Generating continuous variable optical quantum states and entanglement

P. K. Lam[†], W. P. Bowen[†], R. Schnabel[†], N. Treps[†], B. C. Buchler[†], T. C. Ralph[‡], H.-A. Bachor[†]

[†] *Department of Physics, Faculty of Science,*
The Australian National University, Canberra, ACT 0200, Australia.
[‡] *Department of Physics, Centre for Lasers,*
University of Queensland, St. Lucia, QLD 4072, Australia.
tel: +61 2 6125 3523, fax: + 61 2 6125 0741, e-mail: Ping.Lam@anu.edu.au

Quantum information research has recently been shown to have many applications in the field of communication and information processing. Quantum states and entanglement play a central to almost all quantum information protocols, and form the basic building blocks for larger quantum information networks. We present an overview of the research activities at the quantum optics group of the ANU relating to this area. In particular, we demonstrate technology to suppress the noise on a coherent laser beam to below that of even vacuum. This quantum state of light is called "squeezed light". We show experimentally that by mixing two squeezed beams on a beam splitter, a pair of Einstein-Podolsky-Rosen (EPR) entangled beams can be created [1]. This kind of entanglement exhibits below shot noise correlations between both the phase and amplitude quadratures of two beams. Our experimental results in figure 1 show conclusively that our entangled beams demonstrate the famous EPR paradox.

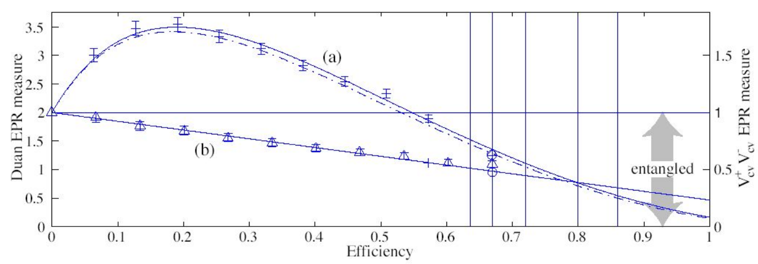

Fig. 1. Measured effect of loss on (a) Reid and Drummonds and (b) Duans EPR measures.

We show that the Stokes operators that map out the Poincaré sphere representation of the polarisation of light can be similarly squeezed and entangled [2, 3] (see figure 2). We experimentally demonstrate both polarisation squeezing and polarisation entanglement in the continuous variable regime.

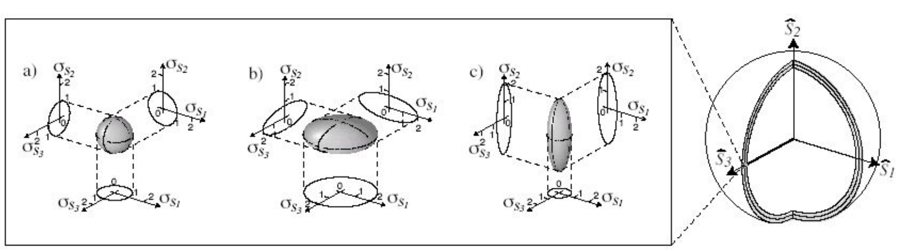

Fig. 2. Measured quantum polarisation noise at 8.5 MHz mapped onto the Poincaré sphere. a) coherent beam, b) beam from two phase squeezed inputs, c) beam from two amplitude squeezed inputs.

References

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