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Quantum non-Gaussian multiphoton light

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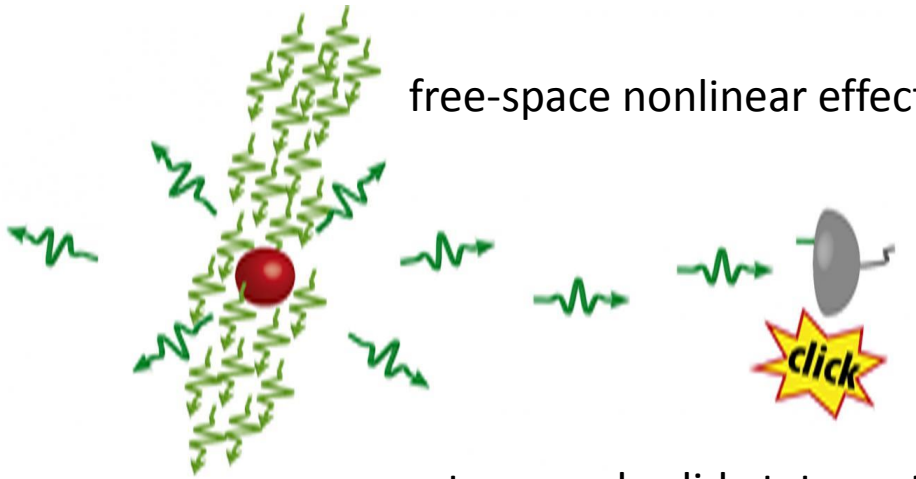
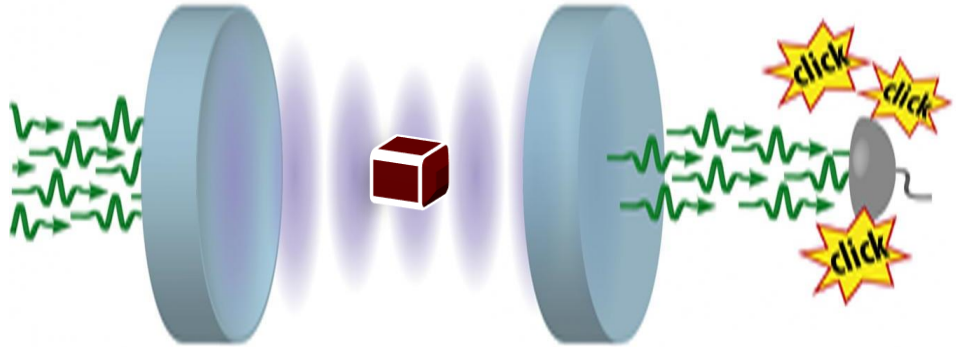
QNG WITNESSES HIGHLY NONLINEAR QUANTUM PROCESSES

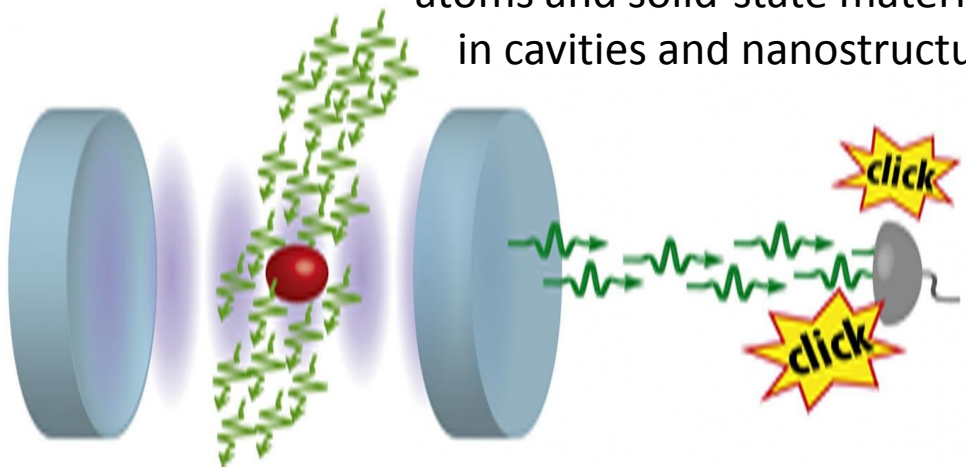
free-space nonlinear effects



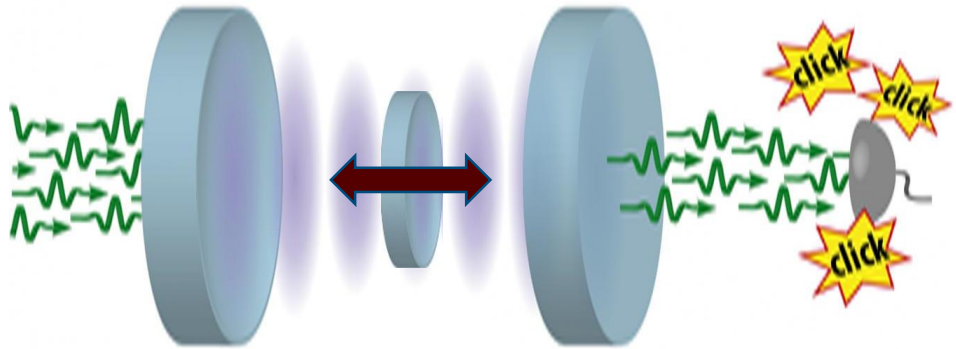
nonlinear optics in cavities and waveguides



