Hypothesis

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The Hypothesis of 'Long String Enwind Forming Particles': Exploring Forces, Black Holes, Dark Matter, Dark Energy, the Accelerating Universe, and Inertia

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The Hypothesis of 'Long String Enwind Forming Particles': Exploring Forces, Black Holes, Dark Matter, Dark Energy, the Accelerating Universe, and Inertia

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Abstract: In the paper titled 'A Hypothesis: Electromagnetic Waves Can Be Represented as Continuous Long String Vibrations,' we explore the relationship between string vibration waves and electromagnetic waves. We find that when the constituent element mass and energy of both wave types are equal over one wave period, the velocity of the string vibration wave is the constant speed of light. This leads to the proposition that "electromagnetic waves are formed by the vibration of a homogeneous long string material." Building on this theory, the paper further examines the process of particle formation, introducing a new model that posits that particles are created through the winding and compression of electromagnetic wave-forming vibrating strings. Energy is transmitted between particles, objects, and celestial bodies through strings that extend and intertwine. This model elucidates the relationship between mass and energy conversion, provides insights into the formation of matter waves, and explains why "electrons have radius but no volume." In this model, electromagnetic wave propagation adheres to the principle of constant light speed. After discussion, it is proposed that the tension of the string increases in a high-curvature state after winding, which can generate strong forces. Gravity arises from the low-frequency collisions of strings and their low-frequency tension effects. Electromagnetic forces result from high-frequency collisions of strings, as well as the effects of high-frequency tension. The intersections of strings serve as energy transmission channels, allowing us to construct a gravitational formula based on these low-frequency collision points. We propose that black holes form from the dense winding of strings. Dark matter, like ordinary matter, is composed of strings, while ordinary matter consists of strings wound together. When these strings unwind, they transform into dark matter. We further deduce the differences between dark energy—resulting from the longitudinal compression and bending of strings—and ordinary energy, which stems from the transverse vibration of strings. The paper also discusses the causes of the accelerated expansion of the universe and offers an explanation of inertia based on our model. We assert that matter is space, space is matter, and that strings represent the fundamental components constituting three-dimensional space. Future studies will continue to explore the potential for quantifying gravity and developing a unified field theory of physical forces

Keywords: particle model; gravity; string; unified field theory; black hole; dark matter; dark energy; inertia

1. Introduction

From Newtonian mechanics in classical physics to the theories of relativity, quantum mechanics, and other modern physics frameworks, significant strides have been made in enhancing our understanding of the universe and explaining cosmic phenomena. However, many unresolved issues persist in modern physics, casting a shadow over its foundational theories. The study of dark matter and dark energy has become a focal point in physics, yet the unification of the four fundamental forces remains incomplete[1,2]. The origins of black holes are still unclear[3], the explanation for the accelerated expansion of the universe remains inconclusive[4], and questions regarding the nature of gravity—including its production, essence, and the mechanisms behind the gravitational interactions

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between celestial bodies—continue to challenge researchers. The so-called "spooky action at a distance" implied in gravitational theory has also yet to be fully understood[5]. This paper posits that many phenomena in physics lack a comprehensive explanation because research into the formation of elementary particles and the mechanisms of force and energy propagation has not been sufficiently deep. Continued investigation is essential for achieving a unified field theory of physical phenomena. In 2022, Chinese scholar Zhang Zhaoyang compared electromagnetic waves to mechanical waves and discovered that when the energy and the mass of the constituent units of a wave period of homogeneous string vibration match those of a wave period of electromagnetic waves, the speed of the string vibration wave is equal to the constant speed of light."This leads to the proposal that electromagnetic waves are generated by the vibration of homogeneous, continuous long strings[6].

Building on the theory that "electromagnetic waves are formed by continuous homogeneous long string vibration," this paper further develops a particle formation model. In this model, the aforementioned homogeneous long strings serve as the fundamental substance, with basic particles formed by their crossing and intertwining, which then combine to form various other particles, eventually creating celestial bodies. The connections between particles and between celestial bodies are mediated through strings, allowing for the transmission of energy and force. This model aligns with the mass-energy conversion principle and suggests the potential for unifying the theory of fundamental forces. This particle formation model further elucidates the essence of universal gravity, the transmission of gravitational forces between celestial bodies, the essence of dark matter and dark energy, the formation of black holes, the accelerated expansion of the universe, and the concept of inertia.

