Boundary-Spacetime Vortex Hypothesis (BSVH) for Sporadic Galaxy Generation

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Preface: A Spiritual Reflection

The Biblical phrase "Let there be light" (Genesis 1:3) symbolizes the universe's first act of order and creation. In cosmology, light marks the emergence of structure from chaos. The Boundary-Spacetime Vortex Hypothesis (BSVH) envisions light as a sporadic phenomenon, generated when intense oscillating gravitational gradients from colliding spacetime vortices at the cosmological boundary excite the quantum vacuum, triggering matter creation and galaxy formation under optimal conditions. Light remains a bridge between the physical and spiritual, chaos and cosmos, seen and unseen.

Abstract

This hypothesis proposes that galaxies form sporadically through spacetime vortex phenomena at the cosmological event horizon. When two vortices collide, they generate intense oscillating gravitational gradients that excite the quantum vacuum, producing high-density photon bursts. These photons undergo pair-production (($E = mc^2$)), creating stable matter that seeds galaxy formation when conditions are optimal. Vortex collision symmetry determines galaxy morphology: off-center interactions yield spiral galaxies with angular momentum, while symmetric interactions form elliptical or spherical structures. Due to the boundary's distance, this process appears static or merger-based locally, occurring beyond observable horizons.

Introduction

Traditional galaxy formation models, relying on primordial gravitational collapse, mergers, and accretion, struggle to explain anomalous high-redshift galaxies, such as the massive, mature systems observed by the James Webb Space Telescope (JWST) at ($z \gtrsim 10$). The BSVH proposes sporadic galaxy formation driven by episodic light and matter production at the cosmological boundary. Intense oscillating gravitational gradients, produced by vortex collisions, excite the quantum vacuum to generate photon bursts, seeding matter creation. This paper emphasizes light production as a gravitational effect on the quantum vacuum, offering a novel explanation for the rapid formation of early massive galaxies.

Analogous Support

Fluid dynamics provides an analogy: turbulent interactions at the leading edges of expanding blast waves (e.g., atomic explosions) generate vortices. Similarly, the cosmological boundary's rapid expansion creates spacetime turbulence, forming vortices that, upon collision, produce intense gravitational gradients. These gradients excite the quantum vacuum, sporadically generating light, akin to vacuum fluctuations in extreme curvature. While scaling fluid dynamics to cosmological boundaries is speculative, quantum electrodynamics (QED) vacuum breakdown experiments support this mechanism.

Detailed Hypothesis

The BSVH posits that the universe's expansion generates spacetime vortices at the cosmological event horizon, where turbulence and curvature prevail. Galaxy formation occurs sporadically when two vortices collide, creating optimal conditions: intense oscillating gravitational gradients that excite the quantum vacuum, producing high-density photon bursts that trigger matter creation.

Photon Generation Mechanism

When two vortices interact, their overlapping gravitational fields generate intense oscillating gradients—rapid variations in spacetime curvature. These gradients excite virtual particles in the quantum vacuum, promoting them to real photons, producing electromagnetic radiation. This mechanism is supported by:

- **Quantum Vacuum Fluctuations**: Intense gradients amplify vacuum energy, as demonstrated in QED vacuum breakdown experiments (e.g., XFEL, 2023).
- **Gravitational Energy Extraction**: Analogous to the Penrose process or Hawking radiation, spacetime curvature provides energy for photon bursts during vortex collisions.
- **Observational Precedents**: High-energy photon emissions near black holes and JWST's "little red dots" (LRDs) suggest curvature-driven radiation.

The photon bursts achieve sufficient energy density for photon-photon pair-production, converting light into stable matter (e.g., electrons, protons) via ($m = E/c^2$). Minor asymmetries, possibly due to CP violation or vortex turbulence, ensure matter accumulates without annihilation, seeding gravitational collapse when conditions (e.g., sufficient matter density, gravitational stability) are optimal.

Morphology Outcomes

Vortex collision symmetry dictates galaxy structure:

- **Off-Center Interactions**: Asymmetric matter distributions gain angular momentum, forming spiral galaxies.
- **Symmetric (Head-On) Interactions**: Uniform collapse produces elliptical galaxies or spherical clusters.

Observational Predictions

The BSVH offers testable predictions, particularly for early massive galaxies:

1. **Anomalous High-Redshift Galaxies**: Telescopes (e.g., JWST, Euclid, Nancy Grace Roman) will detect young, massive galaxies ($\sim 10^{11} \, M_\odot$) at $z \gtrsim 10$, resembling JWST's LRDs, formed sporadically during vortex collisions. Euclid's deep-field surveys could constrain LRD number density, testing the BSVH.
2. **Horizon Photon Anomalies**: Sporadic high-energy photon bursts or gamma-ray transients at cosmological horizons will indicate vacuum-driven light production.
3. **Gravitational Wave Signatures**: Unique gravitational wave patterns from vortex collisions, detectable by LIGO, VIRGO, or LISA.
4. **CMB Anomalies**: Localized cosmic microwave background (CMB) temperature fluctuations near the event horizon, observable by Planck or Simons Observatory.

JWST's LRDs—compact, energetic objects at $z \sim 10\text{-}15$—align with the BSVH, potentially representing early galaxy seeds from vortex-driven events.

Addressing Criticisms

The BSVH treats the cosmological event horizon as a dynamic frontier, despite cosmology's boundaryless view. It leverages known physics—quantum vacuum energy, pair-production, gravitational effects on the vacuum—in a novel context. The sporadic light generation mechanism, driven by oscillating gravitational gradients, aligns with QED and gravitational analogies. The hypothesis's support for early massive galaxies addresses observational anomalies. Future quantitative models will refine energy extraction and matter yield, ensuring consistency with general relativity and quantum field theory.

Feasibility Discussion

The BSVH aligns with:

- **Quantum Vacuum Energy**: Supported by QED experiments and vacuum fluctuation theories, providing a plausible energy source.
- **Gravitational Gradients**: Analogous to Penrose process and Hawking radiation, where curvature excites the vacuum during vortex collisions.
- **JWST Observations**: LRDs, with masses up to ($\sim 10^{11} , M_\odot$) at ($z \gtrsim 10$), suggest sporadic boundary-driven formation.

While vortex collisions are speculative, quantum gravity theories and vacuum instabilities offer compatible frameworks. The focus on gravitational effects on the quantum vacuum strengthens the hypothesis's basis.

Conclusions

The BSVH offers a novel framework for sporadic galaxy formation, driven by quantum vacuum energy and intense oscillating gravitational gradients that excite the quantum vacuum during vortex collisions at the cosmological boundary. It addresses the rapid formation of early massive galaxies (($\sim 10^{11} , M_\odot$)) observed by JWST at ($z \gtrsim 10$), formed within ~500 million years through a non-hierarchical process. JWST's LRDs align with the BSVH's prediction of young, fully-formed galaxies, suggesting vortex-driven pair-production and gravitational collapse. Unlike standard hierarchical models, the BSVH explains the unexpected size, mass, and maturity of these galaxies. However, its speculative nature requires quantitative modeling to confirm matter production and vortex collision frequency. Observational tests targeting high-redshift galaxies, horizon photon bursts, gravitational waves, and CMB anomalies can validate the BSVH, potentially reshaping our understanding of cosmic evolution.

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Formal Credit

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