atoms and solid-state materials
in cavities and nanostructures



cavity quantum optomechanics



https://phys.org/news/2017-04-physicists-quantum-effect-limits-emitted.html

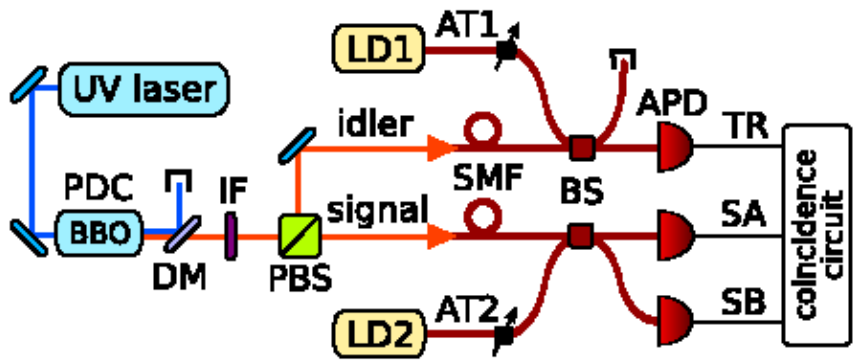
QUANTUM NON-GAUSSIAN LIGHT

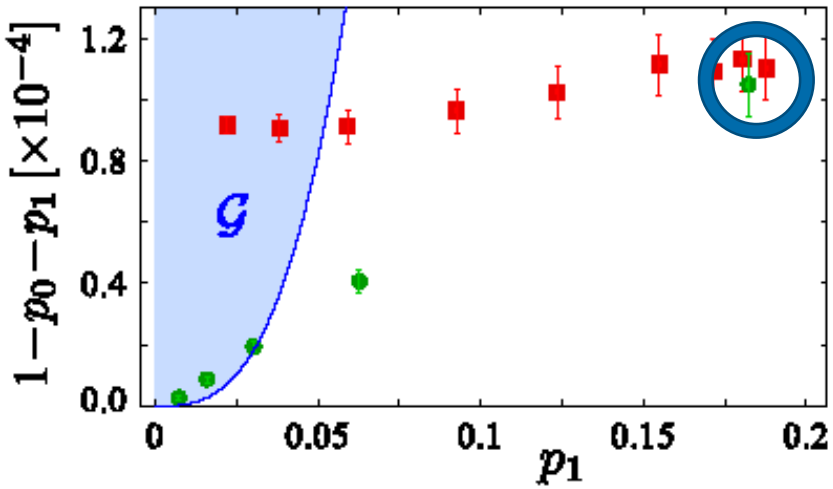
$$\rho_c \neq \int \mathcal{P}(\lambda)|\lambda\rangle\langle\lambda| d\lambda, \quad |\lambda\rangle = S(r,\psi)D(\beta)|0\rangle$$

$$P_{2+} \ll P_1$$

nonclassicality: $P_{2+} < \frac{P_1^2}{2}$

nongaussianity: $P_{2+} < \frac{2}{3}P_1^3$





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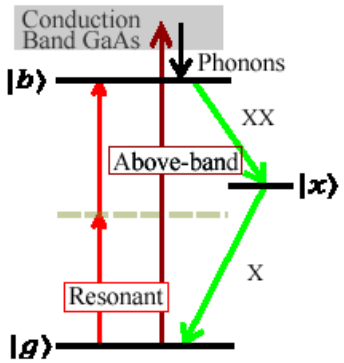
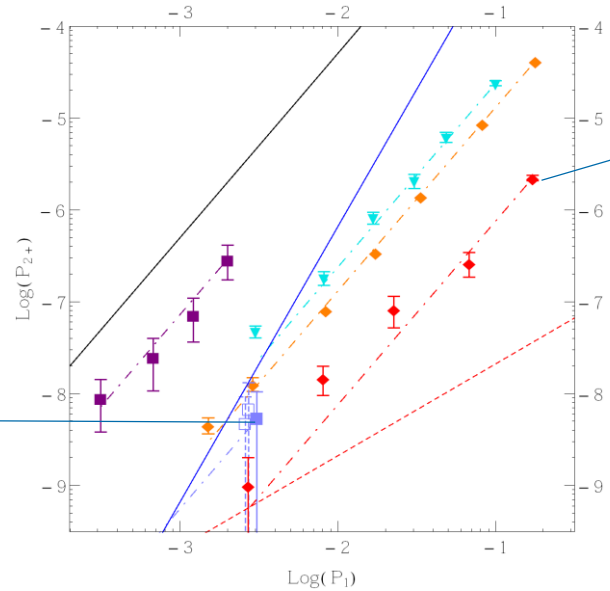
QNG EXPERIMENTS



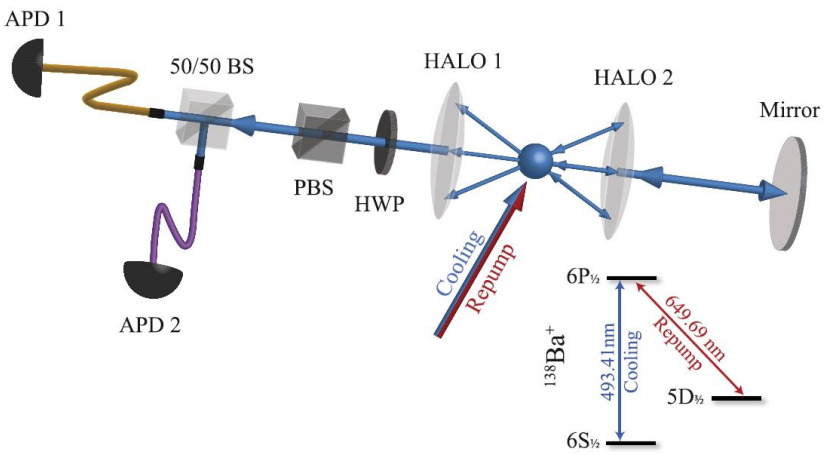
quantum dot

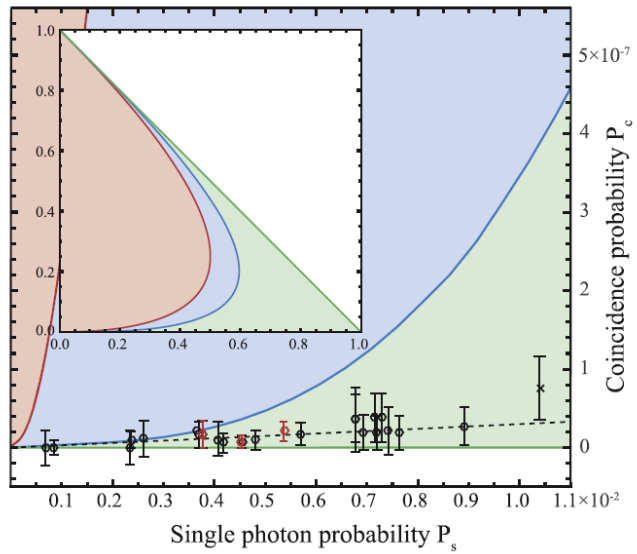


Depth:

18 dB

I. Straka, A. Predojević, T. Huber, L. Lachman, L. Butschek, M. Miková, M. Mičuda, G.S. Solomon, G. Weihs, M. Ježek, and R. Filip, Phys. Rev. Lett. 113, 223603 (2014).





