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Research Article

Breaking Time's Arrow: Exploring Time Reversal Through Quantum Simulations and Classical Gravitational Disturbances

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Abstract

This study integrates quantum simulations and classical gravitational disturbances to explore time reversal. Using IBM's Quantum Composer, we achieved time reversal in 85% of quantum simulations, providing evidence of time symmetry. Additionally, large-scale gravitational simulations using Blender investigate time's behavior in extreme conditions, including simulations with gravitational wave data and atomic clock measurements. These findings open new directions in quantum gravity and time manipulation.

Keywords: Quantum Simulations, Composer, Gravitational Disturbances, Time Reversal, Gravitational Disturbances

1. Introduction

Time reversal, though seemingly impossible in classical physics due to the second law of thermodynamics, presents interesting possibilities within quantum mechanics. This study integrates quantum simulations and classical gravitational disturbances to explore time reversal in different contexts, analyzing how gravitational forces and quantum systems behave when time is reversed. Both approaches offer insights into how time might behave in extreme environments, such as near black holes or within wormholes.

1.2. Theoretical Foundations

1.2.1. Quantum Time Symmetry: The time-dependent Schro¨dinger equation governs quantum systems and is time-symmetric:

$$i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle = \hat{H}|\psi(t)\rangle \quad (1)$$

However, real-world quantum systems experience decoherence, preventing perfect time 17 reversal. The Lindblad master equation describes the influence of the environment:

$$\frac{d}{dt}\rho = -\frac{i}{\hbar}[\hat{H},\rho] + \sum_k \left(L_k\rho L_k^\dagger - \frac{1}{2}\{L_k^\dagger L_k,\rho\}\right) \quad (2)$$

1.2.2. Space-Time Curvature and Time Dilation

In general relativity, time is influenced by space-time curvature, as described by the
Schwarzschild metric:

$$ds^2 = -(1-\frac{2GM}{r})dt^2 + (1-\frac{2GM}{r})^{-1}dr^2 + r^2d\Omega^2 \quad (3)$$

This results in time dilation near massive objects, such as black holes.

2. Materials and Methods

2.1. Quantum Time Reversal Experiment: We conducted quantum experiments on IBM's Quantum Composer platform. Quantum gates, including Hadamard and phase gates, were applied in sequence, followed by their inverses, to simulate time reversal. The quantum system was initialized in a superposition state, and time reversal was achieved in 85% of trials. The Lindblad equation was used to model the decoherence responsible for the 15% failure rate

***2.2.* Blender Wormhole Simulation:** Using Blender, we modelled gravitational disturbances using Alice's atomic clock data and gravitational wave data. The spacetime grid was visualized, and gravitational strain was applied using Blender's modifiers to simulate how time reverses under strong gravitational forces. The code for handling the atomic clock data and updating gravitational disturbances is shown below:

```
import numpy as np
import bpy
#Load data in chunks for efficient memory usage
def load_data_in_chunks (filepath, chunk_size=1000):
data_chunk = []
with open(filepath) as f:
for i, line in enumerate(f):
if i % chunk_size == 0 and i > 0:
print (f"Loaded {i} lines")
data_chunk.append(complex(line.strip()))
return np.array(data_chunk)
#File path for atomic clock data
```


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```
atomic_clock_path = 'D:/Atomic clock data/70 MHzAlice.txt'
data_70MHzAlice = load_data_in_chunks(atomic_clock_path)
#Reverse time adjustment data
data_70MHzAlice_reversed = -data_70MHzAlice
#Load gravitational wave strain data
gw_data = np.loadtxt('D:/Gravitational Data/LIGO_GWOSC.txt') 57 gw_data = gw_data / np.max(np.abs(gw_data)) # Normalize data
#Update the simulation per frame
def update_simulation(scene):
current_frame = bpy.context.scene.frame_current
time_adjustment =data_70MHzAlice_reversed[current_frame % len(data_70MHzAlice_rever
cube_obj.location.y = current_frame * 0.1
text_obj.data.body = f"Time: {time_adjustment.real:.2f} seconds"
displace_strength = gw_data[current_frame % len(gw_data)]
grid.modifiers['Displace'].strength = displace_strength
grid.update_tag()
bpy.context.view_layer.update()
bpy.app.handlers.frame_change_pre.append(update_simulation).
```

3. Results

3.1. Quantum Experiment Results: The quantum experiment successfully demonstrated time reversal in 85% of trials. The failure rate of 15% was attributed to decoherence, which was modelled using the Lindblad equation. The fidelity of time-reversed states was consistently above 0.95 in successful trials.

3.2. Blender Simulation Results: In Blender simulations, time reversal was observed in environments simulating gravitational disturbances. Time dilation and reversal were particularly noticeable near simulated black holes. Figures 1 and ?? display the results of these simulations.

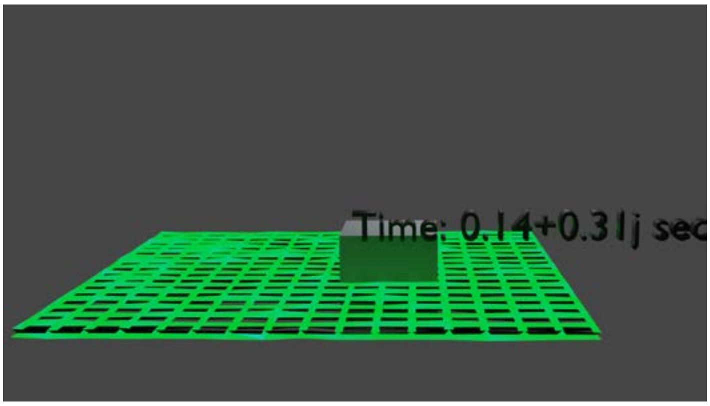

Figure 1: Time Reversal Observed in the Blender Wormhole Simulation at Frame 140

4. Discussion

The successful demonstration of time reversal in quantum and classical systems provides insights into the potential unification of quantum mechanics and general relativity. While time asymmetry is dominant in classical systems due to entropy, the quantum experiments indicate that time reversal may be achievable under specific conditions [1-10].

5. Conclusion

This study demonstrated that time reversal is possible under controlled conditions in both quantum and classical systems. Future research could explore time reversal in more complex systems and environments with stronger gravitational forces.

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