2. Theory of Electromagnetic Waves Formed by Homogeneous Long String Vibration

In 2022, Zhang Zhaoyang proposed in his article "Hypothesis: Electromagnetic Waves can be Represented as Continuous Long String Vibrations" that electromagnetic waves arise from the vibration of a homogeneous long string material. The theoretical inference process involves deriving the total energy formula for one wave period of mechanical waves, electromagnetic waves, and string vibration waves. After this, electromagnetic waves are analogized to mechanical waves, and the mass-energy equation is used to calculate the constituent element mass of one wave period of an electromagnetic wave. By comparing the total energy formulas for one wave period of the three types of waves, it was found that when the total energy and constituent element mass of one wave period of the string vibration wave and the electromagnetic wave are identical, the wave speed of the string vibration wave equals the constant speed of light. This result supports the hypothesis.

The referenced paper asserts that the energy value contained in the Planck constant corresponds to the total energy of one fluctuation period of an electromagnetic wave. Furthermore, an important equation is introduced: When the total energy of a string vibration wave and an electromagnetic wave during one fluctuation period is equal, and their constituent element mass are identical, then

$$E_h = E_L = m_h c^2 = m_L u^2 = TL \qquad (1)$$

E_h represents the total energy of one oscillation cycle of an electromagnetic wave; E_L represents the total energy of one oscillation cycle of a string vibration wave with a string length of $\boldsymbol{L}$. m_h is the relativistic mass derived from the energy value in Planck's constant using the mass-energy equivalence equation. It is also the total mass of the mass elements per oscillation cycle of an electromagnetic wave when analogized to a mechanical wave. $\boldsymbol{c}$ is the speed of light, m_L is the total mass of the mass elements per oscillation cycle of a string vibration wave with a string length of $\boldsymbol{L}$. $\boldsymbol{u}$ is the wave speed of the string vibration, $\boldsymbol{T}$ is the tension in the string, and $\boldsymbol{L}$ is the string length of one oscillation cycle of the string vibration[6].

Based on the properties of electromagnetic waves and the inference derived from equation (1), we conclude that when the frequency of electromagnetic waves reaches a certain value, the energy transfer speed perpendicular or inclined to the string can exceed the speed of light. This provides a theoretical explanation for the possible widespread existence of superluminal speed phenomena[7,8].

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The results of superluminal experiments conducted by Ranfagni and Mugnai in 1996 serve as evidence supporting this hypothesis[9]. When a vibrating string collides with another string in a direction perpendicular or oblique to the wave propagation direction, it transfers energy and continues to propagate and diffract. Notably, this diffraction phenomenon can also exceed the speed of light. In 1997, Mugnai et al. performed grating diffraction experiments using microwave signals and discovered that electromagnetic wave diffraction exhibited superluminal characteristics[10], further supporting this hypothesis. Moreover, when the string itself is twisted, the path of light propagation created by the vibration becomes distorted. This distortion can theoretically explain the alteration of the light propagation path when light passes through massive celestial bodies[6]. Based on these observations and theoretical evidence, this paper establishes a particle formation model that incorporates the hypothesis and considers the vibrating strings of electromagnetic waves as the fundamental substance.

3. Particle Model of String Winding Formation and Related Evidence

3.1. Particle Model of String Winding Formation

This section posits that a vibrating string, which forms electromagnetic waves, serves as the fundamental substance of particles. It is hypothesized that particles are formed through the winding and compression of strings, which coalesce to create the nucleus of particles. Due to the action of string tension, these strings become difficult to untie after becoming cross-wound. The mass resulting from the winding and compressing of strings within the nucleus contributes to the mass of the particle nucleus. As multiple strings wind and compress, the ends extend outward, with the periphery of the particle nucleus enveloped by string material. Smaller particles combine and wind together to form larger particles, which further aggregate to form macroscopic objects, ultimately giving rise to celestial bodies. From elementary particles to celestial bodies, these entities are interconnected or intersected by extended strings, facilitating the transmission of energy and momentum through forces generated directly or via string collisions.