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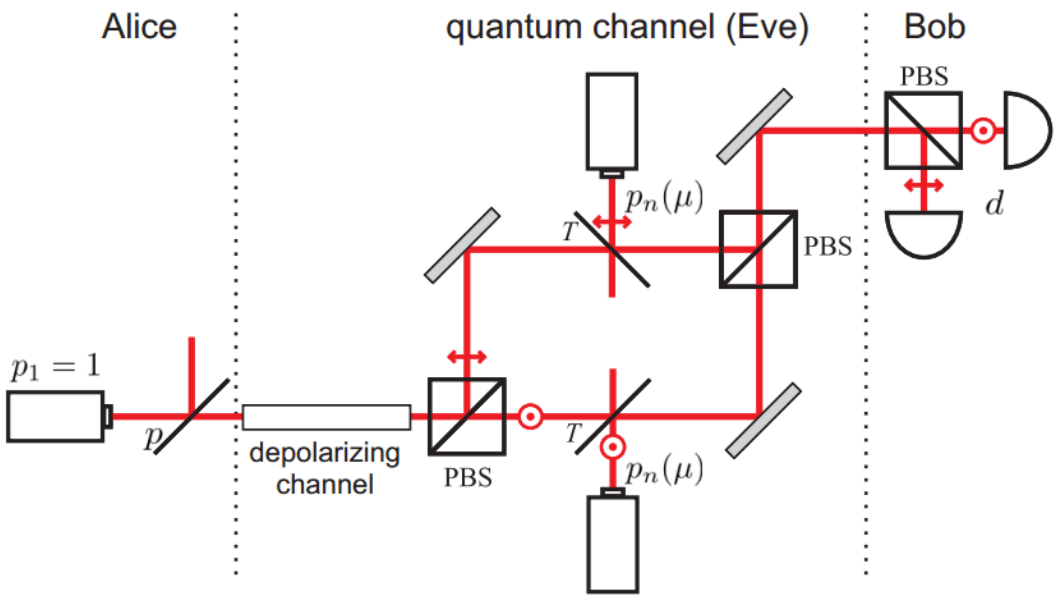
APPLICATIONS OF QNG

Security indicator for QKD BB84 single-photon protocol



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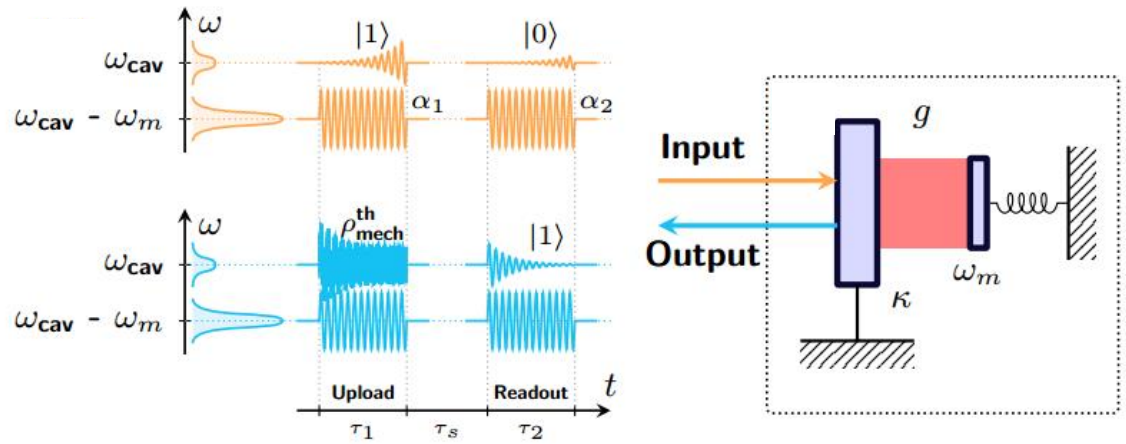
Verification of single photon-phonon-photon transfer



A.A. Rakhubovsky and R. Filip, Scientific Reports 7, 46764 (2017)

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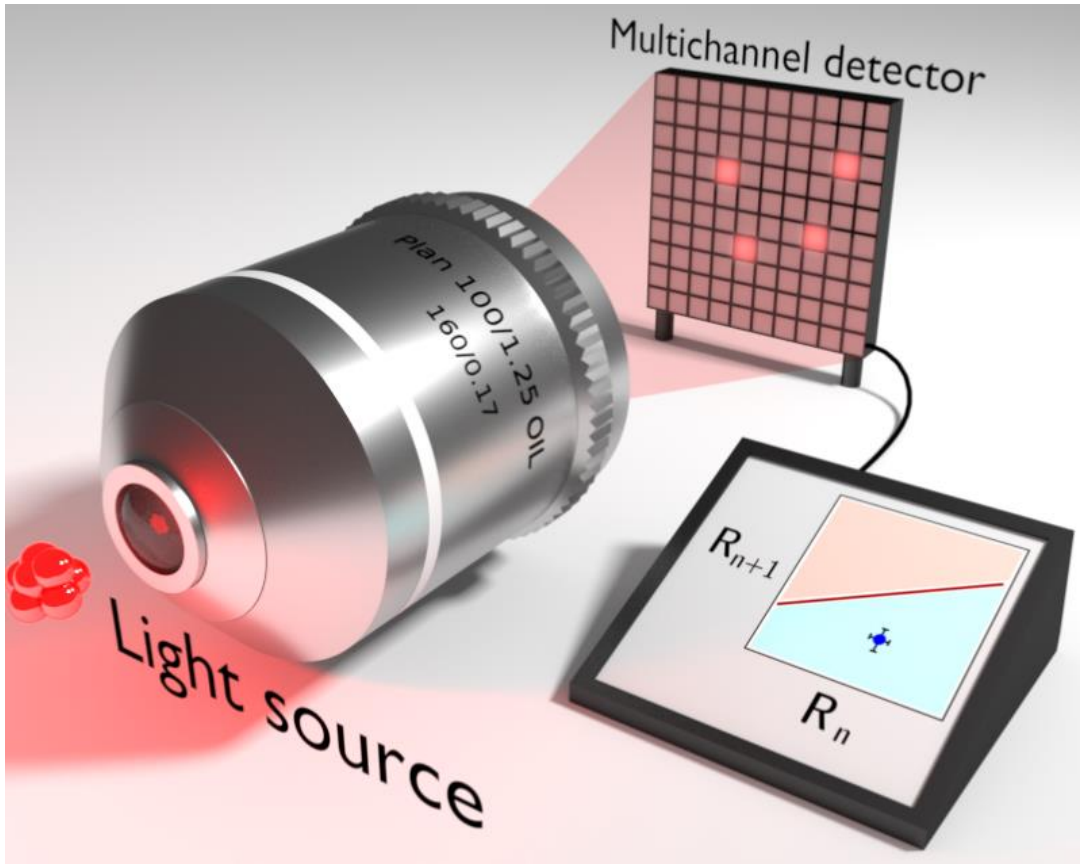
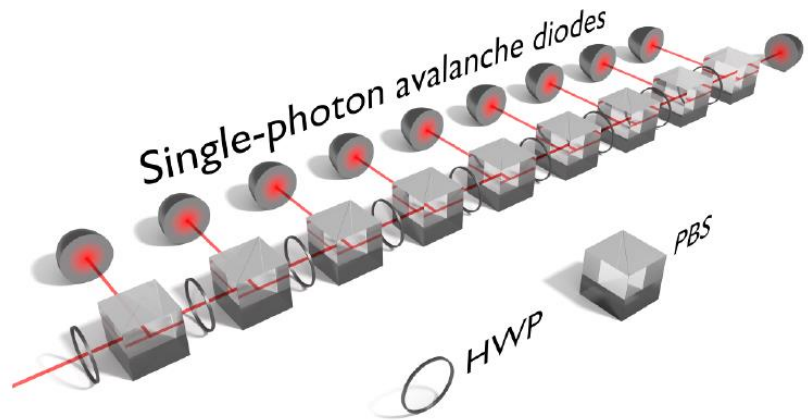
QUANTUM NON-GAUSSIANITY OF MANY PHOTONS





