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Quantum state features of FEL radiation from the occupation number statistics

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The statistical features of the radiation emitted by Free-Electron Lasers (FELs), either by Self-Amplified Spontaneous Emission (SASE-FELs) or by seeded emission (seeded-FELs), are attracting increasing attention because of the use of such light in probing high energy states of matter and their dynamics. We decided to shift the focus from correlation functions towards the reconstruction of the distribution of the occupation numbers of the radiation energy states. We propose a Maximum Likelihood reconstruction of the diagonal elements of the FEL radiation states based on the statistics of no-click events. The ultimate purpose of such a novel approach to FEL radiation statistics is the experimental confirmation of the departure from Poissonian statistics that SASE-FEL radiation exhibits and the laser-like coherence of seeded-FEL light. In this framework, it is interesting to note that the outcome of this work can be extended to any process of harmonic generation from a coherent light pulse, ushering in the study of the preservation or generation of quantum features in general non-linear optical processes.

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