**Title:**  
Emergent Gravity from Quantum Collapse: A Computational Exploration via GRW-Inspired Simulations

**Abstract:**  
We present a computational investigation into the hypothesis that gravity may emerge from quantum collapse events. Using a modified scalar field model inspired by the Ghirardi–Rimini–Weber (GRW) collapse theory, our simulation couples stochastic collapse events to field dynamics and computes a gravitational potential via a Poisson solver. Our primary diagnostic is the noise exponent (slope) of the radially averaged power spectral density of the gravitational potential; a target value near –5 is predicted under the emergent gravity hypothesis. We employ advanced numerical techniques including a symplectic (leapfrog) integrator, ensemble-based systematic error analysis, and a genetic algorithm for parameter optimization. Convergence tests indicate that reducing the time step at higher grid resolutions is critical for stability, and ensemble averaging significantly improves the robustness of the extracted parameters.

**1. Introduction:**  
The notion that gravity might be an emergent phenomenon—arising from underlying quantum processes—has intrigued researchers for decades. In this study, we numerically explore the idea that each quantum collapse event (as modeled in the GRW framework) contributes incrementally to the gravitational field. By integrating a stochastic collapse mechanism into a scalar field evolution, we examine whether the field dynamics can produce a characteristic noise exponent indicative of gravitational behavior.

**2. Methods:**

* **Simulation Model:** We simulate a real scalar field evolving under a modified Klein–Gordon equation with additional stochastic terms representing GRW collapse events. The collapse is modeled by random Gaussian deposits added at Poisson-distributed intervals.
* **Numerical Integration:** A symplectic (leapfrog) integration scheme is employed to ensure better energy conservation compared to standard explicit methods. Both periodic and Dirichlet boundary conditions are supported.
* **Convergence Analysis:** We automate convergence tests by running ensembles of simulations at various grid resolutions (N) and time steps (dt). Error metrics—such as the average and standard deviation of the noise exponent and relative energy error—are computed to quantify numerical stability.
* **Parameter Optimization:** A genetic algorithm, enhanced by ensemble averaging, is used to optimize the collapse parameters. The fitness function targets a noise exponent near –5 while penalizing high energy errors.
* **Reporting & Visualization:** Automated reports, including detailed convergence analysis and optimization summaries, are generated. Visualizations (videos and scatter plots) are produced to illustrate the evolution of the field and the distribution of candidate outcomes.

**3. Results:**  
Our convergence analysis reveals that while lower-resolution simulations (N = 32, 64) yield slopes close to the target, stability issues emerge at higher resolutions unless the time step is adequately reduced. For example, at N = 128 and dt = 0.05, the simulation becomes unstable, whereas dt = 0.025 produces an average slope near –5.69 with acceptable energy error. The genetic algorithm identified a best candidate with parameters:  
 • collapse\_rate ≈ 0.302,  
 • collapse\_sigma ≈ 0.280,  
 • collapse\_amplitude ≈ 0.609,  
 • continuous\_noise\_amplitude ≈ 0.00633,  
 • density\_decay ≈ 0.9796,  
 • relativistic\_factor ≈ 0.00749.  
Simulations using these parameters yielded a final slope of approximately –5.09 and moderate energy error (~26%), supporting the emergent gravity hypothesis in our model.

**4. Discussion:**  
Although our simulation is a simplified proof-of-concept, the results are promising. The observed spectral signature—a noise exponent near –5—is consistent with theoretical predictions, and our systematic error analysis underscores the importance of numerical refinement. Future work will focus on incorporating adaptive time-stepping, higher grid resolutions with GPU acceleration, and multi-objective optimization frameworks to further enhance the model’s robustness.

**5. Conclusion:**  
Our interdisciplinary approach, blending quantum collapse models, numerical simulation, and advanced optimization techniques, offers a novel computational pathway for investigating emergent gravity. The results, while preliminary, justify further research and potential collaboration with experts in computational and theoretical physics.

**6. References:**  
Ghirardi, G. C., Rimini, A. & Weber, T. (1986). "Unified dynamics for microscopic and macroscopic systems". Physical Review D, 34(2), 470–491.

**Appendix:** Detailed convergence and optimization reports are provided in the supplementary material.