$$R_n^{n+2} > H_n^4(x)\left[\frac{R_{n+1}}{2(n+1)^3}\right]^n$$

I. Straka, L. Lachman, J. Hloušek, M. Miková, M. Mičuda, M. Ježek, R. Filip, Nature PJ: Quantum Information, 4, 4 (2018)

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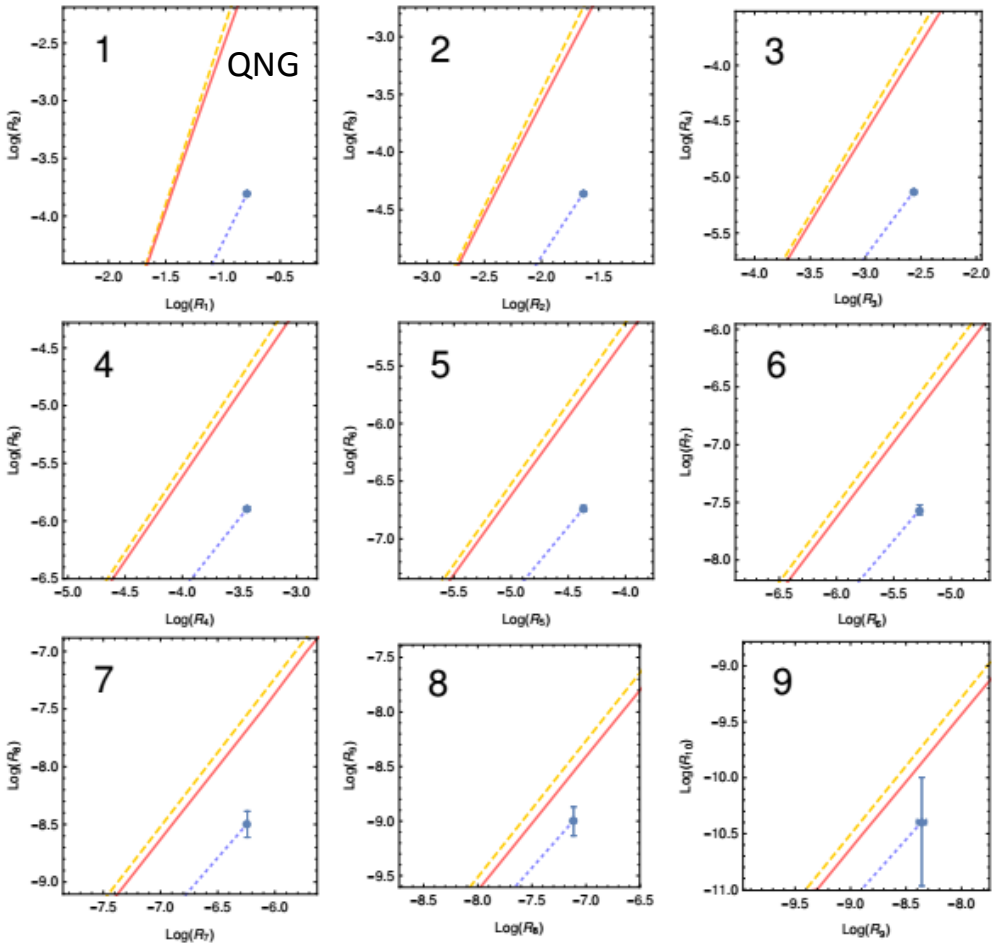
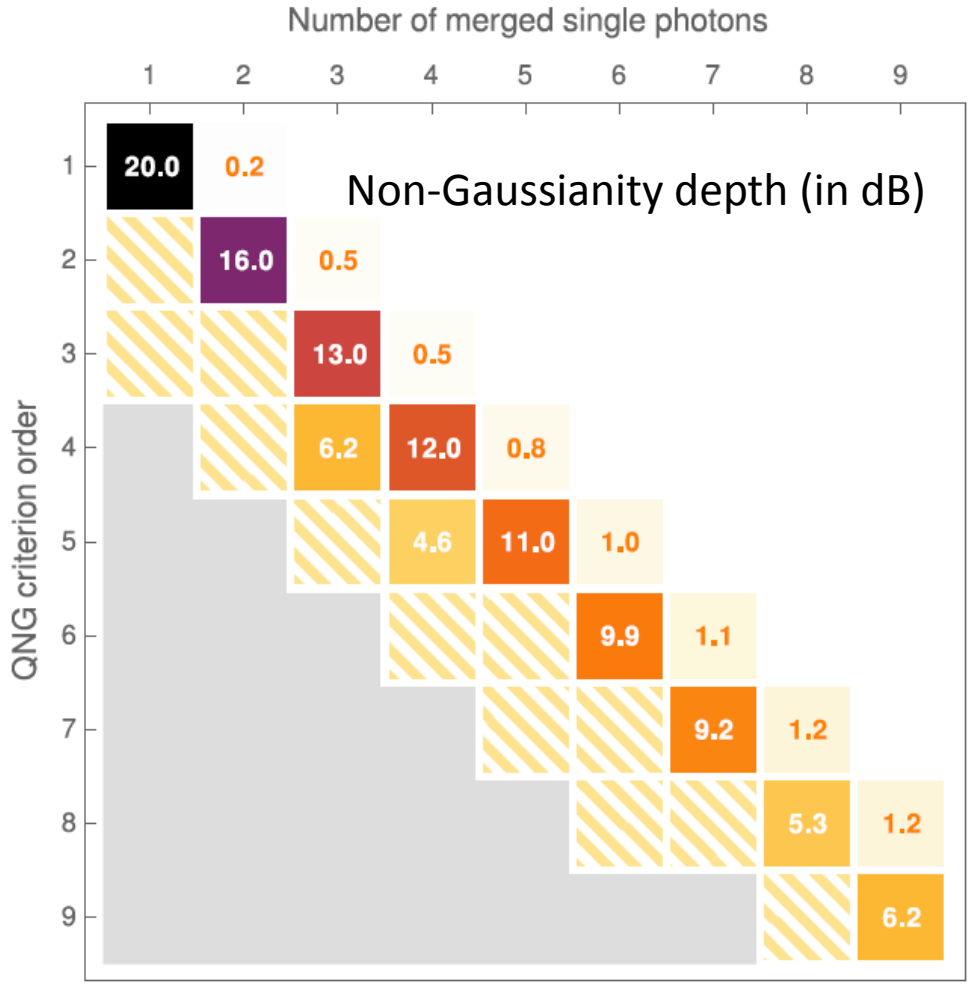
EXPERIMENT