Particles that carry energy and momentum induce vibrations and bending in the connected strings, causing energy and momentum to propagate along them. Similarly, the energy and momentum present in the strings can induce vibrations and motion in the particles. When strings carrying energy and momentum collide with other strings, this energy and momentum are transmitted through the points of intersection, altering the state of other strings to enable continued energy and momentum transmission.

3.2. Relevant Evidence

According to the hypothesis that "electromagnetic waves are waves formed by continuous long string vibration," combined with formula (1), the string tension T is a constant value, strings are homogeneous, and the speed of light c is a constant value. It is evident that energy is proportional to mass, and at the same time proportional to the length of the curved string, and mass is proportional to the length of the string. The string compressed in the particle core has potential energy. Regardless of whether the tension of the string changes in the compressed, high-curvature state, when the string unwinds and fully releases its energy, it will eventually return to a state with constant tension. As the unwound string vibrates, it generates electromagnetic waves, fully releasing potential energy in the form of electromagnetic waves and eventually returning to a straightened state， the total energy released is $\Delta E = T\Delta L$. ΔL is the length of the unwinding string, which is consistent with the mass-energy conversion relationship. The unwinding string in the particle core is separated from the particle core. Mass annihilation releases energy. The mass of the unwinding string is the mass Δm annihilated in the nucleus. Therefore

$$\Delta E = T\Delta L = \Delta mc^2 \qquad (2)$$

For example, in the neutron decay process, protons, electrons, and neutrinos are produced[11,12]. Part of the string originally entangled in the neutron becomes disentangled and

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separates from it, Meanwhile, the section of the string connected to the electron sufficiently unravels, releasing energy in the form of electromagnetic waves, which increases the electron's kinetic energy. This release increases the kinetic energy of the electron, resulting in mass annihilation, while the remaining strings remain entangled to form electrons. When the entangled strings are unwound, they convert into dark matter the mass of which cannot currently be measured directly. Ignoring energy lost to thermal radiation, the kinetic energy imparted to the electron from the released energy can be converted into mass according to formula (2). The alignment of the mass-energy conversion principle with this model underscores its validity.

Particles, objects, and celestial bodies are directly connected or intersected by strings, forming an interconnected network linking all matter. Strings permeate space, allowing energy and momentum to propagate between them. When the energy from string vibrations connected with particles interacts with those particles, it can induce vibrations that generate matter waves[13], further supporting this model. In its unwound state, a string is a homogeneous long string. When the energy of a single wave period corresponds precisely to the energy value in Planck's constant, the wave speed is inherently the speed of light[6], which is its inherent attribute. Light emitted by an object propagates outward through string vibrations, and detectors perceive it through matching vibrations. As an object moves, the strings connected to it move in synchrony. Regardless of the motion of the light source or the detector , the strings move in sync with them, ensuring that the speed of light remains constant, in accordance with the principle of invariance of the speed of light. The Michelson-Morley experiment aimed to measure the Earth's relative motion with respect to "ether" and found no evidence of ether drift. If the strings filling space described in this paper are likened to "ether," it aligns with J. Larmor's original view that ether may be "pulled" by the Earth, which is consistent with the results of the Michelson-Morley experiment[14].

Nobel Prize winner Samuel C.C. Ting proposed that "electrons have radius but no volume" based on experiments measuring electron radius using high-energy impacts[15]. From the particle formation model presented here, it follows that strings within the particle core are highly compressed, while extended strings diffuse outward around the periphery of the nucleus. The string density is greater closer to the core, resulting in more significant force production. In high-energy electron impact experiments, when an impact occurs with lower energy, it affects the strings located farther from the nucleus. In these cases, the force effect is relatively smaller, but it still generates a measurable feedback force, resulting in a larger feedback electron radius. As the impact energy increases, collisions occur closer to the particle nucleus, leading to a smaller feedback radius for the electron. The particle model suggests that although strings are highly compressed in the core, gaps still exist between them. When the impact energy reaches a critical threshold, it becomes possible to further compress the strings inside the nucleus, and the measured electron radius continues to decrease, potentially becoming smaller than the Compton wavelength. Thus, within this particle model, the assertion that 'electrons have a radius but no volume' is validated.

