\lambda \phi + \nabla_\mu \nabla^\nu B_{\nu\lambda} \quad (26)$$

$$\nabla_\lambda f_\mu - \nabla_\mu f_\lambda = -(\nabla_\lambda \nabla_\mu \phi - \nabla_\mu \nabla_\lambda \phi) + (\nabla_\lambda \nabla^\nu B_{\nu\mu} - \nabla_\mu \nabla^\nu B_{\nu\lambda})$$

Since  $(\nabla_\lambda \nabla_\mu \phi - \nabla_\mu \nabla_\lambda \phi) = 0$ , therefore

$$\nabla_\lambda f_\mu - \nabla_\mu f_\lambda = (\nabla_\lambda \nabla^\nu B_{\nu\mu} - \nabla_\mu \nabla^\nu B_{\nu\lambda}) \quad (27)$$

According to Bianchi identity

$$\nabla_\lambda B_{\nu\mu} + \nabla_\nu B_{\mu\lambda} + \nabla_\mu B_{\lambda\nu} = 0$$

Based on the divergence of the above identity in the absolute background, equation (27) can be written as follows.

$$\nabla^\nu \nabla_\nu B_{\mu\lambda} = -V_{\lambda\mu} \quad (28)$$

where  $V_{\lambda\mu} = \nabla_\lambda f_\mu - \nabla_\mu f_\lambda$ . Since according to equation (21)  $f_\mu = 0$ ,  $f_\lambda = 0$ , therefore

$$\nabla^\nu \nabla_\nu B_{\mu\lambda} = 0 \quad (29)$$

Suppose the vector field  $u_\mu$  is responsible for the existence of the asymmetric tensor  $B_{\nu\mu}$  then

$$B_{\nu\mu} = \nabla_\mu u_\nu - \nabla_\nu u_\mu = 2A_{\nu\mu}$$

On writing equation (24) in terms of  $A_{\nu\mu}$

$$\begin{aligned} f_\mu &= -\nabla_\mu \phi + 2\nabla^\nu A_{\nu\mu} \\ f_\mu &= -\frac{1}{2}\nabla_\mu \phi - \frac{1}{2}\nabla_\mu \phi + \nabla^\nu A_{\nu\mu} + \nabla^\nu A_{\nu\mu} \end{aligned} \quad (30)$$

The divergence of the asymmetric tensor  $A_{\nu\mu}$  gives the following equation

$$\nabla^\nu A_{\nu\mu} = \frac{1}{2}\nabla_\mu (\nabla^\nu u_\nu) - \frac{1}{2}\nabla^\nu \nabla_\nu u_\mu$$

According to the research paper, the vector field  $u_\nu$  is responsible for the existence of mass-energy density  $\phi$  in the following way.

$$\phi = \nabla^\nu u_\nu \quad (31)$$

Hence, from equation (30)

$$\begin{aligned} f_\mu &= -\frac{1}{2}\nabla_\mu \phi - \frac{1}{2}\nabla^\nu \nabla_\nu u_\mu + \nabla^\nu A_{\nu\mu} \\ f_\mu &= -\nabla^\nu S_{\nu\mu} + \nabla^\nu A_{\nu\mu} \\ f_\mu &= -\nabla^\nu S_{\mu\nu} - \nabla^\nu A_{\mu\nu} \end{aligned} \quad (32)$$

Where  $\nabla^\nu S_{\nu\mu} = \frac{1}{2}\nabla_\mu \phi + \frac{1}{2}\nabla^\nu \nabla_\nu u_\mu$  and  $S_{\nu\mu} = \frac{1}{2}(\nabla_\mu u_\nu + \nabla_\nu u_\mu)$  is a symmetric tensor formed from the vector field  $u_\mu$ .

$$f_\mu = \nabla^\nu (-S_{\mu\nu} - A_{\mu\nu})$$

Where

$$\rho_{\mu\nu} = -\nabla_\nu u_\mu = -S_{\mu\nu} - A_{\mu\nu} \quad (33)$$

Therefore

$$f_\mu = \nabla^\nu \rho_{\mu\nu} \quad (34)$$

Since

$$\rho_{\mu\nu} = -\nabla_\nu u_\mu \quad (35)$$

So

$$f_\mu = -\nabla^\nu \nabla_\nu u_\mu \quad (36)$$

Because,  $f_\mu = 0$ , therefore

$$\nabla^\nu \nabla_\nu u_\mu = 0 \quad (37)$$

On operating the above equation with operator  $\nabla_\nu$

$$\begin{aligned} \nabla_\nu \nabla^\nu \nabla_\nu u_\mu &= 0 \\ \nabla_\nu \nabla^\nu (S_{\mu\nu} + A_{\mu\nu}) &= 0 \\ \nabla^\nu \nabla_\nu (T_{\mu\nu} + \frac{1}{4} g_{\mu\nu} \phi + A_{\mu\nu}) &= 0 \\ \nabla^\nu \nabla_\nu T_{\mu\nu} + \frac{1}{4} g_{\mu\nu} (\nabla^\nu \nabla_\nu \phi) + \nabla^\nu \nabla_\nu A_{\mu\nu} &= 0 \end{aligned}$$

Here,  $T_{\mu\nu}$  is a traceless symmetric tensor. Since  $\nabla^\nu \nabla_\nu \phi = 0$ ,  $\nabla^\nu \nabla_\nu A_{\mu\nu} = 0$ , therefore

$$\nabla^\nu \nabla_\nu T_{\mu\nu} = 0 \quad (38)$$

The concept behind the derivation of equations (37) and (38) is that the vector field  $u_\mu$  which gives rise to the asymmetric tensor  $B_{\mu\nu}$  during the motion is also responsible for the existence of the mass-energy density  $\phi$ . In other words,  $u_\mu$  manifests itself as a characteristic vector field to the system (the object and its motion). According to equation (38), the four-dimensional Laplacian exists for the traceless symmetric tensor  $T_{\mu\nu}$ . Paper considers equation (35) to be the energy-momentum density tensor in four-dimensional space-time. Equation (37) is the main wave equation associated with the phenomenon. Solving for  $u_\mu$ , allows for the calculation of the physical quantities necessary for studying the static and dynamic states of the object, such as rest mass, the longitudinal and transverse components of the increase in mass with motion, and momentum, in a completely new way.

