`PHSX815_Project4`:
Nosy Waves: They Interfer!

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February 2023

1 Introduction

The study of interference phenomena is crucial in various fields of science, ranging from physics to optics and beyond. Interference experiments provide valuable insights into the wave nature of particles and allow us to understand the behavior of waves in different scenarios. The main objective of this simulation is to examine the influence of random noise and phase variations on the interference pattern formed by waves. This study helps us understand the limitations and challenges associated with real-world interference experiments and provides insights into the analysis of experimental results.

In the following sections, we will present our hypothesis, describe the code and simulation setup, analyze the simulated results, and finally, draw conclusions based on our findings.

2 Hypotheses

In this simulation, our hypothesis is that the introduction of random noise and phase variations will affect the interference pattern formed by the waves. We expect that the random noise will introduce fluctuations in the amplitude of the waves, leading to variations in the intensity of the interference pattern. Additionally, the phase variations will result in a shift or distortion of the interference fringes.

Random noise can arise from environmental factors, measurement limitations, or inherent noise in the wave generation process. Similarly, phase variations can occur due to imperfections in the experimental setup or fluctuations in the wave sources. By investigating the impact of these factors through simulation, we can gain insights into the limitations and challenges faced in real interference experiments and evaluate the accuracy of the measurements and analysis performed.

3 Code and Experimental Simulation

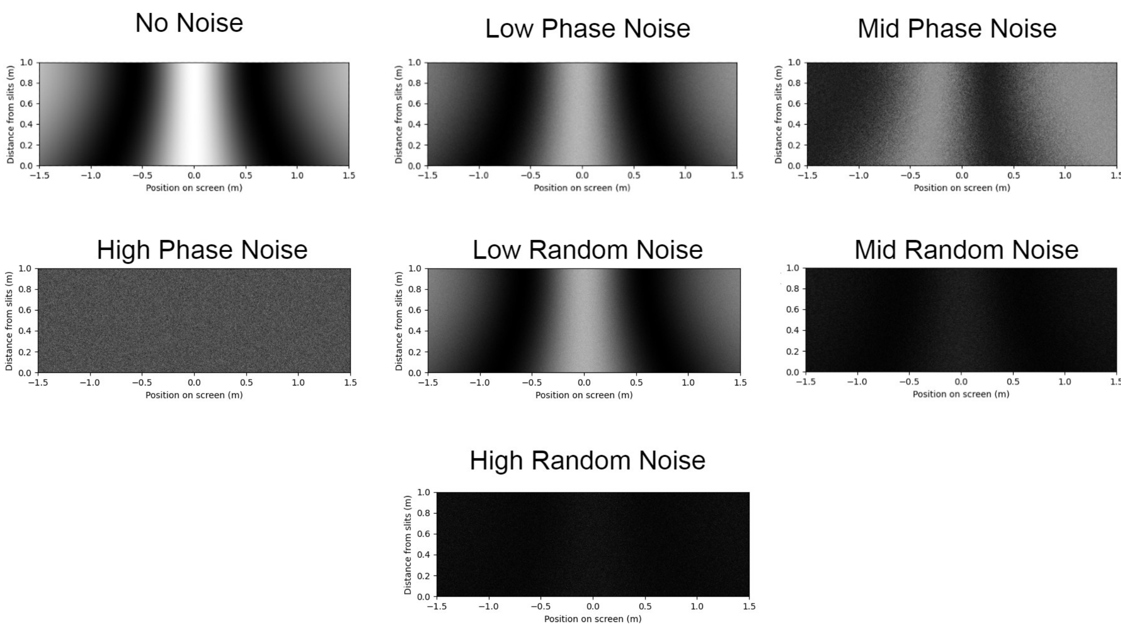
The simulation is implemented in Python using various libraries such as NumPy and Matplotlib. The simulation utilizes a wave function that calculates the interference pattern at different points on the screen. The wave function takes into account the amplitude of the wave, the distance from each slit to each point on the screen, and the phase difference between the waves from each slit with added random phase noise. Random noise is also introduced to the total wave amplitude at each point on the screen.

The interference pattern is then calculated by following formula, and the resulting pattern is visualized using the Matplotlib library; The pattern is displayed as an image, with intensity represented by pixel values, and the image is saved as an output file. The random phase noise is simulated using Uniform random sampling, whereas the random noise is introduced using Gaussian Random sampling.

4 Analysis

Effect of Random Noise: The introduction of random noise in the simulation affects the amplitude of the waves at each point on the screen. This random noise leads to fluctuations in the intensity of the interference pattern. As a result, the interference fringes may become less distinct and exhibit variations in brightness.

Effect of Phase Variations: The simulation incorporates phase variations in the interference pattern by adding random phase noise to the phase difference between waves from each slit. These phase variations result in a shift or distortion of the interference fringes.



5 Conclusion

The simulation suggests that we should reject the null hypothesis in favor of alternative hypothesis. The simulation shows that in N events the fraction of positive muon and negative muons is different. The simulation is almost ready to be used in labs for students. An analysis of posterior distribution might be helpful feature to add before that happens.

In this paper, we presented a simulation of an interference experiment with random noise and phase variations. The simulation aimed to investigate the effects of uncertainties and fluctuations on the observed interference pattern and shed light on the challenges encountered in real-world interference experiments.

For future investigation, the code needs to be optimized for speed.