I. Straka, L. Lachman, J. Hloušek, M. Miková, M. Mičuda, M. Ježek, R. Filip, Nature PJ: Quantum Information, 4, 4 (2018)

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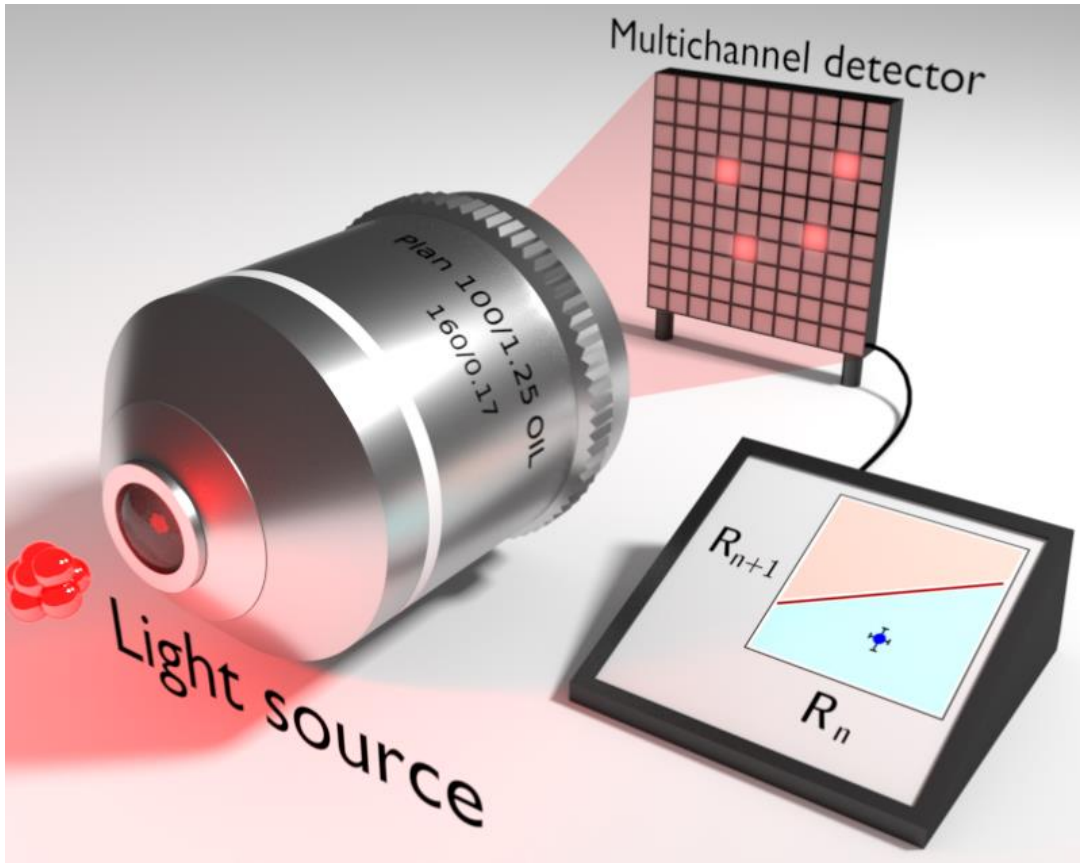
FAITHFUL HIERARCHY OF QUANTUM NON-GAUSSIANITY



Definition:

$$\rho \neq \int P(\alpha,\beta)S(\beta)D(\alpha)\tilde{\rho}_{n-1}S^{\dagger}(\beta)D^{\dagger}(\alpha)\mathrm{d}^2\beta\mathrm{d}^2\alpha$$

Example: $S(\beta)D(\alpha)\left(c_0|0\rangle + c_1|1\rangle\right)$

Approximative formula for small P_e:

$$P_e < \frac{(1+n)^{2n}(2+n)^2(1+n)!P_s^3}{18n^2(n!)^3}$$

L. Lachman, I. Straka, J. Hloušek, M. Ježek, R. Filip, Genuine n-photon quantum non-Gaussian light, arXiv:1810.02546.

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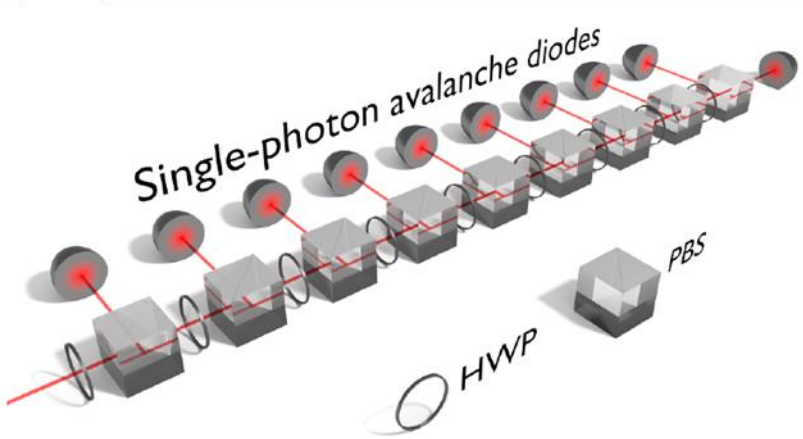
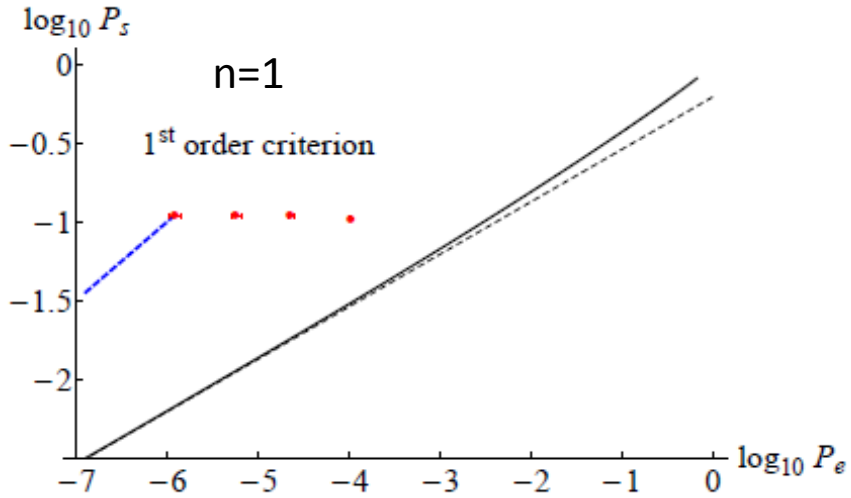
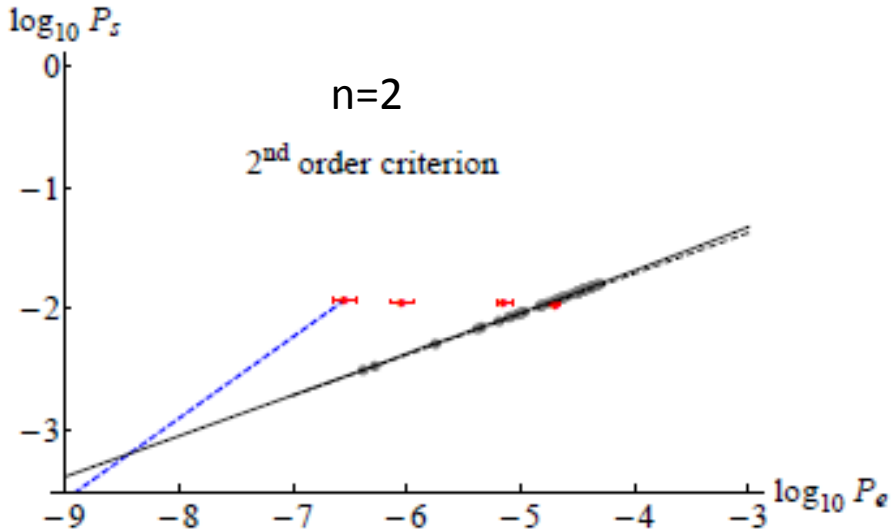
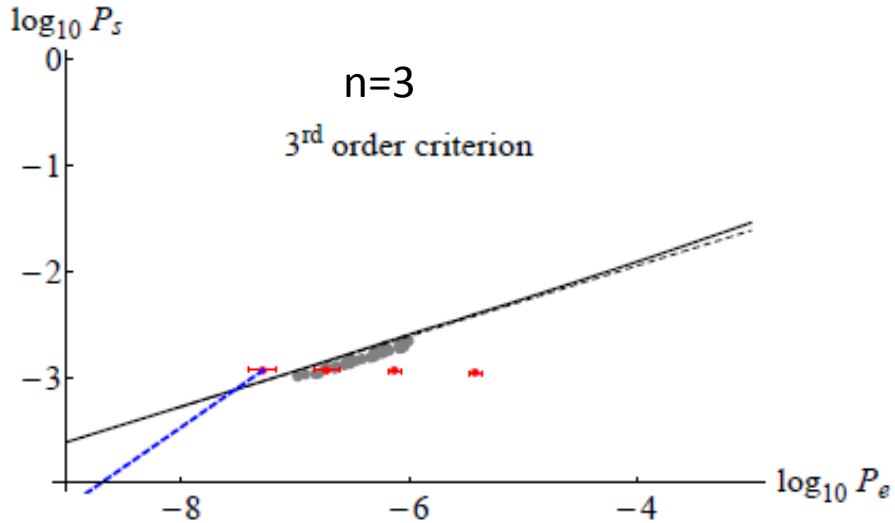
EXPERIMENT









L. Lachman, I. Straka, J. Hloušek, M. Ježek, R. Filip, Genuine n-photon quantum non-Gaussian light, arXiv:1810.02546.

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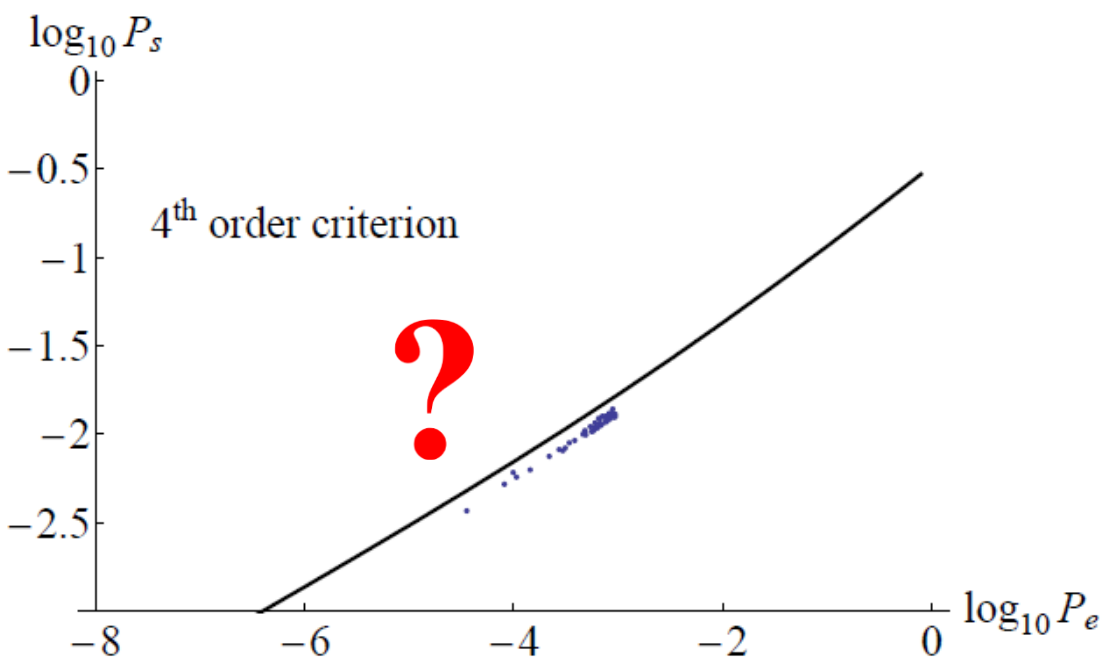
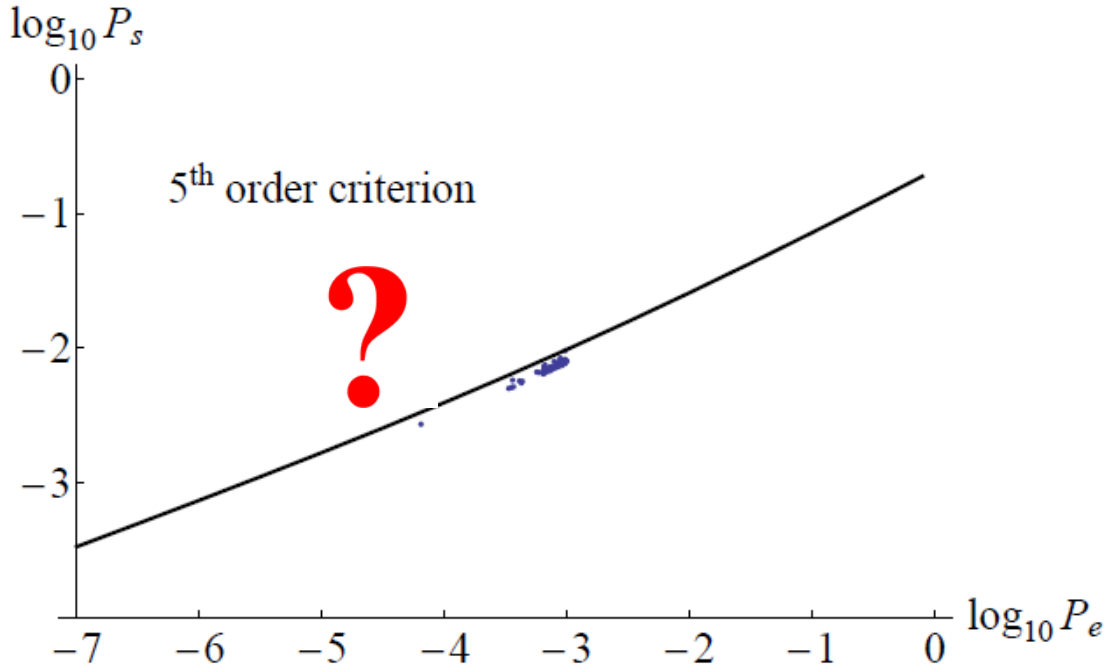
BETTER MULTIPHOTON SOURCES ?