Before writing solution for equation (37), it is necessary to clarify an important point. In the research paper, finally, the massive object appears as a spherical oscillation of  $u_\mu$  in four-

dimensional space-time. If only progressive waves existed due to spherical oscillations, then the oscillations would not be permanent. They would dissipate after a certain time by dissipating the energy contained in the oscillations through progressive waves. However, this is not the case; the mass containing objects persist for a long time. So, what is the reason behind this? The oscillations must certainly produce stationary waves instead of progressive waves. But the formation of stationary waves would require two boundaries. If the object conceived as a spherical oscillation serves as the first boundary, what would be the second boundary? The various forms of material objects present in the rest of the universe would undoubtedly serve as the second boundary. As matter came into existence with the Big Bang, the process of formation of stationary waves from progressive waves would have begun. Although a mathematical explanation of this is not being presented here, only a brief verbal explanation is presented. During the evolution of the universe, this phenomenon must be directly related to cosmic inflation (the expansion of the universe at a very rapid rate in the beginning), the deceleration of this expansion, and then its acceleration again. Since the purpose of this research paper is to study the state of rest and motion of a massive object, we will not discuss much in this direction related to cosmology here. We conclude the above analysis with the statement that the existence of a single massive object in the universe is not possible. After solving equation (37) for the vector field, we will need clearly defined position of both the boundaries of the system to calculate physical quantities related to the system, such as mass-energy, momentum, etc. As we just discussed the first boundary will be the position on surface of the spherical object from its center, but what will be the position of the second boundary? As we just discussed that rest of the material objects responsible for the formation of stationary waves but this is not enough to decide position of second boundary. I believe that every massive object in the universe produces waves in the surrounding background in the form of spherical oscillations, whose frequency decreases with distance from the surface of spherical oscillation. If a large number of mass containing objects are distributed over a very large area, a homogeneous region of waves with approximately the same frequency is formed over a large area. If the subjected mass containing object is located within this homogeneous region, then the frequency of the waves produced by the subjected object will certainly be equal to the frequency of the homogeneous region at a distance determined by the object, from its center. The position of this second boundary should

be determined at this point. These boundaries related to the system itself must contain information about the source necessary to cause the occurrence.

Consider a system (consisting of the body and its affected background) that is at rest or moving within a surrounding homogeneous background, as defined immediately above. See Figure 1. Under this scenario, the vector field  $u_\mu$  representing the moving body can be written in a simplified Cartesian coordinate form, while the mass moves with a uniform velocity along the  $x$  axis in the absolute reference frame.

