Spectral correlation measurement in Hong-Ou-Mandel interference between two independent sources

Rui-Bo Jin[1], Thomas Gerrits[2], Mikio Fujiwara[1], Ryota Wakabayashi[1,3], Shigehito Miki[4], Taro Yamashita[4], Hirotaka Terai[4], Ryosuke Shimizu[5], Masahiro Takeoka[1], Masahide Sasaki[1]

1. National Institute of Information and Communications Technology (NICT), 4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795, Japan
2. National Institute of Standards and Technology (NIST), 325 Broadway, Boulder, Colorado 80305, USA
3. Waseda University, 3-4-1 Okubo, Shinjyuku, Tokyo 165-8555, Japan
4. National Institute of Information and Communications Technology (NICT), 588-2 Iwaoka, Kobe 651-2492, Japan
5. University of Electro-Communications, 1-5-1 Chofugaoka, Chofu, Tokyo 182-8585, Japan

Hong-Ou-Mandel interference between independent photon sources (HOMI-IPS) plays an important role in quantum information processing. A variety of HOMI-IPS experiments have been demonstrated at near-infrared wavelengths or telecom wavelengths [1]. In all the previous HOMI-IPS experiments, the HOM dips are obtained by recording the four-fold coincidence counts as a function of the temporal delay. However, the spectral correlation during the interference is omitted, partially due to technical difficulties, e.g., the acquisition time is too long for measuring a joint spectral distribution. Spectral information, as the conjugate of the temporal information in the Fourier transformation, is definitely of great importance and should be investigated.

Very recently, a new technique of spectral correlation measurement in a HOM interference has been developed by Gerrits, et al [2]. This technique has the merits of high speed and high resolution, therefore, has been used as a powerful tool to analyse the spectral correlation in a HOM interference between signal and idler photons from one spontaneous parametric down conversion (SPDC) source.

In this work, we measure the joint spectral distribution in HOMI-IPS using the new technique developed in [2]. The experimental setup is shown in Fig. 1 (Left). The two independent sources are based on SPDC from two 30-mm-long periodically poled $KTiOPO_4$ (PPKTP) crystals pumped by picosecond laser pulses (76 MHz, 792 nm, temporal duration ~ 2 ps). In Fig. 1 (Left), the dispersion compensation fiber model (DCFMs), the superconducting nanowire single-photon detectors (SNSPDs) [3,4,5] and the time interval analyzer (TIA) constitute a fiber spectral analyzer [6].

Fig. 1(Right: (a)) is the measured four-fold HOM interference between signal1 and signal2, with idler1 and idler2 as heralders. Without subtraction of any background counts, the raw visibility of the HOM dip is 69.9±3.2%, which is consistent with our previous results in [1,7,8]. Fig. 1(Right: (b)-(g)) are the measured joint spectral intensities at different delay positions. The splitting phenomenon in the joint spectral distribution is clearly observed. The experimental results agree well with our theoretical simulations. This experiment not only can deepen our understanding of HOMI-IPS from the viewpoint of spectral domain, but also can be used to improve the visibility of HOMI-IPS by temporal filtering.

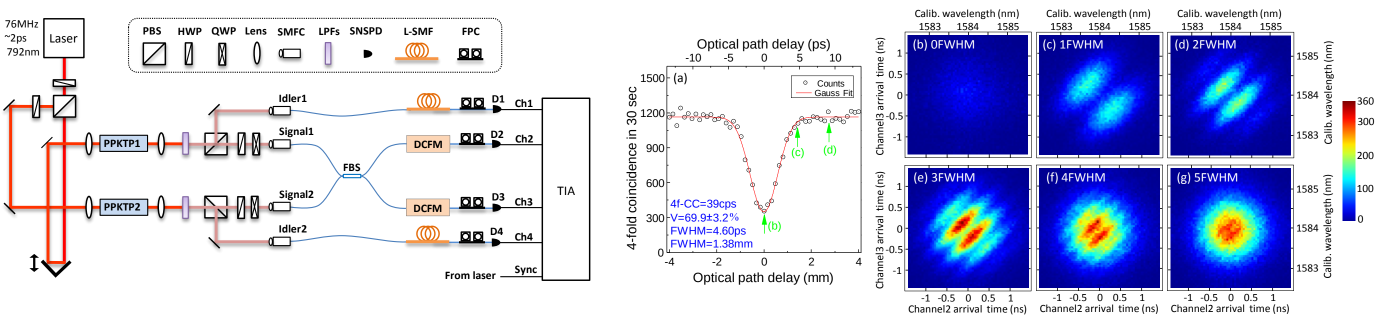

Fig. 1. Left: The experimental setup. DCFM=dispersion compensation fiber model, L-SMF=long single-mode fiber.
Right: (a) The measured four-fold HOM interference between signal1 and signal2, with idler1 and idler2 as herladers.
Right: (b-g) Measured joint spectral intensity at different delay positions in the HOM dip.

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