

# Generation of non-classical light in a photon-number superposition

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## Abstract

We report on the generation of pure quantum light states in a photon-number superpositions of zero-, one-, and even two-photons from the spontaneous emission of a single semiconductor quantum dot.

The ability to generate light in pure quantum states is central to the development of quantum-enhanced technologies. Although controlling the photon number is the backbone of many applications, the generation of pure quantum superpositions in the photon-number basis has remained elusive. Light fields with zero and one photon can be generated by single atoms. However, it has so far been limited to the generation of incoherent superpositions or to coherent superpositions but with a vanishing one-photon part.

Here, we report on the generation of light pulses in a pure quantum superposition of zero, one-, and even two-photons, using a single artificial atom—a semiconductor quantum dot [1]. Performing pulsed coherent control of the atomic population, a pure quantum superposition of vacuum and one-photon is generated with a full control of their relative populations by the laser intensity. Driving the system even stronger, with  $2\pi$ -pulses, a coherent superposition of vacuum, one- and two-photons is generated, with the two-photon part exceeding the one-photon part—a state that shows phase super-resolving interferometry. These observations of text-book idealized quantum optics in semiconductor devices open new paths for quantum technologies with access to the photon-number degrees-of-freedom.

[1] J. C. Lored, C. Anton, et. al, *Generation of quantum light in a photon-number superposition*, arXiv:1810.05170.