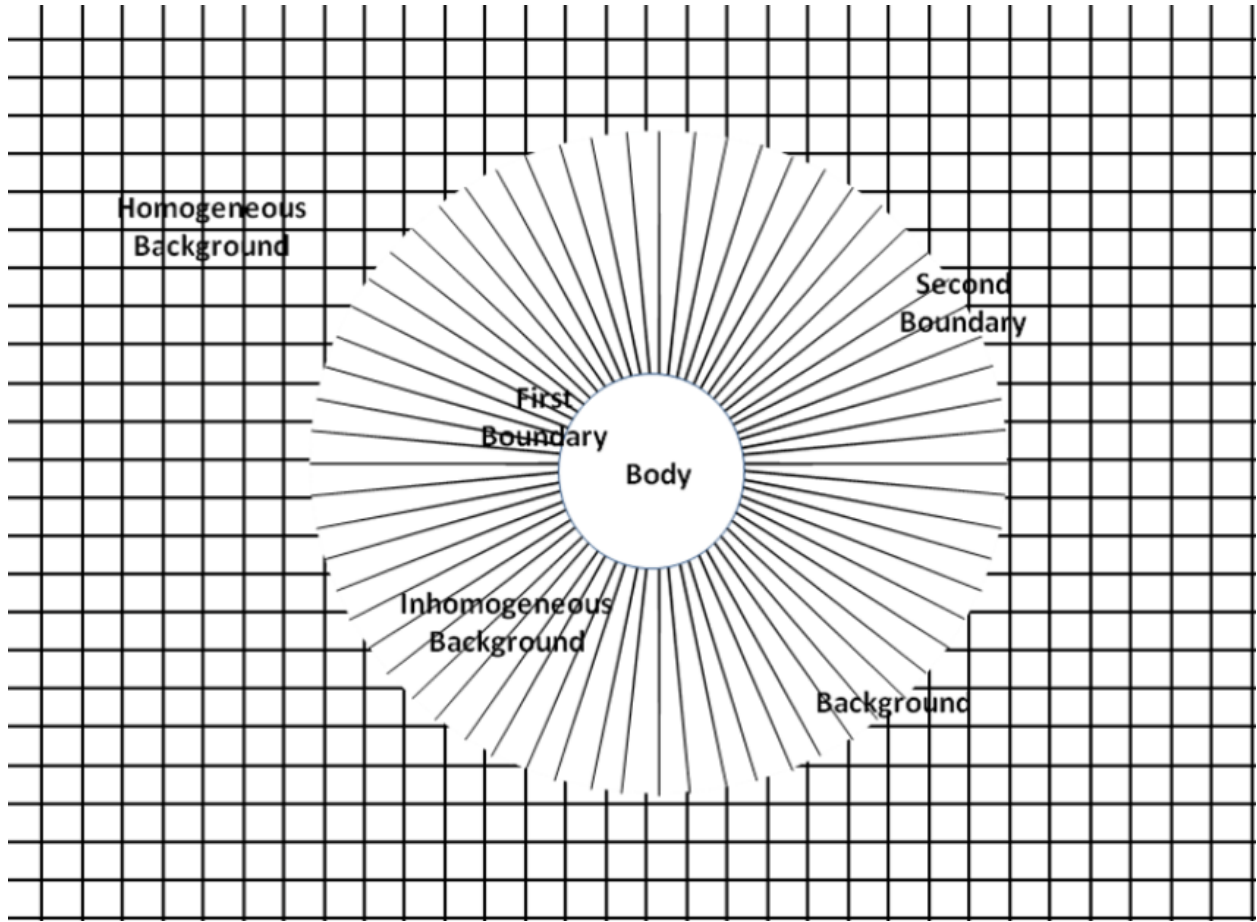


Figure 1

$$u_0 = u_0 \tag{39a}$$

$$u_1 = f(r, x_0) \frac{x_1}{r} + g(r, x_0) \tag{39b}$$

$$u_2 = f(r, x_0) \frac{x_2}{r} \tag{39c}$$

$$u_3 = f(r, x_0) \frac{x_3}{r} \tag{39d}$$

$\mu = 0, i$  and  $i = 1, 2, 3$ . Here, the mathematical structure of  $u_0$  is currently undefined.

Writing  $\rho_{\mu\nu} = -\nabla_\nu u_\mu$  in Cartesian coordinate system

$$\rho_{\mu\nu} = - \begin{bmatrix} \nabla_0 u_0 & \nabla_1 u_0 & \nabla_2 u_0 & \nabla_3 u_0 \\ \nabla_0 u_1 & F_x + g' \frac{x}{r} & F_{xy} + \frac{f}{r} + g' \frac{y}{r} & F_{xz} + \frac{f}{r} + g' \frac{z}{r} \\ \nabla_0 u_2 & F_{xy} & F_y & F_{yz} \\ \nabla_0 u_3 & F_{xz} & F_{yz} & F_z \end{bmatrix} \quad (40)$$

Where,

$$F_x = \left(f' - \frac{f}{r}\right) \frac{x^2}{r^2} + \frac{f}{r}, \quad F_y = \left(f' - \frac{f}{r}\right) \frac{y^2}{r^2} + \frac{f}{r}, \quad F_z = \left(f' - \frac{f}{r}\right) \frac{z^2}{r^2} + \frac{f}{r},$$

$$F_{xy} = \left(f' - \frac{f}{r}\right) \frac{xy}{r^2}, \quad F_{yz} = \left(f' - \frac{f}{r}\right) \frac{yz}{r^2}, \quad F_{xz} = \left(f' - \frac{f}{r}\right) \frac{xz}{r^2}$$

Upon splitting the above mentioned tensor  $\rho_{\mu\nu}$  into symmetric and asymmetric parts,

$$\rho_{\mu\nu} = -S_{\mu\nu} - A_{\mu\nu} \quad (41)$$

Where

$$S_{\mu\nu} = \frac{1}{2} \begin{bmatrix} 2\nabla_0 u_0 & (\nabla_1 u_0 + \nabla_0 u_1) & (\nabla_2 u_0 + \nabla_0 u_2) & (\nabla_3 u_0 + \nabla_0 u_3) \\ (\nabla_0 u_1 + \nabla_1 u_0) & 2\left(F_x + g' \frac{x}{r}\right) & 2F_{xy} + \frac{f}{r} + g' \frac{y}{r} & 2F_{xz} + \frac{f}{r} + g' \frac{z}{r} \\ (\nabla_0 u_2 + \nabla_2 u_0) & 2F_{xy} + \frac{f}{r} + g' \frac{y}{r} & 2\left(F_y + \frac{f}{r}\right) & 2F_{yz} \\ (\nabla_0 u_3 + \nabla_3 u_0) & 2F_{xz} + \frac{f}{r} + g' \frac{z}{r} & 2F_{yz} & 2\left(F_z + \frac{f}{r}\right) \end{bmatrix} \quad (42)$$

$$A_{\mu\nu} = \frac{1}{2} \begin{bmatrix} 0 & (\nabla_1 u_0 - \nabla_0 u_1) & (\nabla_2 u_0 - \nabla_0 u_2) & (\nabla_3 u_0 - \nabla_0 u_3) \\ (\nabla_0 u_1 - \nabla_1 u_0) & 0 & \frac{f}{r} + g' \frac{y}{r} & \frac{f}{r} + g' \frac{z}{r} \\ (\nabla_0 u_2 - \nabla_2 u_0) & -\frac{f}{r} - g' \frac{y}{r} & 0 & 0 \\ (\nabla_0 u_3 - \nabla_3 u_0) & -\frac{f}{r} - g' \frac{z}{r} & 0 & 0 \end{bmatrix} \quad (43)$$

From the perspective of the main objective of the paper (which is to identify the foundational cause behind the momentum of a massive object), a precise understanding of the anti-symmetric tensor  $A_{\mu\nu}$  derived within the employed coordinate system is indispensable. As we have observed earlier, the conceptual design  $\phi = \nabla^\nu u_\nu$  of this research work dictates that the symmetric tensor  $S_{\mu\nu}$  is absorbed into the scalar potential  $\phi$  as well as into the antisymmetric tensor  $B_{\nu\mu}$  under the Hodge identity. This mathematical formulation can be revisited as follows.