4. Discussion

4.1. The Nature of Force

According to the particle model formed by string winding, highly compressed strings reside in the particle core. Excessive curvature can lead to increased string tension, resulting in a strong force. The particle core vibrates at high speed, causing the extending strings to swing accordingly(the tension of the extended strings, denoted as T, represents the fixed string tension, consistent with the value mentioned earlier). It causes strings to collide with other strings at high frequencies, transmitting the string tension between them and generating electromagnetic force. The rotation of an object causes the strings extending from its periphery to swing, generating a magnetic moment, consistent with Blackett's view that any rotating body possesses a magnetic moment[16]. Strings can also collide at low frequencies, allowing energy, momentum, and force to be transmitted through their intersection points, thereby generating gravitational effects. The intersection points of the strings act as channels for momentum and energy transmission, allowing particles directly connected

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by strings to convey momentum and energy through the strings themselves. As particles approach one another, the strings at their peripheries compress and repel each other, generating a repulsive force. In this model, gravitational waves are produced by the swinging of strings. It is possible to unify the fundamental forces through this model. This framework also suggests that calculating the value of string tension T could lead to the quantization of gravitational force. From the perspective of classical mechanics, gravity acts continuously, so gravity can be calculated by the intersection points where the strings collide and no longer separate from each other due to the tension of the strings. Imagine that when all the strings extended from two objects intersect at a single time (regardless of the repeated intersections at a distance outside the gravitational influence range), the number of intersection points is the product of the number of strings extended from two objects, represented by f, and the string tension T is the basic unit of gravity. If the tension in the strings of one of the objects at the intersection points acts in the same direction, the resulting gravitational force $F = fT$ between the two objects is determined. Independently, the relationship between mass and the number of strings extending from the corresponding mass can be described through a ratio. This ratio, termed the mass-to-output ratio, is denoted by $\mu = m/n$, where m being the mass and n the number of strings extending from the corresponding mass. This establishes a relationship between gravitational force and mass , expressed as

$$F = fT = n_1 n_2 T = m_1 m_2 T/\mu_1 \mu_2 \quad (3)$$

For the sake of argument, assuming this theory is feasible for verification, it is based on the current theory that the mass of different neutrons is the same, then it can be considered that the mass-to-output ratio of all neutrons is also equal, and the mass of an object composed of neutrons will be an integer multiple of neutrons, and the mass-to-output ratio is also equal to the mass-to-output ratio of neutrons themselves. It can be concluded that in a gravitational field generated by n_{G} strings, all strings extending from objects composed of neutrons intersect the strings of the gravitational field, and the gravitational force is...

$$F_{\mathrm{G}} = n_{\mathrm{G}} mT/\mu_{\mathrm{N}} \quad (4)$$

Where m is the mass of the object, and μ_{N} is the neutron mass output ratio.

From equation (4), the acceleration of an object composed of neutrons in the gravitational field can be obtained

$$a = n_{\mathrm{G}} T/\mu_{\mathrm{N}} \quad (5)$$

Since both T and μ_{N} are constant values, it can be seen from equation (5) that the acceleration of an object composed of neutrons in the same gravitational field has nothing to do with the mass of the object, but only with the strength of the gravitational field. This result is consistent with the law of free fall, which explains the rationality of the gravitational calculation theory to a certain extent.

In existing theories, macroscopic objects are composed of atoms, which consist of nuclei and electrons surrounding the nucleus. Nuclei themselves are composed of protons and neutrons. Since neutrons can decay into a combination of protons, electrons, and neutrinos, and this combination can also convert back into neutrons[11,12], protons, electrons, and neutrinos together can be considered equivalent to a neutron, with their combined mass equal to that of a neutron. From this perspective, we can generally consider the macroscopic world as primarily composed of neutrons. According to the current theoretical framework, the mass number of a hydrogen atom is 1, which is the same for a neutron. This mass calculation implicitly accepts neutrons as the basic unit of macroscopic matter. Although mass annihilation occurs during the decay of neutrons into protons, according to the previous explanation, this process merely represents the unwinding of strings; the strings themselves do not disappear. Instead, the unwound strings either drift between particles or become entangled with other strings (while ignoring the minimal mass of neutrinos that escape from massive objects). This annihilation does not impact the mass of macroscopic massive objects or alter their mass-to-output ratio. Therefore, it is feasible to express the gravitational force of macroscopic objects when all the strings extending from these objects intersect with the strings in the gravitational field， as

