The observation of Two-photon Interference with different spectral bandwidth

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We experimentally investigate a two-photon interference between a heralded photon from spontaneous parametric down-conversion (SPDC) and a weak coherent photon (WCP) from laser source, by changing the spectral band width of the heralded photon. The experimental result shows a maximum interference visibility of 0.4 when SPDC is employed a 1nm bandpass filter and it indicates that the perfect interference visibility of 0.5 will occur when two different photons have the same spectral band width.

1. Introduction

The observation two-photon interference, especially Hong-ou-Mandel interference (HOMI) [1], is the fundamental topic in quantum optics. In recent years, several theoretical and experimental studies have performed the interference between a WCP and a heralded photon from SPDC, working on exploring the identity of photons. However, achieving the perfect visibility of 0.5 is still difficulty since these two independent sources have their own characteristics[2]. Some of groups have customized the nonlinear crystal to match the characteristic of laser source as much as possible. Here, our quantum heralded source is extracted from a commercialized BBO type- Ⅱ crystal and WCP is directly from laser source. Through carefully engineering the spectral band width of the heralded photon source, we still can achieve the two-photon interference visibility of 0.4, even though the two photon sources having spectrum difference. Further improvement is possible when the two photons have the same spectral band width. This will bring some practical applications, such as quantum communication, quantum information processing and quantum metrology.

2. Experimental setup

The schematic diagram of the experimental setup enables observing the interference of two independent photons by measuring the two-photon fold coincidence counts of the two-port of HOMI, as shown in Fig.1. The PBS 1 separates laser source into two arms. The left arm laser is strongly attenuated and split by a weak coherent photon A (WCPA) and a weak coherent photon B (WCPB) at PBS 2. WCPA with an optical delay is prepared to interfere with the heralded photon on PBS 4. WCPB is used as an auxiliary light. The right arm laser travels the second harmonic generator to generate pump light. A two-photon with orthogonal polarization at 798 nm was generated by pumping light into the type- Ⅱ SPDC. After filtering the V polarization by PBS 3, the residual photon with H polarization, named heralded photon, meets WCPA on PBS 4. The two-photon interference can be observed in the coincidence counts when blocking the WCPB.

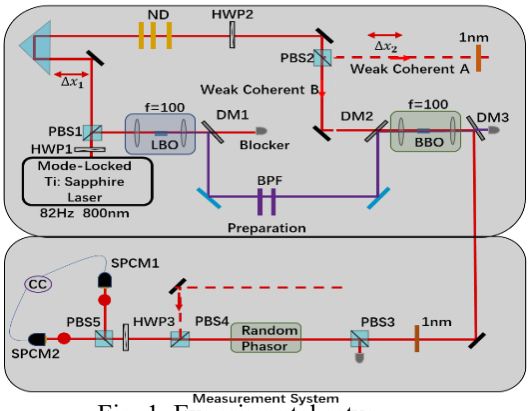

Fig. 1. Experimental setup

3. Experimental Results and discussion

Figure.2 (a) shows the HOM interference of SPDC photon pairs by employing a 1nm band pass filter when blocking the WCPA and WCPB. The visibility is 0.9 and the dip FWHM is about 300μm by the 1nm filter. We also measure the HOM interference of WCP, the visibility is near 0.5 and the dip FWHM is about 820μm. Figure.2 (b) shows the HOM interference between the WCPA and the heralded photon filtered by 1nm filter. The interference visibility is about 0.4 and the dip FWHM is about 440μm. It is interesting that the HOM dip FWHM is changed when two different photon sources having own spectral band width.

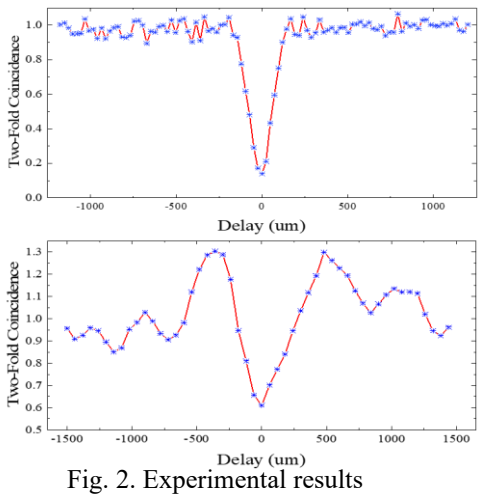

Fig. 2. Experimental results

1) C. K. Hong, Z. Y. Ou, and L. Mandel, Phys. Rev. Lett. **59**, 2044 (1987).
2) F. Bovino et al., Phys. Rev. Lett. **95**, 240407 (2005).