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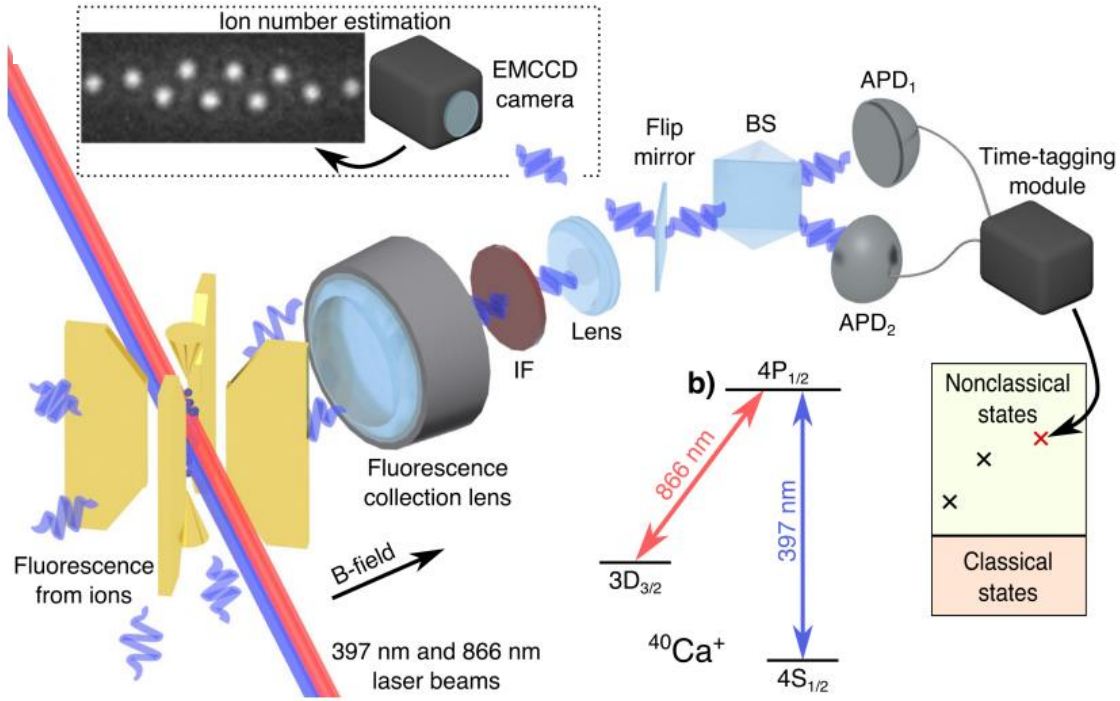
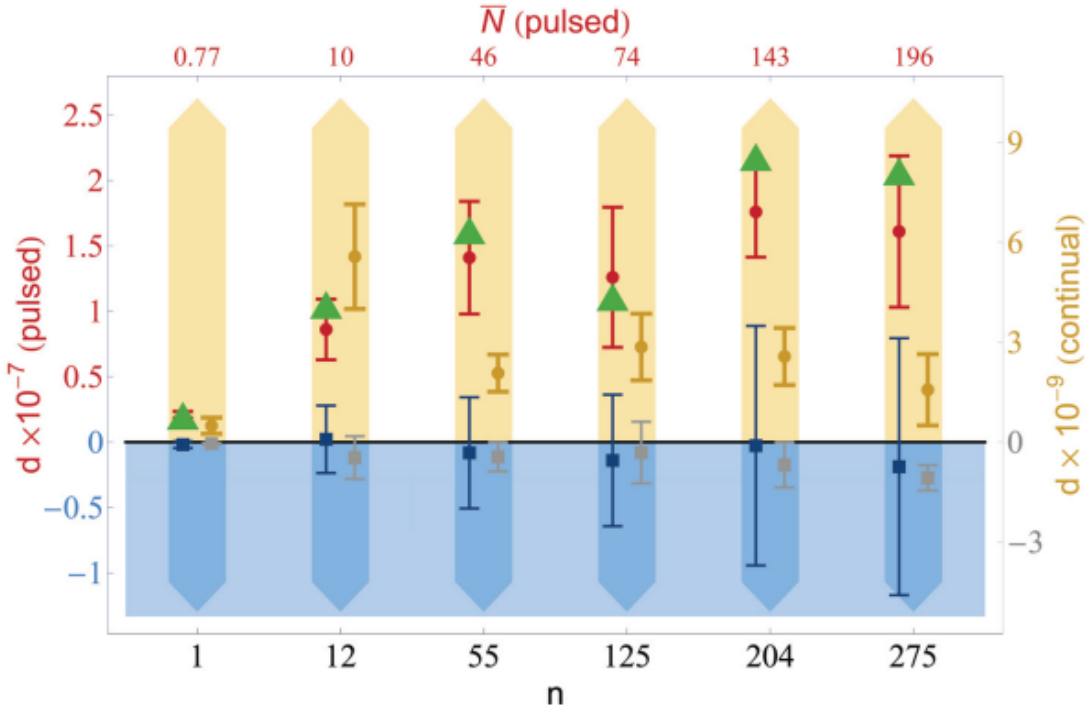
NONCLASSICALITY FROM MANY IONS





Nonclassicality of light can be detected for bright light from many emitters (>1000).