$$\rho_{\mu\nu} = -\nabla_\nu u_\mu$$

$$\rho_{\mu\nu} = -\frac{1}{2}(\nabla_\nu u_\mu + \nabla_\mu u_\nu) - \frac{1}{2}(\nabla_\nu u_\mu - \nabla_\mu u_\nu)$$

$$\begin{aligned}
\rho_{\mu\nu} &= -S_{\mu\nu} - A_{\mu\nu} \\
\rho_{\mu\nu} &= -S_{\mu\nu} + A_{\nu\mu} \\
\nabla^\nu \rho_{\mu\nu} &= -\nabla^\nu S_{\mu\nu} + \nabla^\nu A_{\nu\mu} \\
\nabla^\nu \rho_{\mu\nu} &= -\nabla^\nu S_{\mu\nu} - \nabla^\nu A_{\nu\mu} + \nabla^\nu A_{\nu\mu} + \nabla^\nu A_{\nu\mu} \\
\nabla^\nu \rho_{\mu\nu} &= -\nabla^\nu S_{\mu\nu} - \nabla^\nu A_{\nu\mu} + \nabla^\nu (2A_{\nu\mu}) \\
-\nabla^\nu S_{\mu\nu} - \nabla^\nu A_{\nu\mu} &= -\frac{1}{2} \nabla^\nu (\nabla_\nu u_\mu + \nabla_\mu u_\nu) - \frac{1}{2} \nabla^\nu (\nabla_\mu u_\nu - \nabla_\nu u_\mu) \\
-\nabla^\nu S_{\mu\nu} - \nabla^\nu A_{\nu\mu} &= -\nabla^\nu \partial_\mu u_\nu = -\partial_\mu \nabla^\nu u_\nu = -\partial_\mu \phi \\
2A_{\nu\mu} &= B_{\nu\mu}, \quad f_\mu = \nabla^\nu \rho_{\mu\nu} \\
f_\mu &= -\nabla_\mu \phi + \nabla^\nu B_{\nu\mu}
\end{aligned}$$

Since,  $f_\mu = 0$  therefore

$$f_\mu = \nabla_\mu \phi = \nabla^\nu B_{\nu\mu} \tag{49}$$

$$f_\mu = \nabla^\nu B_{\nu\mu} \tag{50}$$

In above equations any type of explicit mathematical structure of  $u_0$  is not available. Furthermore, the differentiation of  $\hat{x}_i$  and  $\hat{x}_0$  with respect to each other is also unclear. To obtain this insight, the definition of time established in equation (18) provides a clear direction. Concurrently, this mathematical description of time can be derived by solving the four-dimensional Laplacian of the vector field  $u_0$  from equation (37), subject to the system's internal constraints and boundary conditions.

Equation (43) shows that when the body is moving in a straight line, the components  $B_{23}$  and  $B_{32}$  of the anti-symmetric tensor  $B_{\mu\nu}$  under the Cartesian coordinate system have zero values. Therefore, Equation (49) can be written in the following way in the absolute background.

$$f_0 = g^{11} \nabla_1 B_{10} + g^{22} \nabla_2 B_{20} + g^{33} \nabla_3 B_{30} \tag{52}$$

$$f_1 = g^{00} \nabla_0 B_{01} + g^{22} \nabla_2 B_{21} + g^{33} \nabla_3 B_{31} \tag{53}$$

$$f_2 = g^{00} \nabla_0 B_{02} + g^{11} \nabla_1 B_{12} \tag{54}$$

$$f_3 = g^{00} \nabla_0 B_{03} + g^{11} \nabla_1 B_{13} \tag{55}$$

This research paper describes wave equations obtained from the four-dimensional Laplacian of physical quantities such as mass-energy density  $\phi$ , fundamental vector fields  $u_\mu$ , etc., when the general metric tensor  $g^{\mu\nu}$  is replaced by the Minkowski metric tensor  $\eta^{\mu\nu}$ . If experiments and observations confirm the wave behavior of the above equations, it follows that the absolute background behaves like Minkowski space-time. In above equations  $f_1$  is longitudinal

component of force density,  $f_2$  and  $f_3$  are transverse components of force density.  $f_1$  is the value of the force density responsible for the motion of the object along the  $x$  axis. Force densities  $f_2$  and  $f_3$  generate vibrations in the direction ( $y$  and  $z$  axes) perpendicular to the direction of motion, which is known as the Zitterbewegung effect in relativistic quantum mechanics.  $f_0$  represents the total force density generated by the motion. Of the above equations, equation (53) needs to be analyzed in particular, because this equation contains the answer to the main question of the research paper: why does a mass containing body continue to move forward in a fixed direction with a constant magnitude of speed in an absolute background unless an external force is applied. To ask directly, what exactly is momentum? Equation (53) can also be written as follows with the metric signature (+, -, -, -) in Minkowski space-time.

$$f_1 = \partial_0 B_{01} - (\nabla \times B)_1 \quad (56)$$

According to the above equation, the force density  $f_1$  responsible for the motion gives rise to a divergence of the component  $B_{01}$  of the asymmetric tensor with respect to the time axis and a curl of the components  $B_{ij}$ . The force density  $f_1$  periodically approaches its minimum (possibly zero) and maximum ( $f_1$ ) values unless another external force is applied to the body. Taking the volume integral of the above equation gives

$$\int f_1 dV = \int \partial_0 B_{01} dV - \int (\nabla \times B)_1 dV \quad (57)$$

But according to the physics of the system

$$\int (\nabla \times B)_1 dV = 0 \quad (58)$$

So

$$\int f_1 dV = \int \partial_0 B_{01} dV$$

If the conditions of the system allow the differential and integral operators in the above equation to be interchangeable, this is not always possible for the system to allow, then

$$F_1 = \frac{d}{dx_0} \int B_{01} dV = \frac{d}{dt} \int \frac{B_{01}}{c} dV = \frac{d}{dt} \int \frac{B}{c} \hat{x}_1 dV \quad (59)$$

$$F_1 = \frac{dP_1}{dt} \quad (60)$$

Where,

$$P_1 = \int \frac{B}{c} \hat{x}_1 dV \quad (61)$$

$B$  and  $c$  are the magnitudes of the tensor component  $B_{01}$  and the velocity  $\mathbf{c}$  of the waves respectively. Therefore, according to the paper, the Newtonian momentum  $P_1$  of the moving massive object is defined by equation (61). The time component of the anti-symmetric tensor  $B_{\nu\mu}$  generated in the direction of the external force applied on the body represents the momentum. The rectilinear motion of an object in a direction, say  $x_1$ , when an external force is applied, can be explained from a completely new point of view through equations (56), (59), and (61). I believe this perspective allows a closer look at the fundamental causes responsible for the motion. The force  $F_1$  and momentum  $P_1$  in equation (60) are the same force and momentum that were defined using classical mechanics in Section 1, establishing equation (4).