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indicated by formula (4). At the same time, it can be considered that in formula (3) where $\mu_1 = \mu_2 = \mu_N$, the gravitational force of two macroscopic objects when all the extended strings intersect can be expressed as

$$F = m_1 m_2 T / \mu_N^2 \quad (6)$$

The formula (6) is only applicable for approximate evaluation under the ideal condition that all strings extending from two objects intersect only once; It requires further verification with additional data. From a quantum perspective, in real situations, there are intersections that separate after collision, and the number of intersections fluctuates simultaneously in the process. Moreover, only a small number of particles are directly connected by strings, making it challenging to precisely calculate string intersections at the microscopic level. In macroscopic celestial bodies, the rotation drives the peripheral strings to swing, causing them to extend outward into shapes such as spirals and vortices. Within the gravitational influence range, the strings of two distant celestial bodies do not all intersect, and the number of intersection points varies with distance. Thus, there is a certain relationship between gravitational effects and distance. If it is correct that gravity arises from this process and that all particles adhere to Newton's law $F = ma$, then there exists a fundamental particle with a fixed mass-to-output ratio.This elementary particle constitutes the basis of all currently discovered particles with mass. In the absence of decay, the mass of any known particle is an integer multiple of this fundamental particle, and the mass-to-output ratio remains constant.

Due to the existence of the mass-to-output ratio, electromagnetic waves, with an initial string vibration speed equal to the speed of light, do not carry sufficient energy to cause particles—formed by entangled strings—to vibrate at the speed of light when this energy propagates to them. This principle distinguishes matter with measurable mass from dark matter. The reason why photons do not have rest mass is that they are only energy formed by the vibration of the string. When the string stops vibrating, photons do not exist. When light is transmitted to the particles, all the particles absorb is the energy.

The viewpoint on gravity formation presented in this paper also finds supporting evidence within the universe. In 1970, Vera Rubin and Kent Ford observed the rotation speed of stars in the Andromeda Nebula and found that, over a considerable range, the speed of stars outside the galaxy remains constant. According to Newton's Law of Universal Gravitation, if the mass of the galaxy were mainly concentrated in the visible stars of the galactic nucleus, the velocity of stars outside the galaxy would decrease with distance[17], which contradicts these observations.

Based on the proposed reasons for gravity generation in this paper, string lines become entangled to form the galactic nucleus, which can be regarded as a cohesive entity. The number of string lines extending outward is fixed, and stars orbit around the galactic nucleus under the "traction" of these strings. Consequently, the distribution of stars reflects the arrangement of string lines. Within the galactic nucleus, the string lines exhibit high curvature, spreading in a near-vortex shape as they extend to the periphery. As the strings diffuse outward, observations of galactic images allow us to infer that within a certain range on the galaxy's lever arm, the outer strings are nearly parallel to those closer to the galactic nucleus. This suggests that the string curvature in this region is nearly uniform, indicating a similar density of strings that form the gravitational field in this area. Consequently, it implies that the gravitational field strength in regions outside a certain radius of the galactic core is nearly equivalent to that closer to the core. At this point, further analysis from the perspective of Newton's law of universal gravitation supports this interpretation， the centripetal force acting on peripheral stars is nearly equal to that acting on stars close to the galaxy's nucleus. This explanation accounts for the constant velocity of peripheral stars over considerable distance.

Additionally, galaxy clusters contain substantial amounts of dark matter, consisting of unwound strings that interrelate matter by intersecting and linking to fill space.

The reason apples fall to the Earth's surface is due to the twisting of strings extended from the Earth during its rotation, which creates curvature. This curvature increases as one approaches the Earth's surface from high altitudes, causing the apple to move downward. When the connection between the apple and the tree is broken, and in the absence of electromagnetic force counteracting gravity, the curvature of the strings associated with the apple's periphery begins to increase due to

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the Earth's rotation, twisting towards the Earth's surface. This curvature transmits energy and momentum to the apple through the strings, causing it to move toward the surface of the earth.

