

# Abstract

Two-photon interference due to the Hong-Ou-Mandel (HOM) experiment is analysed via the second-order correlation function. Photon representation is constructed with consideration to the Gaussian temporal mode function. The outputs of this experiment are represented using the second order correlation function  $g^2(t)$ . The  $g^2(t)$  is graphed and the presence of the quantum beat is verified as the frequency difference between the two photons is varied. The  $g^2(t)$  is then integrated over all possible detection times ( $t$ ) and detection delays ( $\tau$ ) to determine the probability distribution of measuring two photons. Photon frequency is again varied to determine its effect on the presence of the HOM dip. HOM dip is seen to rise as the photon frequency difference increases. The presence of the quantum beat, along with a difference in the HOM dip due to change in frequency confirms that HOM experiment can be used to determine photon distinguishability.

# Table of Contents

CHAPTER 1 Introduction.....	1
CHAPTER 2 Historical and Mathematical Context .....	3
2.1 Quantum Background .....	3
2.1.1 Quantum Information Processing .....	3
2.1.2 States and Measurement .....	6
2.1.3 Quantum Harmonic Oscillator.....	8
2.1.4 Quantum Optics .....	10
2.2 Hong-Ou-Mandel Experiment .....	16
2.2.1 Experimental Set Up.....	16
2.2.2 Results.....	18
2.3 Hanbury-Brown Twiss Experiment .....	19
2.3.1 Historical Context .....	19
2.3.2 The Experiment and the Correlation Function.....	20
CHAPTER 3 Methodology and Results .....	22
3.1 The Second-Order Correlation Function – HOM Edition .....	22
3.2 Probability Distribution and Detection of the Quantum Beat.....	24
3.3 The Gaussian Photon .....	25
CHAPTER 4 Conclusions and Future Considerations .....	27
ACKNOWLEDGEMENTS.....	30
BIBLIOGRAPHY.....	31

# Table of Figures

Figure 1- Which Trajectory Do We Pick? .....	1
Figure 2 - The Beat Effect [12] .....	2
Figure 3- Particle on a Spring [9] .....	8
Figure 4 - The Possible Beam Splitter Outputs [5] .....	17
Figure 5 - Experimental Setup [11] .....	18
Figure 6 - The HOM Dip [6] .....	18
Figure 7 - Second Order Correlation Function .....	25
Figure 8 - Probability Distribution for Two Gaussian Photons with a Pulse Width of 2 .....	26