Kramers-Kronig detection in the quantum regime

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Abstract :

We investigate, in [1], the quantization of the Kramers-Kronig detection (KKD) initially developed in classical coherent communications [2]. KKD is a direct detection technique using a single photodiode making it fundamentally different to traditional double homodyne detection (DHD) and heterodyne detection (HRD) [3]. However, in the case of spectrally engineered field of interest, KKD digital signal processing can reconstruct the phase of the measured field with the measured intensity and thus reconstruct both quadratures of the field. KKD is then a Gaussian measurement equivalent to DHD and HRD in the asymptotic regime in the local oscillator and the beamsplitter characteristics. We investigate the phase information measured with KKD in the quantum regime for bosonic coherent states [4] and pure single mode and mixed states. Finally, we propose an alternative spectral tomography technique for single photon states [5] inspired from KKD and relying on single photon state spectral engineering.

References

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Figures

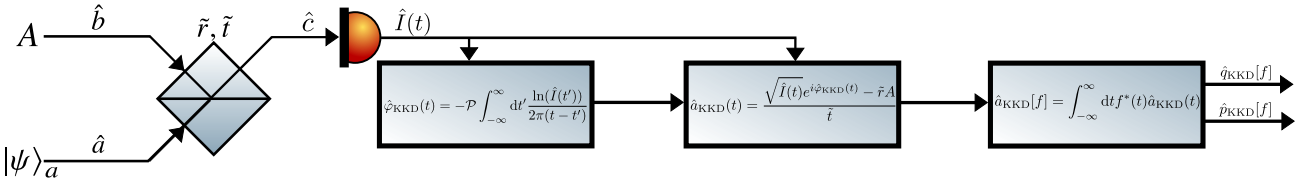

Figure 1: Kramers-Kronig detection setup. The spectrally engineered quantum signal of interest is mixed with a strong classical monochromatic local oscillator on a highly unbalanced beamsplitter. A single output is measured with a photodiode and the intensity measurements are processed digitally with a Hilbert transform to reconstruct the phase of the measured output. The complex signal of interest is reconstructed and then projected digitally on a mode. Finally, the quadratures are extracted by taking the Hermitian or anti-Hermitian parts.