Depending on the conditions prevailing in the system, the volume integral of the force density  $f_2$  and  $f_3$  must be zero. For elementary particles, this should account for phenomena such as the zitterbewegung effect.

Writing equation (50) in Minkowski space-time as follows

$$+\partial_0\phi = f_0 \quad (62a)$$

$$-\partial_1\phi = f_1 \quad (62b)$$

$$-\partial_2\phi = f_2 \quad (62c)$$

$$-\partial_3\phi = f_3 \quad (62d)$$

Integrating equation (62a) with respect to  $x_0$  and then integrating through volume gives the total increase in mass due to motion; integrating equation (62b) with respect to  $x_1$  and then integrating through volume gives the increase in longitudinal component of mass and kinetic energy due to motion; and integrating equations (62b) and (62a) with respect to  $x_2$  and  $x_3$  respectively and then integrating through volume gives the increase in transverse component of mass due to motion. The calculation of increase in mass and kinetic energy can also be obtained by solving the wave equation (23) within the boundary conditions applied by the system.

## 4. Results and Discussion

The mass-energy of any massive object is the potential energy of the object relative to the entire universe, and this potential energy is the cause of inertia. This phenomenon is viewed in such a way that the massive object, through its inherent mass-energy, is related to the material distributed in the rest of the universe. According to the law of action and reaction, *prima facie* it appears that the presence of matter in the rest of the universe is necessary for the motion of the massive object. Both of these concepts align with Ernst Mach's philosophy of inertia [58]. However, it would be more appropriate to view the states of rest and motion of a massive object in such a way that the mass-energy of the object, as a reaction, produces a deformation within the absolute background. Furthermore, during the state of motion of the object, the energy responsible for motion also produces a deformation within the absolute background. On this basis, the presence of the material objects in the rest of the universe is not mandatory for the inertia of the subjected object. In exactly the same way, an isolated massive object can execute motion; for this, the presence of other massive objects in the rest of the universe is not essential. However, to bring the body from a state of rest to a state of motion, matter or radiation is required as a base. We have begun to understand mass and motion properly since the time of Galileo and Newton. According to this paper mass and motion are essentially different manifestations of the same cause which is underlying vector field of the system. Albert Einstein's General Theory of Relativity is the most comprehensive work on space-time. By establishing a new concept to explain the state of motion of a massive object, an attempt has been made to further develop our understanding of space-time. Based on the derivation of the equations obtained in the research paper, it becomes clear that space-time is not a fundamental entity of nature. At first glance, space-time is a mathematical artifact designed by the human race for the study of the related phenomena. The action-reaction responsible for the existence of any phenomenon provides the ground for the creation of space-time. Space and time are not required for the action-reaction to occur. Space and time are required to understand and explain the occurrence of action-reaction. In reality, neither time nor space is real. If we mathematically create the space based on the action in the action-reaction inherent in any phenomenon, then the creation of time will be based on the reaction. The object (material body) and the background (space-time) are different manifestations of the same entity (perhaps any specific field). Space-

time and phenomena are interrelated. The background (space-time) in which a mass containing body moves is not completely empty. Here, I would like to mention an incident from the history of physics from the first half of the twentieth century. The special theory of relativity plays a significant role in the development of quantum field theory. Under the special theory of relativity, Albert Einstein completely rejected the concept of the ether by replacing the Galilean transformation with the Lorentz transformation. However, some research papers by the then physicists Hendrik Antoon Lorentz and Henri Poincare indicate that they were not in favor of completely rejecting the concept of ‘an infinite space with physical properties’ [25, 59]. They believed that the Lorentz transformation was an expression of the physical properties of the space, which could be deduced from the laws of classical mechanics. In Section A of the present paper, Equation (4) is established using Newton's second law of motion and Albert Einstein's mass-energy equivalence relation. In Section B, equation (4) was redefined based on continuum mechanics, a key step toward finalizing the paper. The interaction between ‘body and background’ is, in fact, the reason why light has the same speed in all coordinate systems.

Two inconsistencies emerge under Section A: (a) The one-dimensional solution of Equation (4) yields the transverse component of the mass increment with velocity, whereas it should have yielded the longitudinal component. (b) The three-dimensional solution of Equation (4) is physically untenable, as it violates the relativistic constraint that no object can travel faster than the speed of light. Deriving an equation for the increase in mass with velocity is not the purpose of this paper. However, if we could derive an equation for the increase in mass with velocity based on new concepts, it would indicate that we are moving in the right direction. Therefore, an attempt was made to speculate about the possible reasons behind these two inconsistencies. The main reason behind these two inconsistencies is—solving Equation (4) by considering the potential energy of a mass containing object as a zero-order tensor (scalar). I believed that the above inconsistencies could be eliminated if it were considered a second-order tensor (dyad). Subsequently, I attempted to steer the paper in this direction. To solve equation (4) in Section B, the force acting on the body, which is responsible for both its existence (rest-mass) and motion, is considered equal to the volume integral of the divergence of the second-order stress tensor. Finally, we find that the energy-momentum density in four-dimensional space-time is the gradient tensor of the vector field which is defined to write the physics of the system (massive object either at rest or in motion). It is important to clarify here that energy is generally written

mathematically as a quadratic proportional to the physical quantity on which it depends. However, there are some exceptions, such as Planck's energy equation. In this paper, the energy equation is not obtained as a quadratic of the related physical quantity; it is gradient tensor of the vector field.

