Generator of arbitrary classical photon statistics

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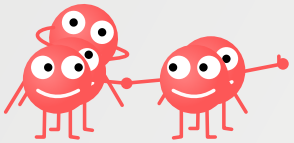


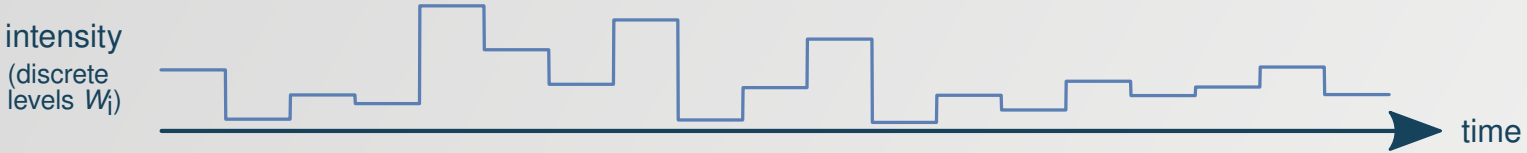
We propose and experimentally demonstrate a device for generating light with arbitrary classical photon-number distribution [1]. We use programmable acousto-optical modulation to control the intensity of light within the dynamic range of more than 30 dB and inter-level transitions faster than 500 ns. We also propose a universal method of obtaining the distribution of optical intensity from the desired photon-number distribution. We experimentally demonstrate photon statistics generation for up to 500 photons. The proposed device can produce any classical light statistics with given parameters including Poissonian, super-Poissonian, thermal, and heavy-tailed distributions like log-normal. The maximum generated bunching was observed to be $g^2(0) \sim 350$.

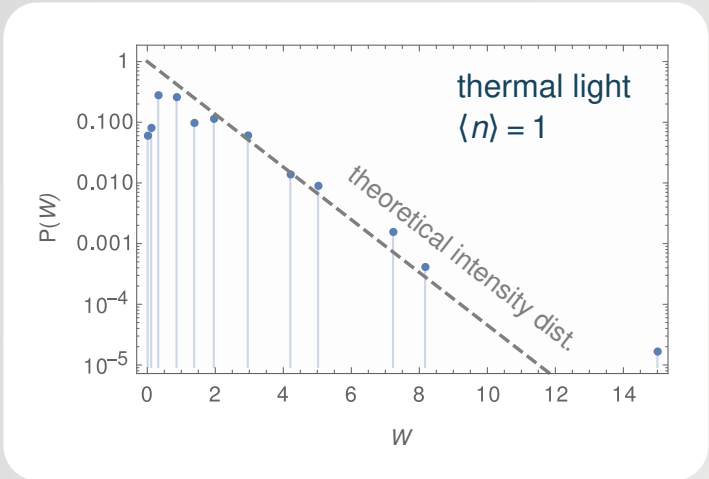
[1] I. Straka, J. Mika, M. Ježek, Opt. Express 26, 8998 (2018).

GAČR 17-26143S

POM Photonics Online Meetup

Method: intensity and photon-number distributions





Random switching between discrete intensity levels

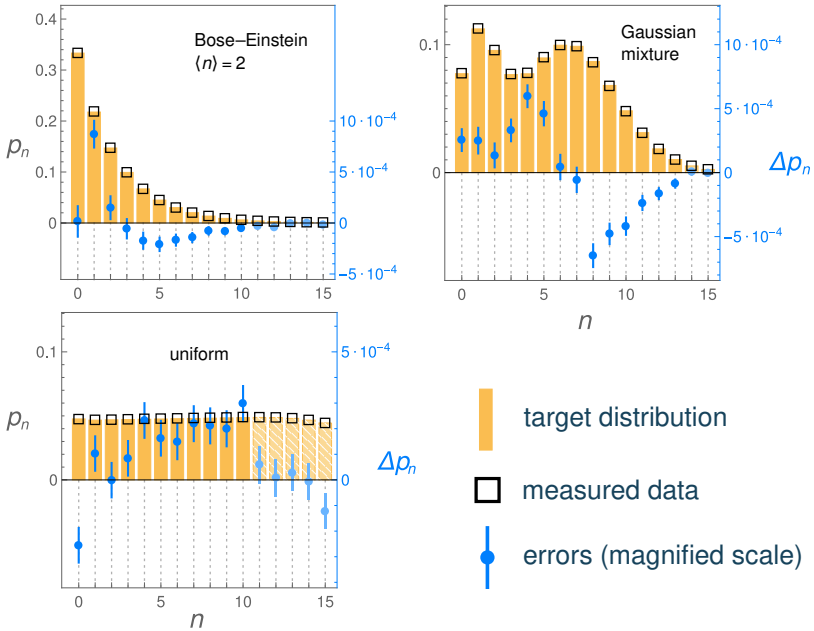
Mandel's formula transforms intensity statistics $P(W_i)$ into photon statistics p_n:

