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Revealing the quantum nature of a continuous laser carrying orbital angular momentum

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Revealing the quantum nature of a source that generally is considered classic radiation is significant. In quantum optics and generally in optics we have the scalability problem as the experiment extends. Hence, finding sources that can overcome this challenge is essential. Radiation from a continuous wave (CW) source is described by the dynamics of quasi-classical (coherent) states. Such a source, though abundant with photon rate but fail to represent a single-photon source. Theoretically, the quantum aspect of such states can be observed in the weak limit hinting to the high single-photon rate. Yet, since these states are superposition of different particle-states of radiation, we need post-selection to achieve this result and within the weak limit. However, this high rate has never been observed. In this work, we experimentally demonstrate that the weak limit of quasi-classical states supplemented by orbital angular momentum (OAM) can deliver a high photon rate producing a quantum signature. Through our experiment, we realize two-photon bunching with the projection of OAM from a continuous wave source. We observe that this approach can produce the result from a single photon source with high accuracy after the post selection. In addition, this can be considered as confirmation that OAM is an intrinsic property of light at the quantum level. In fact, since there is no interaction with matter, the post-selected photon rate from this approach can be considered as an upper bound for the single-photon generation based on the input power. This work is a step forward toward a more diverse and practical use of quasi-classical states in the domain of quantum optics and quantum information.

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