Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Extraction of correlated 2-photons with near unity efficiency

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— We report a source of 2-photons that can be extracted with near unit efficiency. The reduced mode area of solid-core microstructure fibers lets a light pulse induce significant nonlinear optical interaction inside a short fiber, making it easy to generate 2-photon entanglement. However, the photon extraction efficiency is low due to the small core size ($d \sim 1$ μm) that requires high numerical aperture (NA) lenses to couple light in and out of the fiber. Tapering the core at the fiber end to 10 μm allows the use of anti-reflection-coated lenses of smaller NA, to achieve a single-photon extraction efficiency of $\eta_f = 96\%$. Using a pair of volume holographic gratings for selecting any wavelength of interest increased our spectral transmittance for that wavelength to $\eta_g = (98\%)^2$, enabling a near unit efficiency in extracting a single photon from the fiber source: $\eta_f \eta_g = 92.2\%$. The final 2-photon detection efficiency of 10% includes the efficiencies of single-photon detection modules ($\sim$ 70% each) and single-mode fiber collection ($\sim$ 50% per channel). At an average pump power of $P = 50$ μW and a laser repetition rate of $R = 76$ MHz, we detect 50 photon pairs s^{-1} with $g^{(2)}(0) = 0.0055$ and a coincidence-to-accidental ratio of 900:1. Higher pair rates at the same $g^{(2)}$ level can be achieved by increasing R.With better photon detection, this source may enable loophole-free Bell tests.

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Date submitted: 17 Nov 2008

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