**Research on Graviton Superluminal Phenomena Based on Negative-Mass Dark Matter Field Combination Theory and Its Cosmological Implications**

**Authors:** Li Zhijun, Zhao Guangyao

**Abstract:**Based on the Li Zhijun field combination theory, this paper explores the physical mechanism of graviton superluminal motion in a negative-mass dark matter field and its profound impact on cosmology. The theoretical model indicates that gravitons, due to their extremely small rest mass, experience repulsive resistance from the negative-mass dark matter field and may propagate at speeds exceeding the speed of light. This phenomenon challenges the traditional assumption of the speed of light as a universal limit and provides new insights into explaining the formation of early cosmic structures, the black hole information paradox, and other fundamental problems. By incorporating the latest experimental observation data, this paper proposes feasible schemes for verifying graviton superluminality, aiming to provide new directions for the development of quantum gravity theory.

**Keywords:** Graviton superluminality; Negative-mass dark matter field; Quantum gravity; Cosmology; Li Zhijun field combination theory

1. **Introduction**

Einstein’s general relativity describes gravity as a geometric effect of spacetime curvature and assumes the speed of light as the ultimate speed for information transmission in the universe. However, recent precise experiments by Chinese scientists have measured the upper limit of the photon’s dynamic mass ( kg), suggesting that the photon’s rest mass may be non-zero, which poses a potential need for revision of the traditional electromagnetic theory framework. If gravitons exist and their rest mass (estimated kg) is much smaller than that of photons, they may achieve superluminal motion in a negative-mass dark matter field due to weaker repulsive resistance.

The Li Zhijun field combination theory proposes that the universe contains a negative-mass dark matter “soup” field, whose repulsive resistance on elementary particles is inversely proportional to the particle’s rest mass. This framework provides a new approach to unifying gravity and quantum mechanics, particularly as the superluminality of gravitons may redefine causality and cosmic evolution models. Based on this theory, this paper constructs a self-consistent mathematical model for graviton superluminality and discusses its implications for cosmic structure formation, black hole physics, and quantum gravity theory.

1. **Theoretical Framework: Particle Motion Model in Negative-Mass Dark Matter Field**

**2.1 Repulsion Mechanism of Negative-Mass Dark Matter Field**

Let the energy density of the negative-mass dark matter field be The repulsive resistance it exerts on moving particles satisfies the following relationship with the particle’s rest mass :

where k is the field coupling constant. The resistance direction is opposite to the particle’s motion direction. The effective equation of motion can be written as:

Combining with the relativistic momentum (where is the Lorentz factor), the steady-state relationship between particle velocity v and rest mass is derived:

This equation shows that the smaller the particle’s rest mass, the closer its velocity approaches or even exceeds the speed of light c.

**2.2 Critical Conditions for Graviton Superluminality**

When the graviton’s rest mass the correction term approaches zero, allowing the graviton velocity to exceed the speed of light. For example, if kg and then This result matches the graviton “projection” data observed by the Nanjing University team through polarized light scattering experiments.

Table 1: Mass-Velocity Relationships and Energy Equations for Different Particle Classes

| **Particle Class** | **Rest Mass Range (kg)** | **Velocity Characteristics** | **Mass-Energy Equation** | **Energy Source** |
| --- | --- | --- | --- | --- |
| Particle-level (photon) |  |  |  | Conventional sources (nuclear fusion, etc.) |
| Graviton-level |  |  |  | Quasar jets |
| odderon-level |  |  |  | Big Bang energy source |

**2.3 Compatibility with Existing Theories**

Graviton superluminality does not necessarily violate relativity. The speed of light limit in special relativity applies to massive particles and information transmission, while gravitons as excitations of spacetime itself may follow different rules. Additionally, the existence of negative-mass dark matter may explain dark energy effects, with its energy density potentially related to the cosmological constant providing cosmological-scale self-consistency for superluminal phenomena.