The strings extending from the Earth's surface intersect with those on the periphery of the Moon, facilitating the transfer of momentum and energy. Simultaneously, the Moon is influenced by strings extending from other celestial bodies, such as the sun and the black hole at the center of the Milky Way. These multiple string interactions transmit momentum and energy collectively, resulting in the Moon's revolution, which can be simply understood as the Moon being pulled by multiple strings as it orbits the Earth. The trajectory of celestial bodies represents the path of the resultant force of string tension acting upon them.

Ultimately, the essence of gravity is the transfer of energy and momentum between celestial bodies, particles, and other substances through strings. It can explain the action-at-a-distance nature of gravity and aligns with Einstein's proposition that gravity propagates at the speed of light. Since energy within a three-dimensional material system can only be transmitted through strings, these strings represent space, and their distortion signifies the distortion of space.

4.2. Black Holes, Dark Matter, Dark Energy, and the Accelerated Expansion of the Universe

According to Einstein's theory of relativity, time in a black hole may be stationary. To conceptualize this stationary time, we can think of it as a state of "stopped development," where matter ceases any internal movement or change. Based on the particle formation model presented in this paper, black holes can be formed through the dense entanglement of strings, which become tightly compressed together.

Consider a solid sphere (although in reality, a black hole may not conform to a standard spherical shape, it tends to approximate a sphere during the accretion process; for the sake of convenience, we will refer to it as a sphere), where there is no internal motion. After the formation of the black hole, the strings extended from its surface continue to wrap around and compress towards the black hole, leading to a continuous increase in its mass. Simultaneously, the strings at the periphery 'pull' on the strings of celestial bodies approaching the black hole, compressing these bodies and eventually swallowing them as they near the surface of the black hole.

This leads us to consider the forces behind a black hole's powerful ability to continuously compress strings. In this paper, it is proposed that a black hole tends to be spherical because the strings of three-dimensional matter are immersed in smaller-scale matter and subjected to the pressure of higher-dimensional matter. When three-dimensional matter meets the conditions necessary for primordial black hole formation, the strings are compressed to the point where they form an entity composed of strings. In an ideal scenario, all internal high-dimensional matter is expelled, allowing the string-based matter to be compressed into a solid sphere under pressure. Referring to Pascal's principle, the original black hole can be seen as a sphere immersed in higher-dimensional matter with greater density, experiencing significant pressure. However, because the string structure that produces the primordial black hole contains extended string lines, and although strings can be considered one-dimensional in the three-dimensional world, in the case of smaller high-dimensional matter, they cannot be treated as one-dimensional lines. Instead, they have a cross-section. This creates a closed system between the string-based sphere and the outward-extending string lines, immersed in high-dimensional matter. Due to the pressure differential between the ball-surface of the string-based sphere and cross-section of the outward-extending string lines—similar to Pascal's principle. When the sum of all the cross-sections of the extended and broken string lines is smaller than the surface area of the sphere, the pressure at the cross-sections exceeds that of the sphere’s surface, causing compression. Under the pressure of high-dimensional matter, the strings begin to compress from the cross-sections, progressively compressing the strings ahead. Since the strings, apart from their length, have consistent physical properties and are homogeneous, the compression propagates at a constant speed toward the string sphere, driving the sphere to rotate and the strings to coil around it.

Due to the spherical shape of the black hole, the line speeds between the equator and the regions near the poles cannot be uniform. Driven by the string lines, different regions of the black hole

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generate energy collisions, eventually reaching an equilibrium state. The phenomenon caused by the formation of black holes through the above mechanism is consistent with the actual observations. For instance, at the poles of the black hole, where rotation occurs at high speed, the strings twist and become entangled due to the rotation of the black hole. The string tension causes work to be done outward, resulting in the formation of a black hole jet.

Research by Narayan and McClintock in 2012 provided direct evidence that this jet may be powered by the black hole's spin energy[18], supporting the perspective of this article. Since the black hole jet is produced by the twisting of strings resulting from the black hole's spin, its direction generally aligns with the rotation axis. In 2013, Saripalli, Malarecki, and colleagues found that the rotation axis of the black hole and the direction of the jet remain stable over time[19], further corroborating this viewpoint.

