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Revealing hidden photons: imperfect photocounting measurements and their applications

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In quantum optics it is widely believed that all measurements with coherent states of light and their statistical mixtures can be explained without the need to quantize the electromagnetic field. Quantum states that do not satisfy this condition are considered to be nonclassical. Nowadays, optical nonclassicality is often considered as an important resource for creating quantum entanglement with linear passive optical elements, quantum computation, quantum metrology, etc.

In real-world scenarios, measurements are imperfect. For example, many photocounting techniques are unable to distinguish between adjacent numbers of photons. These imperfections can dramatically change our conclusions about the quantum nature of light: even experiments with highly nonclassical light can be explained in terms of classical electrodynamics.

In this talk, I will briefly review our recent works related to the theory of realistic photodetection [1-3], noisy free-space channels [4], and highly effective methods for testing nonclassicality under such unfriendly conditions [5,6]. I will discuss whether the impossibility of detecting nonclassicality means it is lost as a quantum resource [7]. Finally, I will present an application of our theory to some models of nonuniversal quantum computation [8,9].

[1] A. A. Semenov, et al., PRA 109, 013701 (2024).

[2] V. A. Uzunova and A. A. Semenov, PRA 105, 063716 (2022).

[3] E. V. Stolyarov, et al., PRA 108, 063710 (2023).

[4] M. Klen, et al., PRA 109, 033712 (2024).

[5] A. A. Semenov and A. B. Klimov, NJP 23, 123046 (2021).

[6] V. S. Kovtoniuk, et al., PRA 109, 053710 (2024).

[7] V. S. Kovtoniuk, et al., arXiv:2408.04740 [quant-ph] (2024).

[8] V. Ye. Len, et al., Phys. Scr. 97, 105102 (2022).

[9] I. S. Yeremenko, et. al., PRA 110, 043715 (2024).

Type of presence

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