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Experimental studies on bright quantum states of light

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Bright quantum states of light are progressively a subject of intense research owing to the fact that these states can provide much stronger interactions with matter and with each other than the fait (microscopic) stets of light. As they contain large numbers of photons, they resemble with classical systems. Thus it becomes essential to investigate to what extent such states exhibit "quantumness". Microscopic Bell states, which are four modes squeezed vacuum states, are one such bright system containing typically 106 photons per pulse. We wish to implement a method namely 'three-dimensional quantum polarization tomography' for characterization of polarization and squeezing features of these states. In addition, we wish to explore the non-classical correlations and entanglement features of these states. In recent years, these bright photon states have found potential applications in fundamental tests, gravitational wave detection, quantum storage, and absolute measurement of detectors' quantum efficiency. The polarization features of macroscopic Bell states are characterized using the method of quantum polarization tomography, which utilizes three-dimensional inverse radon transform to reconstruct the polarization quasi-probability distribution function of a state from the probability distributions measured for various Stokes observables. The reconstructed distributions obtained for these states are compared with those obtained for a coherent state with the same mean photon number. The results demonstrate squeezing in one or more Stokes observables (polarization squeezing). In addition, in these states, photon-number correlation measurements are performed using a standard Bell-test setup, and explicit quantum correlations are observed for conjugate polarization-frequency modes, as shown in the figure 1. We also test the entanglement witnesses for these states and it is observed that these states violate of the separability criteria, inferring that all these bright quantum states are polarization entangled.

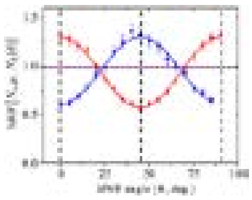

Figure 1: Photon number correlations observed for bright quantum states. Red circles represent the triplet macroscopic state; whereas blue squares show the singlet macroscopic state measurement.

Recent Publications

1. B Kanseri, T Iskhakov, I Agafonov, M Chekhova and G Leuchs (2012) Three dimensional quantum polarization tomography of macroscopic Bell states. Physical Review A 85:022126.
2. C R Muller, B Stoklasa, C Gabriel, C Peuntinger, J Rehacek, Z Hradil, A B Klimov, G Leuchs, C Marquardt and L L Sanchez Soto (2012) Quantum polarization tomography of bright squeezed light. New Journal of Physics 14:085002.
3. P A Bushev, V P Karassiov, A V Masalov and A A Putilin (2001) Biphoton light with hidden polarization and its polarization tomography. Optics and Spectroscopy 91(4):526-531.
4. T Sh Iskhakov, M V Chekhova, G O Rytikov and G Leuchs (2011) Macroscopic pure state of light free of polarization noise. Physical Review Letters 106:113602.
5. B Kanseri, T Iskhakov, M Chekhova, G Rytikov and G Leuchs (2013) Multi-photon non-classical correlations in entangled squeezed vacuum states. Physical Review A 87:032110.

Biography

Bhaskar Kanseri is currently working as an Assistant Professor at Indian Institute of Technology Delhi. He leads a research group namely Experimental Quantum Interferometry and Polarization (EQUIP). His research interests include experimental quantum optics, quantum information science (quantum cryptography and quantum computing), non-linear optics, and in coherence and polarization optics. He is a Member of several optical societies including, Optical Society of America, SPIE, Indian Laser Association and Optical Society of India.

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