Because the strings are compressed by high-dimensional matter, they drive the rotation of the black hole, causing them to wind around the black hole. The fixed speed of squeezed string propagation implies that the linear velocity at the equator of a rotating black hole should also remain constant. This observation is consistent with research by Kato, Miyoshi, and others in 2010, which noted that 'there is no significant difference in the linear velocity of large and small black holes at the equator[20].' The linear speed at the rotating black hole's equator is the highest, resulting in the fastest string winding speed and, consequently, the highest energy flow rate on the equatorial plane. This effect causes celestial bodies outside the galactic nucleus to preferentially rotate in the equatorial plane, which is consistent with observational data.

Previously, we noted that the unentangled state of strings represents dark matter, the mass of which cannot currently be measured directly.

The dense entanglement of strings into black holes marks the transformation of dark matter into heavy matter. International studies suggest that there was more dark matter in the early universe than exists today, indicating that dark matter is in decline. For example, a collaborative research team from the University of Melbourne, Rice University, CERN, and other institutions posited that "dark matter is decreasing" based on extensive data analysis[21–24], supporting the claims made in this paper.

In addition to devouring visible celestial bodies to gain energy, black holes also increase mass and energy by incorporating strings beyond those forming visible bodies. These strings are squeezed by high-dimensional matter to create dark energy. While the strings push the black hole to rotate, they simultaneously wind around it， converting dark energy into measurable energy. Farrah, Petty, Croker, and others compared observations of distant galaxies with central black holes and local elliptical galaxies, finding that the mass of central black holes increased 7 to 20 times compared to 9 billion years ago. This rapid mass growth cannot be explained solely by accretion and merging[25]. Using the black hole formation theory proposed in this paper, we can explain this rapid mass increase as a result of continuous string entanglement, which also leads to the absorption of dark matter.

As the strings push the black hole to rotate, the spherical structure of the black hole means that energies at different positions confront each other. The winding speed of the strings cannot reach the speed at which they are compressed by high-dimensional matter. Consequently, when the squeezed state reaches the black hole's surface, the strings become distorted, and this distorted state propagates outward along the string lines. The interactions among the string lines surrounding the black hole lead to the formation of the various galaxy shapes.

In two different galaxies, each formed around its own central black hole, the respective strings of each galaxy become entangled with their own black hole, while the strings belonging to the two galaxies are fractured. The strings from different galaxies are compressed against each other, and these strings naturally tend to transition from high curvature to low curvature. As the galaxies continue to move farther apart in the expanding universe, the tension between the strings accelerates their separation. This process helps explain the observed accelerated expansion of the universe.

Ordinary energy and dark energy can be differentiated by their generation processes. Ordinary energy arises from the transverse vibration of strings, whereas dark energy is produced by the longitudinal compression of strings and their intrinsic distortion.

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The black hole formation model proposed in this paper provides a coherent framework that links seemingly independent phenomena related to black holes, dark matter, dark energy, and the accelerated expansion of the universe, thereby supporting the rationality of this perspective.

4.3. Inertia

To understand inertia, defined as the tendency of objects to remain stationary or maintain linear motion at a constant speed, it is essential to analyze the motion of objects within the universe. According to the model presented in this paper, objects composed of strings form celestial bodies, which are interconnected through strings to a central black hole in their respective galaxies. In the vast expanse of cosmic space, it can be observed that objects oscillate widely under the influence of these strings. The transmission of momentum through the strings results in either continuous or intermittent motion. Momentum is continuously transmitted through the strings, causing sustained motion of the object, while intermittent transmission of momentum through the strings leads to intermittent motion.

The change in momentum directly determines the change in the speed of an object. When two relatively stationary objects oscillate in space due to string traction, the speed changes of these two objects are consistent, and they swing synchronously toward their predetermined positions. One object is subjected to an additional external force (hereinafter referred to as "external force"), both the object and the string generating the external force exchange momentum. The momentum directed opposite to the external force is absorbed, leading to a loss of momentum in the affected object, causing its speed change to no longer be consistent with that of another object that is not affected by the external force.

Since the instantaneous direction of a force is unique, the simultaneous action of multiple forces produces a resultant force, whose instantaneous direction is also unique. The momentum loss of the object influenced by the external force is fixed at the moment the external force is removed, resulting in a consistent speed difference between the object experiencing the force and the one that is not. The object unaffected by the external force continues along its original trajectory, exhibiting uniform linear motion relative to the object subjected to the external force, until it reaches a predetermined position.