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E. Moreva, P. Traina, J. Forneris, I. P. Degiovanni, S. Ditalia Tchernij, F. Picollo, G. Brida, P. Olivero, M. Genovese, Direct experimental observation of nonclassicality in ensembles of single photon emitters, Phys. Rev. B 96, 195209 (2017)

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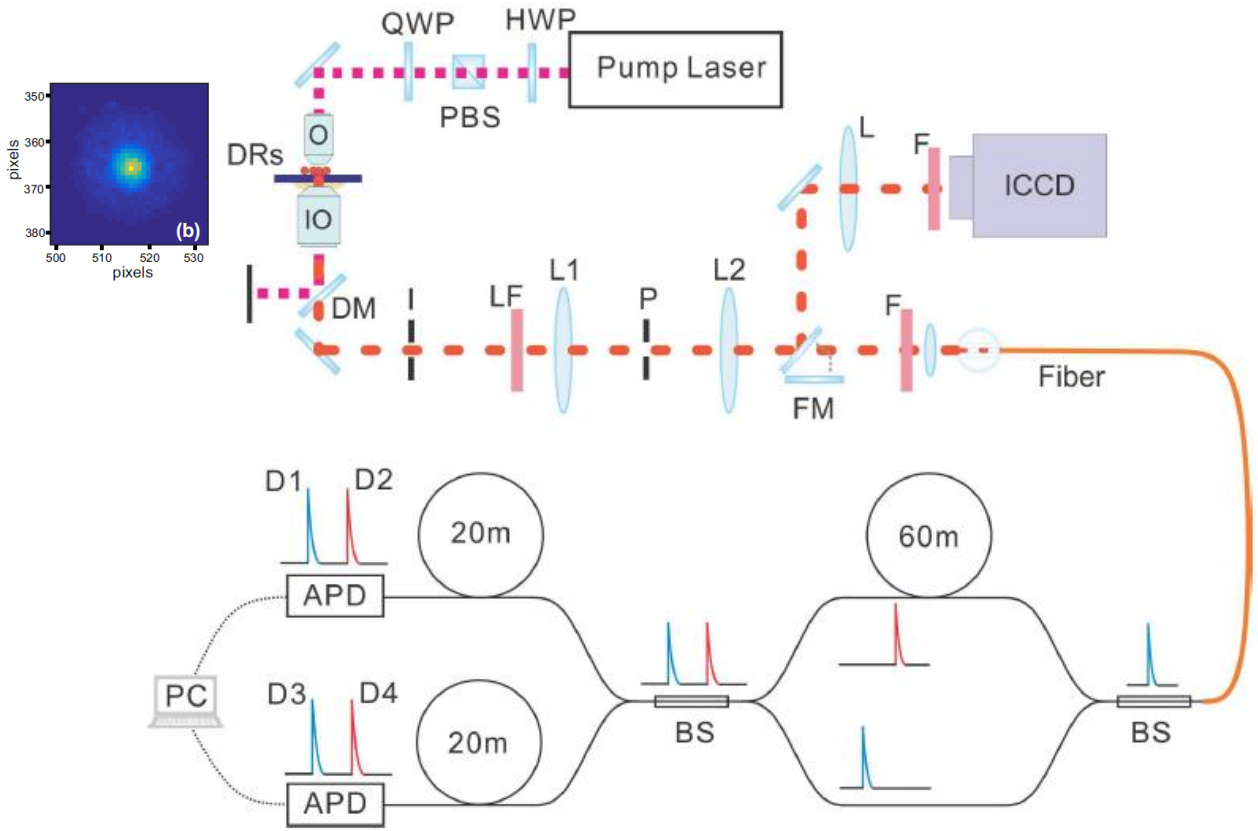
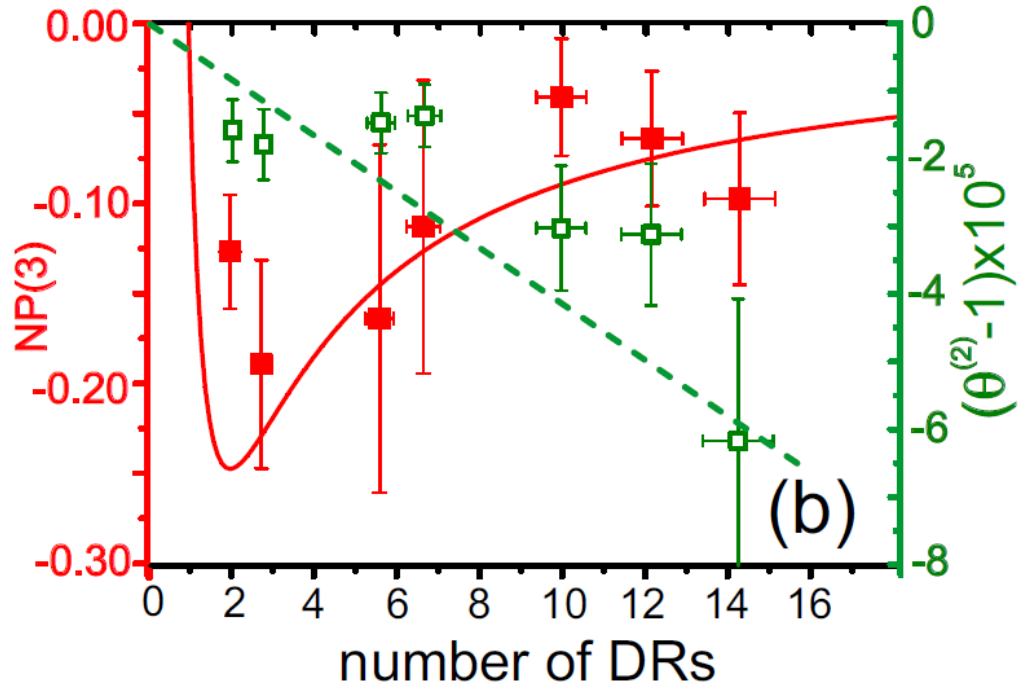
NONCLASSICALITY FROM MANY DOTS



$$\theta^{(k)} = \frac{P_{0\otimes k}}{\prod_{i=1}^{k} P_{0[i]}}$$



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NEXT TARGETS

- quantum non-Gaussian of multiphoton light (NV centers, quantum dots, molecules, optomechanical structures)
- quantum non-Gaussian coherence and interference

- thermally induced nonclassical and quantum non-Gaussian mechanical states of ions and macroscopic oscillators

PhD and postdoc positions available!