Image distillation through modulation of an undetected beam

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Induced-coherence quantum imaging takes advantage of photon pairs correlations to image an object without detecting the photons that illuminate the object [1]. The object's information is transferred from the photon that illuminates the object to the interference pattern of its partner photon, which is detected. These photon pairs are emitted by spontaneous parametric down-conversion, and are hyper-entangled in many degrees of freedom, including energy and momentum. In this way, the pair can be spectrally separated into the electromagnetic spectrum (non-degenerate case). This fact becomes relevant if we need to image at wavelengths with detection constraints, e.g., mid-infrared, hyperspectral, or terahertz wavelengths.

Quantum imaging also offers the possibility of separating a quantum image from classical noise [2]. The process called distillation is explained as follows. We have two images: a classical image and a quantum image. The classical one is considered noise. When the two images are superimposed on the camera, we can apply a post-selection detection technique to retrieve only the quantum component image.

Finally, a quantum holography technique employing undetected photons has recently been introduced [3]. In this work, we show a new distillation method based on single-photon interference. Therefore, no coincidence measurements are needed. Our method uses the same modulation that uses the quantum holography process to retrieve the object information. We can explain this considering that the statistical fluctuation of the intensity noise is lower than the intensity fluctuation of the modulation of the quantum image. In this way, our technique is resilient to high intensities of noise.

References

[1] G. B. Lemos et al., Nature, 512 (2014) 409–412.
[2] H. Defienne et al., Sci. Adv. 5 (2019) eaax0307.
[3] S. Töpfer et al., Sci. Adv. 8 (2022) eabl4301.

Figures

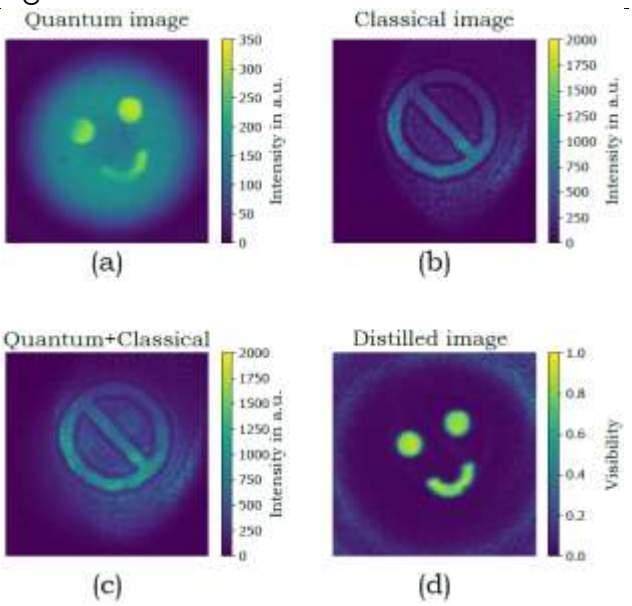

Figure 1: Distillation imaging processing.