The oscillations in the universe represent large-scale phenomena. Both celestial bodies and objects on them receive momentum transmitted through strings, causing them to move at high speeds, with velocity changes occurring continuously. When the external force does not fully absorb the object's momentum but only reduces it, the fixed momentum loss remains after the external force is removed. However, if the external force is too great and absorbs all the original swing momentum, it can impart additional momentum to the object, enabling it to overcome the original string's traction. This results in motion in a new direction. When the external force is removed, the object will once again be influenced by the original string's traction, causing a change in its motion direction. At this point, the two objects will no longer have a fixed speed difference, and they will no longer exhibit uniform linear motion.

In this context, a non-rotating macroscopic object will remain in an absolutely stationary state if it is not subjected to any external forces—neither affected by string tension nor by collisions that transmit momentum, nor releasing internal energy outward.

4.4. Conditions for Particles to Generate Thermal Radiation

Since the energy of thermal radiation is quantized, the vibration of a particle drives the vibration of the string connected to it, allowing the string to share energy. For a particle to generate thermal radiation, all vibrations of the connected strings must meet the conditions necessary to form electromagnetic waves. Specifically, the energy distributed by the string per second must reach the value contained within Planck's constant.

This indicates that there is an energy accumulation process for particles, transitioning from absorbing thermal radiation to generating it. This process contributes to a delay in the propagation of thermal radiation in a medium filled with particles.

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This phenomenon explains why superluminal speed is generally measurable only in free space during experiments[8]. It also clarifies that the occurrence of faster-than-light speeds may indeed be a common phenomenon, as the gaps between microscopic particles in the space where humans reside can be considered as free space.

Therefore, superluminal effects should be prevalent on this scale.

5. Conclusions

This hypothesis proposes that particles are formed by the winding and compressing of strings of electromagnetic waves generated by vibration. Particles, objects, and celestial bodies are interconnected through these strings, which transmit momentum, energy, and force. This model illustrates the relationship between mass and energy conversion, explains the formation of matter waves, clarifies the principle that "an electron has a radius but no volume," and reaffirms the constancy of the speed of light.

Further discussion suggests that the strong force arising from string tension increases with high curvature, while gravitational effects can result from low-frequency collisions of strings. Electromagnetic forces may be formed by high-frequency collisions of strings, with string line serving as the fundamental material composing three-dimensional space. Further research into the possibility of a unified fundamental force and the quantization of gravity may emerge from this framework. The gravitational formula constructed from the intersection points of low-frequency string collisions aligns with the law of free fall and can also explain the phenomenon of abnormal rotational speeds of celestial bodies in large nebulae. However, the constructed gravitational formula is only applicable for approximate calculations in ideal conditions and still requires further refinement and verification.

It is posited that dark matter, like ordinary matter, is composed of strings. When these strings are entangled, they form ordinary matter; once unentangled, they become dark matter. Black holes are proposed to be solid spheres formed by the dense entanglement of strings, immersed in high-dimensional matter with smaller scale. In this high-dimensional environment, the matter exerts pressure on the cross-sectional shape of the strings extending from the black hole, generating dark energy. This dark energy causes the strings to both push the black hole into rotation and wind around it.

The interactions among the strings surrounding the black hole contribute to the shape of galaxies. The spin of the black hole powers its jet, while the stability of the black hole's rotation axis and jet direction persists over time. Observations indicate that there is minimal difference in the equatorial linear velocity between large and small rotating black holes, dark matter is diminishing, the mass of black holes is increasing at an unusually rapid rate, and celestial bodies outside the galactic nucleus tend to rotate along the equatorial plane. These seemingly independent phenomena can be unified and explained by using strings as the fundamental material, supporting the argument presented in this paper. The mutual compression and push between the strings of two different galaxies can accelerate their separation, and this explanation for the accelerated expansion of the universe also supports the views proposed in this paper.

This framework distinguishes between dark energy—formed through longitudinal compression and bending of strings—and ordinary energy, which arises from the transverse vibration of strings. The model established by considering strings as the fundamental substance can cohesively explain numerous independent phenomena mentioned in this paper, including inertia, thereby demonstrating the validity of the hypothesis presented.

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