A massive object during the motion produces a second-order asymmetric tensor, which is actually the Gravitomagnetic Field Tensor. If the external force on the object is applied in the direction of the  $x$  axis, then according to equation (61), the component  $B_{01}$  of this asymmetric tensor represents momentum.

$$P_1 = \int \frac{B}{c} \hat{x}_1 dV \quad (61)$$

The mutual relationship between the components of this asymmetric tensor is capable of completely explaining the state of motion of the mass containing object.

$$\int f_1 dV = \int \partial_0 B_{01} dV - \int (\nabla \times B)_1 dV \quad (57)$$

According to the physics of the system, the second term on the right side of the above equation is non-zero for the force density, but when the volume integral of the entire equation is taken to find the total magnitude of the external force on the object, and then this term becomes zero.

$$\int (\nabla \times B)_1 dV = 0 \quad (58)$$

The physical interpretation of the above result is that if an external force is applied to the body in the direction of the  $x$  axis, then a ring-like structure is generated in the  $x - y$  and  $x - z$  planes of the background of the object, represented by  $B_{12}$  and  $B_{13}$ , respectively. If the volume integral of the above equation is zero, it means that the toroidal ring formed by these rings does not rotate about the  $x$  axis, but these rings rotate about an axis passing through their own center and perpendicular to their plane, i.e.,  $B_{12}$  about the  $z$  axis passing through it and  $B_{13}$  about the  $y$  axis passing through it. After the volume integral of equation (57), the remaining non-zero terms, which describe Newton's first and second laws of motion, must be related to the action-reaction force required to propel these ring-like structures in a periodic manner along the  $x$  axis. It is my belief that the rotation of  $B_{12}$  and  $B_{13}$  about an axis passing through their own center and

perpendicular to their plane, while moving in the direction of the  $x$  axis, is responsible for the uniform motion of the massive object.

Here, I would like to discuss the physical process of setting a massive object from a state of rest to a state of motion, specifically from the perspective of the role played by the electromagnetic fields of the constituent atoms and molecules of the object. Generally, when an external force is applied to bring an object from rest to motion, in what form does this force manifest? We recognize it as a mechanical force. In reality, it is the electromagnetic force that operates here. At the interface where an external agent exerts a pushing force on an object, the force is manifested due to the mutual repulsion between the electromagnetic fields of the constituent atoms and molecules of both the agent and the object.

I am inclined to consider whether the ring-like structure defined by Equation (58) is, in fact, responsible for the very existence of elementary particles. When a force is applied to set an object from rest to motion, this force acts directly upon the structure of the elementary particles responsible for the composition of the object. The extent to which the applied force alters the structure of these constituent elementary particles depends entirely on the energy level inherent within the force. In low-energy phenomena, this process remains confined to the electromagnetic domain.

The phenomenon responsible for the origin of the universe can be modeled as an exceedingly high-energy, unstable oscillation of a specific primordial field—a cosmic transition traditionally referred to as the Big Bang. According to the principle of causality, the specific primordial field must have already been in existence. Nothing can emerge from absolute nothingness. If the Big Bang is indeed an ultra-high-energy phenomenon occurring within a specific primordial field, then elementary particles may have manifested in a manner analogous to what occurs when a force is applied to set an object in motion. Evidence for this is also observed in experiments involving ultra-high-energy collisions of elementary particles.

My purpose in the above analysis is to clarify that when work is done on an object to set it in motion, the work is done on the structure of the constituent particles associated with the composition of the object. According to the paper, the body (matter) and the background (space-time) emerge from a vector field defined to write the physics of the phenomenon. During the

motion of the object, no point of this vector field is moved; only the energy employed is transferred, similar to the energy transmitted by a wave in a medium. This energy employed represents the elementary particles in the form of a ring, a toroidal ring, or something even more complex. When an attempt is made to set an object in motion at a low energy level, a general change occurs in the structure of the elementary particles associated with the composition of the object, which manifests as the rectilinear motion of object. If the same phenomenon occurs at a higher energy level, the structure of the elementary particles changes to such an extent that their very nature changes and new elementary particles also come into existence.

The paper provides the mathematical framework necessary to derive the longitudinal and transverse components of the increase in mass with motion. The resulting equations do not necessarily have the same mathematical structure as those derived from the special theory of relativity because here we are not working in inertial frame and with physical parameter like velocity of the object. The paper discusses a low-energy system (an ordinary mass containing object and its motion) in detail with a new perspective, but it can contribute as a first step towards understanding the ultra-high-energy state of the Universe (the Big Bang).

In the research paper, Equation (37) has not been solved for  $u_\mu$  in the manner in which it ought to have been solved. This is because space-time emerges from  $u_\mu$  itself, according to the physics of the system. Based on the indirect involvement of continuum mechanics in the development of this concept, vector field should be a displacement vector field. In continuum mechanics, the displacement vector field arises from the coordinates of a coordinate system. In reality, to solve equation (37), there is no pre-existing coordinate system as in continuum mechanics. Space-time is determined by the force responsible for the existence and motion of the object. Space-time also varies with distance from the center of the object. There are also some other reasons that have not been adequately explained here. Solving equation (37) with all these constraints is itself a detailed study of some fundamental problems in physics. For this reason, the paper has been finalized based on the minimally simplified possible solution, which is equation (39), available in current mathematical physics for the system in question, so that the ideas presented in this paper can be shared with experts in this field. In the next paper, we will attempt to solve the relevant equations in real situations, both in the presence of external influence (other massive object) and ‘in the absence of external influence (absolute background),’ with the necessary

boundary conditions. Solving the equations in the presence of external influence (other massive body) provides a new concept of gravity, which I believe can help re-understand the problem of dark matter. This research paper is articulated within the framework of classical field theory, and its quantization is viable. If the quantization of this concept can be successfully extended to explain the fundamental forces of nature, it could offer a streamlined and elegant alternative to Loop Quantum Gravity and String Theory. It is hoped that, as an alternative to Loop Quantum Gravity, the extension of this concept will be free from arduous mathematical methods, and as an alternative to String Theory, it will be free from the requirement of extra dimensions.

According to certain concepts, space and time are said to be granted existence by the consciousness inherent in the mind [23, 60, 61]. This is possible. The brain may present the true nature of the phenomenon to our consciousness in such a way that we perceive it as something like space-time. In fact, in the early stages of studying nature, we identified physical quantities such as position, time, speed, velocity, acceleration, mass, momentum, force, energy, etc. as concepts necessary to understand and explain related phenomena. Physical quantities and related concepts have been modified with the increasing accuracy of experiments and observations. This is how physical quantities have been unified, or in other words, their relation to the fundamental components has been revealed, directly or indirectly. In these scientific endeavors, the human brain and its inherent consciousness have played the role of the primary mediator; therefore, it is my belief that from the perspective of physics, the intervention of the brain and consciousness must also be included in the effort to unravel the mysteries of nature [62].