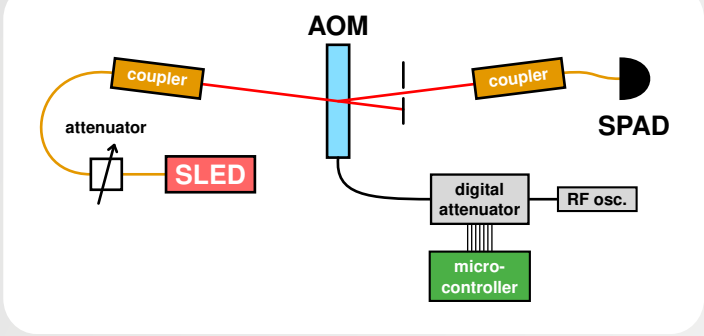
$$p_n = \sum_i \frac{W_i^n}{n!} e^{-W_i} P(W_i)$$

Inversion done using non-negative least squares

Example of a solution that matches given p_n perfectly for $n \leq 10$.

Results: photon statistics





Acousto-optical intensity modulation:
32 dB dynamic range, 128 levels, 300-ns response

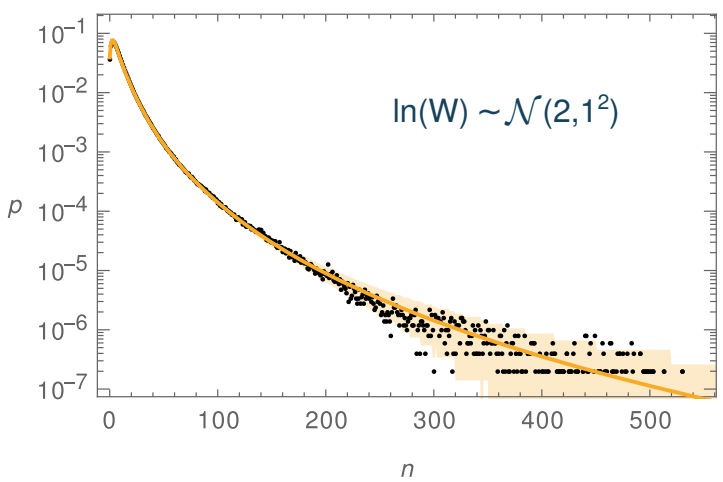
Accuracy ~ 10^{-4}

Works identically for pulsed light

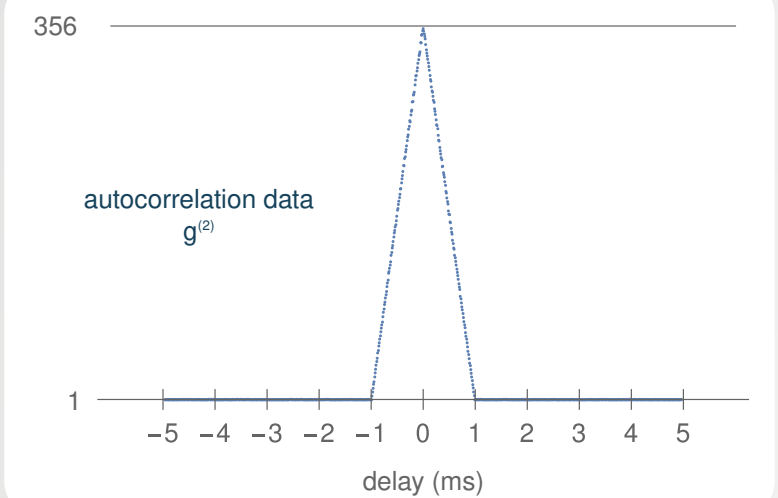
Det. recovery time ≪ det. window ≪ modul. period ≪ meas. time

23 ns 10 μs 1 ms 100 s

Results: heavy-tailed statistics and bunching



Heavy-tailed photon statistics in the form of a log-normal distribution.



Intensity autocorrelation function $g^{(2)}$ with the maximum bunching possible for the dynamic range.