

제 1형 매개하향변환과정으로 생성된 얽힘 광원의 분광 특성에 관한 연구

Spectral properties of entangled photon pairs generated via frequency-degenerate type-I SPDC

백소영*, 김윤호

포항공과대학교 물리학과

*simply@postech.ac.kr

The spectral properties of the SPDC photon pairs are especially important as they are strongly coupled to the Shih-Alley/Hong-Ou-Mandel-type two-photon quantum interference effect, which is at the heart of many quantum information and quantum metrology applications of entangled photons. Complete understanding of the spectral properties of the entangled photon pairs generated via the SPDC process, therefore, is an essential step toward developing engineered two-photon entangled states(1-2).

In this paper, we report experimental and theoretical studies on the single-photon spectra and the two-photon joint spectral properties of the entangled photon pair generated via frequency-degenerate type-I SPDC pumped by a cw uv laser in both the collinear and the noncollinear regimes.

In the noncollinear frequency-degenerate type-I SPDC, the signal and the idler photons propagate by making an angle θ with respect to the pump beam, see Fig. 1. In this case, the single-photon spectra showed broadband nature but the spectra were not centered at the degenerate wavelength. The two-photon joint spectrum, on the other hand, exhibited much reduced two-photon bandwidth and the experimentally observed two-photon joint spectrum was not symmetric about the degenerate wavelength. See Fig. 2(a). We have explained the observation by studying the properties of the noncollinear degenerate type-I SPDC, taking into account the experimental setup, i.e., the collection

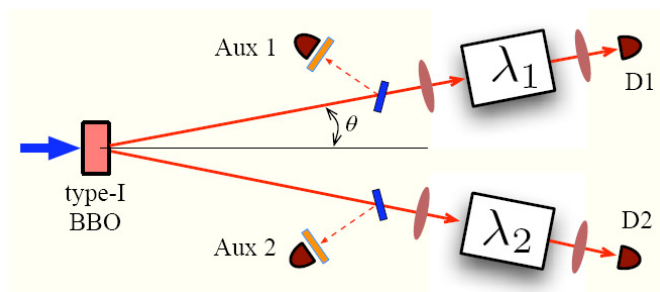


Fig. 1 Experimental setup for measuring the spectral properties of noncollinear degenerate type-I SPDC

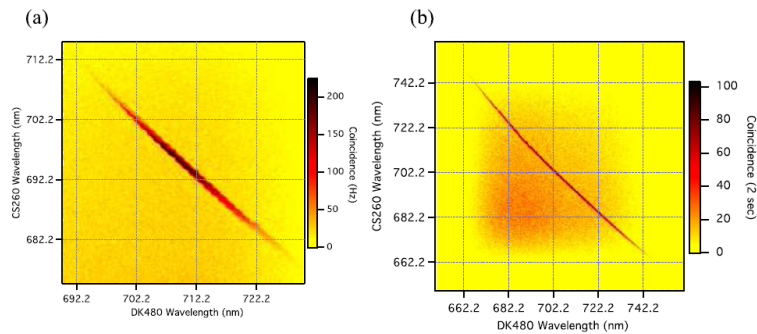


Fig. 2 Measured two-photon joint spectra of type-I SPDC under different phase matching conditions. (a) non-collinear ($\pm 3^\circ$) (b) collinear degenerate type-I SPDC.

angles of the photons. We have found that the effective two-photon bandwidth of noncollinear degenerate type-I SPDC is strongly affected and greatly reduced by the limited pair collection angles. As a result, the two-photon joint spectrum for noncollinear degenerate type-I SPDC is extremely sensitive to small alignment errors while the single-photon spectra are not.

For collinear degenerate type-I SPDC, we have found that the single-photon spectra and the two-photon joint spectrum are both very broadband in nature. See Fig. 2(b). In addition, the symmetric two-photon joint spectrum showed frequency anticorrelation between the pair photons for broad spectral ranges.

The experimental results reveal that the two-photon joint spectra for type-I SPDC have distinctive features depending on the specific phase matching condition used. To correctly account for the observed data theoretically, it is necessary to explicitly include the emission pattern of the SPDC photons when calculating the single-photon and, especially, the two-photon joint spectra. A theoretical model which correctly account for these features will be presented, in addition to the complete set of experimental data.

Reference

1. Y.-H. Kim and W.P. Grice, *J. Mod. Opt.* 49, 2309 (2002).
2. W.P. Grice, A.B. U'Ren, and I.A. Walmsley, *Phys. Rev.A* 64, 063815 (2001).