**Research Plan: Time-Driven Quantum Collapse & Double-Slit Interference Compression**

**1. Research Objectives**

**1.1 Hypothesis**

* Wavefunction collapse occurs naturally over time, independent of measurement.
* Interference fringes do not disappear as particle mass increases but rather compress, creating the illusion of classical behavior.
* Machine learning can predict wavefunction collapse time based on quantum data.

**1.2 Key Questions**

1. ***Does quantum superposition decay over time even without external measurement?***
2. ***Do double-slit interference fringes compress as mass increases instead of disappearing?***
3. ***Can we use machine learning to predict the time at which a quantum system collapses?***

**2. Data Collection**

**2.1 Quantum Superposition Data**

<https://zenodo.org/records/6510863>

**3. Methodology**

**3.1 Time-Driven Quantum Collapse Simulation**

* Implement an exponential decay function for wavefunction collapse:

where is a time-dependent collapse rate.

* Use Python (NumPy, Matplotlib) to simulate superposition probability decay.

**3.2 Double-Slit Interference Compression Simulation**

[**https://datadryad.org/stash/dataset/doi:10.5061/dryad.jh9w0vtcb**](https://datadryad.org/stash/dataset/doi:10.5061/dryad.jh9w0vtcb)

* Simulate wave interference patterns for varying particle masses.
* Implement a model where:

to predict how fringe spacing shrinks as mass increases.

**3.3 Machine Learning Model for Collapse Prediction**

* Train a linear regression model to predict wavefunction collapse time.
* Use real quantum data to validate results.
* Implement in Scikit-Learn & Pandas.

**4. Expected Outcomes**

**4.1 If Hypothesis is Correct**

✅ Superposition probability decays naturally over time, even without measurement. ✅ Interference fringes compress, showing quantum behavior persists at large scales. ✅ Machine learning successfully predicts collapse time.

**4.2 If Hypothesis is Incorrect**

❌ Superposition remains indefinitely unless measured (Copenhagen Interpretation holds). ❌ Interference disappears completely for large particles instead of compressing. ❌ Machine learning predictions fail due to lack of time-based collapse correlation.

**5. Next Steps**

1. Collect quantum coherence data from IBM Q & AWS Braket.
2. Implement TDQC simulation (tdqc\_simulation.py).
3. Implement double-slit interference model (double\_slit\_model.py).
4. Train ML model for collapse prediction (machine\_learning\_model.py).
5. Analyze & compare results in Quantum\_Collapse\_Analysis.ipynb.
6. Compile findings into research paper (docs/research\_paper.md).