Quantum information and quantum optics at Queen's

Myungshik Kim
Queen's University Belfast

- Dr. Mark Tame
- Dr. Jaeyoon Cho
- Mr. Carlo Di Franco
- Mr. Sean Springer
- Dr. Daniel Bellester
- Dr. Chris Ogden

- Dr. McCann's Group

- Dr. Paternostro's Group

What do we do?

- Cavity QED
  - Single atom in a cavity
  - Let us couple them
  - How about a few atoms in a cavity
  - How about a few atoms in coupled cavities
  - JC, CO
- Quantum properties of nano-structured media
  - MT, DB
- Photon networks
  - MT
- Foundations of Quantum mechanics
  - SS, Visitors
- Spin chains
  - C di F -- MP
- Quantum Optics
  - MSK

Adding/subtracting a photon

$$\hat{a}\left|n\right\rangle = \sqrt{n}\left|n-1\right\rangle$$

$$\hat{a}^{+}\left|n\right\rangle = \sqrt{n+1}\left|n+1\right\rangle$$

Quantum Optics

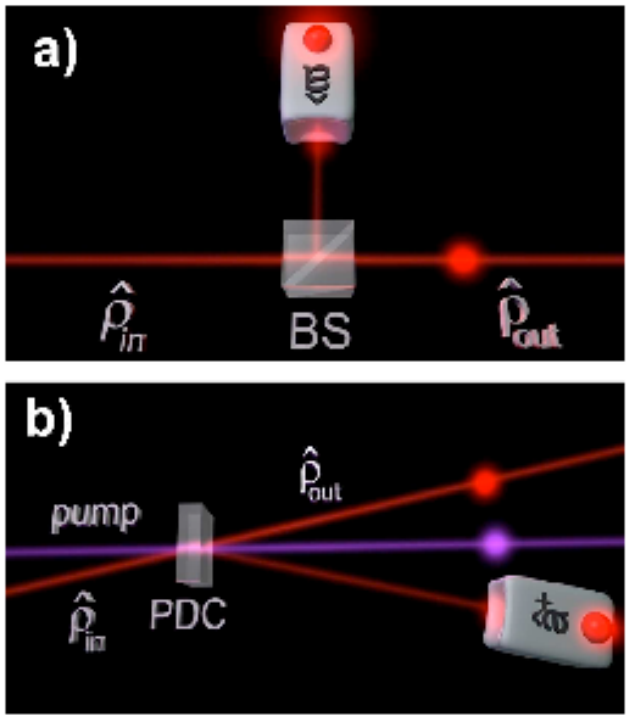

Figure 1: Setups to subtract (a) and add (b) a single photon from/to a light field. $\hat{\rho}_{in}$ and $\hat{\rho}_{out}$ denote the density operators of the input and output fields; BS is a low-reflectivity beam splitter; PDC is a nonlinear crystal where parametric down-conversion takes place; $\hat{a}$ and $\hat{a}^\dagger$ denote on/off photodetectors that herald the success of the corresponding quantum operation on the initial field state.

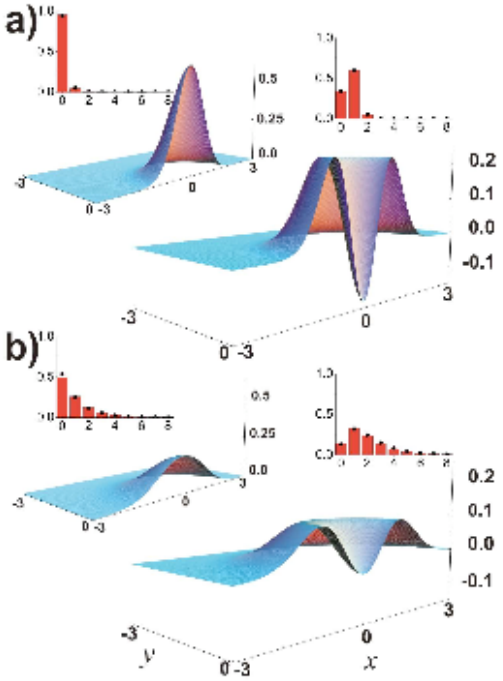

Figure 2: The Wigner functions and photon number probability distributions for thermal fields (left panels) of mean photon number 0.08 (a) and 1.15 (b) and corresponding photon-added thermal fields (right panels).

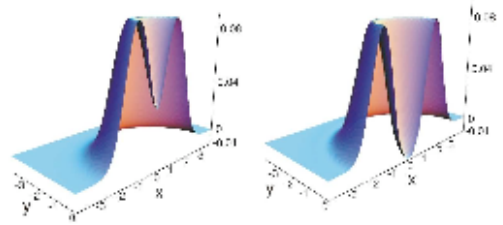

Figure 3: The Wigner functions for the initial thermal field after a photon is first added then subtracted (left) a photon is first subtracted then added (right).

Thank you