## **5. Conclusion**

The physical process of motion of a massive object can be clearly understood by delving deeper. Fundamentally, no such phenomenon as the rectilinear mechanical motion of an object exists; what manifests in this guise is simply a periodic transfer of intricately intertwined energy, driven by a periodic variation of the governing vector field defined for the system. This very same causal vector field gives rise to an intrinsic physical property—mass. The equations derived in this paper clearly explain the reason for the existence of inertia (mass). This paper could be the first attempt to start from a new perspective towards answering the questions of how space-time comes into existence and what is the reason behind its origin. This paper establishes a second-order energy-momentum density tensor, which is obtained as the gradient of the characteristic

vector field of the system in four-dimensional space-time. The insights gained from this paper pave the way for developing a new concept of gravity that could play a crucial role in resolving the dilemma surrounding dark matter.

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## References

1. Green, M. B., Schwarz, J. H., & Witten, E. (1987). *Superstring Theory* (Vols. 1–2). Cambridge University Press.
2. Peskin, M. E., & Schroeder, D. V. (1995). *An Introduction to Quantum Field Theory*. Addison-Wesley.
3. Weinberg, S. (1967). A Model of Leptons. *Physical Review Letters*, 19(21), 1264–1266. <https://doi.org/10.1103/PhysRevLett.19.1264>
4. Salam, A. (1968). Weak and Electromagnetic Interactions. In N. Svartholm (Ed.), *Elementary Particle Theory* (pp. 367–377).
5. Arnison, G., et al. (UA1 Collaboration). (1983). Experimental observation of isolated large transverse energy electrons with associated missing energy at  $\sqrt{s} = 540$  GeV. *Physics Letters B*, 122(1-2), 103–116. [https://doi.org/10.1016/0370-2693\(83\)91177-2](https://doi.org/10.1016/0370-2693(83)91177-2)

6. Aad, G., et al. (ATLAS Collaboration). (2012). Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. *Physics Letters B*, 716(1), 1–29. <https://doi.org/10.1016/j.physletb.2012.08.020>
7. Georgi, H., & Glashow, S. L. (1974). Unity of All Elementary Particle Forces. *Physical Review Letters*, 32(8), 438–441. <https://doi.org/10.1103/PhysRevLett.32.438>
8. Pati, J. C., & Salam, A. (1974). Lepton Number as the Fourth Color. *Physical Review D*, 10(1), 275–289. <https://doi.org/10.1103/PhysRevD.10.275>
9. Rovelli, C. (2004). *Quantum Gravity*. Cambridge University Press.
10. Peebles, P. J. E. (1993). *Principles of Cosmology*. Princeton University Press.
11. DeWitt, B. S. (1967). Quantum theory of gravity. I. The canonical theory. *Physical Review*, 160(5), 1113–1148. <https://doi.org/10.1103/PhysRev.160.1113>
12. Parmenides. (n.d.). On Nature (H. Diels & W. Kranz, Trans., 1959). In G. S. Kirk & J. E. Raven, *The Presocratic Philosophers* (2nd ed., pp. 115–132). Cambridge University Press.
13. Sattler, B. M. (2019). Time and space in Plato's Parmenides. *Etudes platoniciennes*, 15, 9–36. <https://doi.org/10.2143/ETP.15.0.3284776>
14. Democritus. (n.d.). In H. Diels & W. Kranz (Eds. & Trans.), *Die Fragmente der Vorsokratiker* [The fragments of the pre-Socratics] (1951). Weidmann. (Original work from 5th century BCE fragments)
15. Plato. (1997). *Timaeus* (D. J. Zeyl, Trans.). Hackett Publishing Company. (Original work written ca. 360 BCE)
16. Aristotle. (1984). *Physics* (R. P. Hardie & R. K. Gaye, Trans.). Clarendon Press. (Original work written ca. 350 BCE)
17. Kak, S. (1999). Concepts of space, time, and consciousness in ancient India. *arXiv preprint physics/9903010*. <https://arxiv.org/abs/physics/9903010>
18. Valmiki. (2009). *Yoga-Vasistha* (R. K. Sharma & S. R. Sharma, Trans.). Motilal Banarsidass. (Original work dating 3rd century BCE or earlier)
19. Descartes, R. (1644). *Principles of Philosophy* (D. H. Robinson, Trans., 1983). Reidel Publishing Company. (Original work published 1644)
20. Newton, I. (1999). *The Principia: Mathematical Principles of Natural Philosophy* (I. B. Cohen & A. Whitman, Eds. & Trans.). University of California Press. (Original work published 1687)
21. Galileo Galilei. (1953). *Two New Sciences* (S. Drake, Trans.). University of Wisconsin Press. (Original work published 1638)
22. Leibniz, G. W., & Clarke, S. (1717/1956). *The Leibniz-Clarke correspondence* (H. G. Alexander, Trans.). Manchester University Press.
23. Kant, I. (1998). *Critique of Pure Reason* (P. Guyer & A. W. Wood, Trans. & Ed.). Cambridge University Press. (Original work published 1781)
24. Mach, E. (1897). *Contributions to the Analysis of the Sensations* (C. M. Williams, Trans.). Open Court Publishing. (Original work published 1886)
25. Lorentz, H. A. (1895). *Attempt of a Theory of Electrical and Optical Phenomena in Moving Bodies*. Leiden: E.J. Brill.
26. Poincaré, H. (1912). L'espace et le temps. *Revue générale des sciences pures et appliquées*, 23(5), 97–109.
27. Poincaré, H. (1905). Sur la dynamique de l'électron. *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, 140, 1504–1508.
28. Einstein, A. (1905). Zur Elektrodynamik bewegter Körper. *Annalen der Physik*, 17(10), 891–921.
29. Minkowski, H. (1908). Raum und Zeit [Space and Time]. *Physikalische Zeitschrift*, 10(104), 75–88.
30. Yau, H. Y. (2025). Quantized field with excitations of spacetime. *Progress in Physics*, 19(3), 123–134.
31. Veneziano, G. (1968). Construction of a crossing-symmetric, Regge behaved amplitude for linearly rising trajectories. *Il Nuovo Cimento A (1965-1970)*, 57(1), 190–197.
32. Yoneya, T. (2000). String theory and the space-time uncertainty principle. *Progress of Theoretical Physics*, 103(6), 1081–1125. <https://doi.org/10.1143/PTP.103.1081>
33. Horowitz, G. T. (2005). Spacetime in string theory. *New Journal of Physics*, 7(201). <https://doi.org/10.1088/1367-2630/7/1/201>
34. Lemaître, G. (1931). The beginning of the world from the point of view of quantum theory. *Nature*, 127(3210), 706.
35. Einstein, A. (1916). Die Grundlage der allgemeinen Relativitätstheorie. *Annalen der Physik*, 49, 769–822.
36. Drake, S. (1964). Galileo and the law of inertia. *American Journal of Physics*, 32(8), 601–608. <https://doi.org/10.1119/1.1970872>