1. **Cosmological Implications and Observational Verification**

**3.1 Impact on Early Universe Structure Formation**

If gravitons are superluminal, their propagation speed during cosmic inflation may be much higher than light speed, more efficiently smoothing the distribution of cosmic matter and solving the horizon problem in traditional Big Bang models. For example, the anisotropy of cosmic microwave background radiation may originate from enhanced causal connections due to graviton superluminality.

**3.2 Black Hole Information Paradox and Gravitational Wave Astronomy**

Graviton superluminality may provide a new solution to the black hole information paradox: information could escape the black hole event horizon via superluminal gravitons, avoiding information loss. Furthermore, precise measurements of the arrival time difference () between gravitational waves and electromagnetic signals from binary neutron star mergers (e.g., GW170817) can verify graviton superluminality. Future observations of cases with would provide direct evidence of superluminality.

Table 2: Potential Observational Verification Schemes for Graviton Superluminality

| **Verification Method** | **Principle** | **Expected Phenomenon** | **Current Experimental Progress** |
| --- | --- | --- | --- |
| Gravitational wave-electromagnetic signal time difference | Compare arrival times of GW and EM waves from same astronomical event | (GW arrives earlier) | GW170817 event , future higher precision needed |
| Quasar jet energy analysis | Quasar energy exceeds explainable range by existing theory () | Obeys graviton-level mass-energy equation | Quasar energy observed up to times solar nuclear fusion |
| Atomic stability research | Anomalous energy source for electron nuclear orbit motion | odderon-level energy equation provides power | Atomic lifetime far exceeds nuclear energy support limit |

**3.3 Consistency with Cosmological Observations**

If gravitons are superluminal, the gravitational potential energy they carry may affect the cosmic expansion rate. By comparing supernova redshift data with theoretical predictions, the negative-mass field parameter can be inferred. For example, if cosmic accelerated expansion is related to graviton superluminality, measurements of the Hubble constant might show anisotropic characteristics.

1. **Theoretical Self-Consistency and Extended Discussion**

**4.1 Compatibility with Quantum Field Theory**

Graviton superluminal motion can be made self-consistent through the concept of virtual particles: quantum field theory allows virtual particles to briefly exceed light speed, while gravitons as ground state excitations of spacetime might possess similar characteristics without violating causality. Additionally, the coupling between gravitons and anti-gravitons in Li’s theory (A-field and C-field mutual exclusion) can be viewed as a form of dynamic symmetry breaking, avoiding conflict with Noether’s theorem.

**4.2 Extension of Particle Physics Standards**

The graviton in the standard model is hypothesized as a spin-2, mass-0 boson. If its superluminality is confirmed, new gauge symmetries (such as supersymmetry or extra dimensions) would need to be introduced to explain its interaction with the Higgs mechanism. For example, the velocity of odderon-level matter (where is graviton velocity) might correspond to physical phenomena at the Planck scale.

**4.3 Experimental Challenges and Prospects**

Current experiments face two major challenges:  
\* Extreme environmental requirements: Graviton detection requires conditions near absolute zero () and ultra-strong magnetic fields ( times Earth’s magnetic field)

* Instrument precision limitations: Existing equipment cannot directly capture graviton signals, requiring new methods such as polarized light scattering technology or quantum interferometers

Future verification may be achieved through space gravitational wave detectors (e.g., LISA) or direct dark matter detection experiments (e.g., LZ collaboration).

1. **Conclusion and Outlook**

Based on the Li Zhijun field combination theory, this paper demonstrates the physical possibility of graviton superluminal motion in negative-mass dark matter fields and analyzes its profound impact on cosmic structure formation, black hole physics, and quantum gravity unification. The theoretical model shows that:  
1. Gravitons may propagate superluminally due to extremely small rest mass experiencing weak resistance from negative-mass fields  
2. This phenomenon can explain puzzles such as quasar energy sources and atomic stability  
3. The theory can be experimentally verified through gravitational wave time difference measurements and cosmological observations

Future work will focus on the quantization of graviton superluminality and its extension in odderon-level matter models. If confirmed, this theory would advance the grand unification of quantum gravity theories and provide new paradigms for frontier issues such as cosmic dark matter and dark energy.

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