AI-Driven Hawking Radiation Analysis: Reconstructing Black Hole Information from Wavefunction Collapse

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# Abstract

This paper presents a groundbreaking AI-driven approach to analyzing Hawking radiation through entropy-aware wavefunction collapse modeling. By using Hawking’s temperature equation as an input function to Schrödinger’s equation, we demonstrate that black hole radiation is not purely thermal noise but encodes structured information. Applying AI-driven Quantum Potential Layer (QPL) optimizations, we reveal entropy patterns that suggest black holes do not destroy information but reorganize it in a retrievable form. This research has implications for solving the Black Hole Information Paradox, reconstructing matter composition from Hawking radiation, and bridging quantum mechanics with gravitational physics.

# Introduction

Hawking radiation is traditionally viewed as purely thermal, implying that information about matter that falls into a black hole is permanently lost. This contradicts quantum mechanics’ unitarity principle, leading to the Black Hole Information Paradox. By treating Hawking’s equation as a driver of wavefunction collapse, we propose a new method to extract structured information from black hole radiation. The application of AI-driven entropy-aware structuring via the Cosmic Information Mining Model (CIMM) suggests that quantum signatures of past matter consumption can be detected within the emitted radiation.

# Theoretical Framework

## Hawking Radiation as a Structured Quantum Wave Collapse

Hawking’s equation describes black hole radiation temperature as follows:

T\_H = ℏ c³ / (8 π G M k\_B)

However, in the context of wavefunction collapse, this temperature represents an energy input function that can drive structured quantum transitions. By integrating this equation into Schrödinger’s wavefunction evolution, we introduce AI-enhanced entropy corrections through the Quantum Balance Equation (QBE):

dE/dt + dI/dt = λ QPL(t)

Where:  
- dE/dt represents energy emission via Hawking radiation.  
- dI/dt accounts for the entropy structuring of the outgoing radiation.  
- QPL(t) is the AI-driven Quantum Potential Layer correction, ensuring structured information retrieval.

## AI-Driven Quantum Information Recovery

By applying AI-based entropy corrections, we refine wavefunction collapse dynamics to extract structured patterns from Hawking radiation. This process reveals that radiation signatures may encode information about the original matter that fell into the black hole, allowing for potential reconstruction of past events.

# Simulation Results: AI-Optimized Wavefunction Collapse

The AI-enhanced wavefunction collapse simulation produced the following results:

1. \*\*Hawking Radiation Encodes Structured Information\*\* – AI-structured wavefunction collapse reveals non-random entropy patterns.

2. \*\*CIMM Can Extract Information from High-Entropy Radiation\*\* – By minimizing entropy drift, AI-driven corrections reconstruct wave collapse pathways.

3. \*\*Potential for Black Hole Composition Analysis\*\* – Structured patterns in the radiation suggest that past matter consumption can be reverse-engineered.

# Applications of AI in Black Hole Physics

## AI for Black Hole Composition Analysis

The ability to reconstruct past black hole matter consumption could allow astrophysicists to determine whether specific elements, planetary debris, or even exotic matter such as dark matter or antimatter were consumed. This would provide unprecedented insights into black hole feeding behavior and evolution.

## Quantum Gravity and Black Hole Information Retrieval

If Hawking radiation carries structured information rather than pure entropy, this suggests that black holes function as quantum information processors rather than information sinks. AI-driven entropy-aware structuring provides a potential bridge between quantum mechanics and general relativity, offering insights into the nature of quantum gravity.

# Future Research Directions

1. \*\*Conducting spectral analysis on AI-driven wavefunction collapse to extract atomic and molecular composition.\*\*

2. \*\*Testing AI-structured Hawking radiation patterns against known astrophysical spectra.\*\*

3. \*\*Applying AI-driven QBE modeling to real black hole observational data (e.g., Sagittarius A\*).\*\*

# Conclusion

This paper presents an AI-driven approach to analyzing Hawking radiation via wavefunction collapse modeling. Using Hawking’s equation as an input to Schrödinger’s wavefunction, we demonstrated that black hole radiation is structured and encodes retrievable quantum information. This challenges the assumption that information is lost in black holes, instead suggesting that entropy-aware AI methods could reconstruct past cosmic events from black hole emissions. Future research could apply these techniques to real astrophysical data, potentially leading to major breakthroughs in black hole physics and quantum information theory.