37. Newton, I. (1687). *Philosophiæ Naturalis Principia Mathematica* [Mathematical Principles of Natural Philosophy]. Royal Society.
38. Einstein, A. (1905). Does the inertia of a body depend upon its energy content? *Annalen der Physik*, 18(13), 639–641. <https://doi.org/10.1002/andp.19053231314>
39. Higgs, P. W. (1964). Broken symmetries and the masses of gauge bosons. *Physical Review Letters*, 13(16), 508–509.
40. Descartes, R. (1637/1954). *La Géométrie* (D. E. Smith & M. L. Latham, Trans.). Dover Publications.
41. Lagrange, J.-L. (1788). *Mécanique analytique* [Analytical Mechanics]. Veuve Desaint.
42. Hamilton, W. R. (1834). On a General Method in Dynamics. *Philosophical Transactions of the Royal Society of London*, 124, 247–308.
43. Hamilton, W. R. (1835). Second Paper on a General Method in Dynamics. *Philosophical Transactions of the Royal Society of London*, 125, 95–144.
44. Poincaré, H. (1906). Sur la dynamique de l'électron. *Rendiconti del Circolo Matematico di Palermo*, 21(1), 129–176.
45. Einstein, A. (1905). Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt [On a Heuristic Point of View Concerning the Production and Transformation of Light]. *Annalen der Physik*, 17(6), 132–148.
46. de Broglie, L. (1924). *Recherches sur la théorie des quanta* [Research on the quantum theory] (Doctoral dissertation, University of Paris). *Annales de Physique*, 3e série, 10(3), 22–128.
47. Schrödinger, E. (1926). Quantisierung als Eigenwertproblem (Erste Mitteilung) [Quantization as an Eigenvalue Problem (First Communication)]. *Annalen der Physik*, 384(4), 361–376.
48. Klein, O. (1926). Quantentheorie und Fünfdimensionale Relativitätstheorie [Quantum Theory and Five-Dimensional Relativity]. *Zeitschrift für Physik*, 37(12), 895–906.
49. Gordon, W. (1926). Der Comptoneffekt nach der Schrödingerschen Theorie [The Compton Effect according to Schrödinger's Theory]. *Zeitschrift für Physik*, 40(1-2), 117–133.
50. Bang, J. Y., & Berger, M. S. (2009). Wave Packets in Discrete Quantum Phase Space. *Physical Review A*, 80(2), 022105. <https://doi.org/10.1103/PhysRevA.80.022105>
51. Anonymous. (2016). Bosonic string theory: 25 space dimensions. *Dummies*. <https://www.dummies.com/article/science/physics/quantum-physics/bosonic-string-theory-25-space-dimensions-243754/>
52. Rovelli, C. (1998). Loop quantum gravity. *Living Reviews in Relativity*, 1(1), 1. <https://doi.org/10.12942/lrr-1998-1> [arXiv:gr-qc/9710008]
53. Hubble, E. (1929). A relation between distance and radial velocity among extra-galactic nebulae. *Proceedings of the National Academy of Sciences*, 15(3), 168–173.
54. Noether, E. (1918). Invariante Variationsprobleme. *Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse*, 1918, 235–257.
55. Rueda, A., & Haisch, B. (2005). Gravity and the quantum vacuum inertia hypothesis. *Annalen der Physik*, 14(10–11), 858–870.
56. Haisch, B., Rueda, A., & Dobyns, Y. (2001). Inertial mass and the quantum vacuum fields. *Annalen der Physik*, 10(5), 393–414.
57. Giné, J., & Luciano, G. (2021). Modeling inertia through the interaction with quantum vacuum fluctuations. *arXiv preprint arXiv:2103.xxxx*.
58. Mach, E. (1883). *Die Mechanik in ihrer Entwicklung: Historisch-kritisch dargestellt* [The Science of Mechanics: A Critical and Historical Account of Its Development]. F. A. Brockhaus.
59. Granek, G. (2001). Poincaré's ether: C. Conventionalism revisited. *Philosophy, Apeiron*, 8(2), 46–60.
60. Berkeley, G. (1710). *A Treatise Concerning the Principles of Human Knowledge*. Wikipedia. [https://en.wikipedia.org/wiki/George\\_Berkeley](https://en.wikipedia.org/wiki/George_Berkeley)
61. Bergson, H. (1907). *Time and Free Will: An Essay on the Immediate Data of Consciousness* (F. L. Pogson, Trans.). George Allen & Unwin.
62. Fried, I., MacDonald, K. A., & Wilson, C. L. (2023). Mapping time and space: Neurons decode human existence. *UCLA Neuroscience News*. <https://neurosciencenews.com/neuroscience-time-space-mapping-23425/>

