maximum pump power of 213 mW, corresponding to only 1.9×10^{-4} noise photons per pulse. Figure 4 illustrated the signal to noise ratio of LG modes $l = 0$ (red) and $l = 1$ (blue). When the pump power increased from 0 to 60 mW, the SNR raised rapidly for the quantum conversion efficiency increased sharply. Beyond that, the SNR of Gaussian beam decreased as the conversion efficiency became saturated. For LG beam $l = 1$, the SNR was stable as the conversion efficiency linearly increased with the pump power. At the maximum pump power, the SNR was still as high as about 50:1.

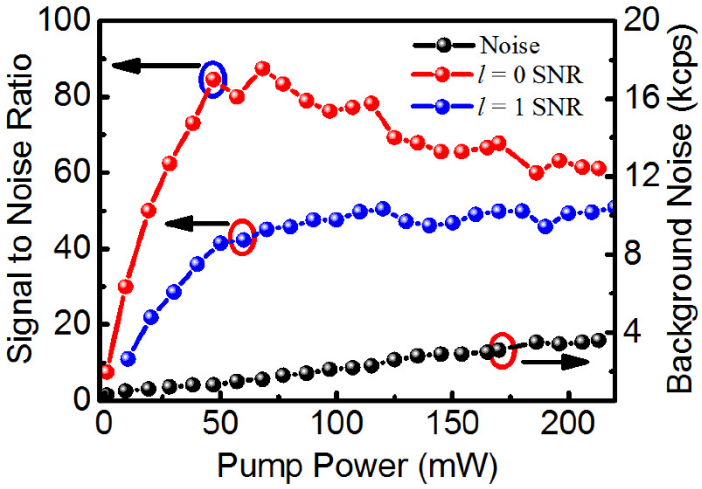

Fig. 4. Signal to noise ratio for different OAM value beams (Left) and the background noise (Right) as a function of the pump power.

4. Discussion

In summary, we demonstrate the high efficiency frequency upconversion of photons carrying orbital angular momentum for a quantum information interface. Photons carrying OAM of $1\hbar$ were converted from telecom wavelength to the visible regime with 68% quantum conversion efficiency, which could be potential applied in quantum information techniques using OAM encoding of the photons. Further research should be done to improve the system toward high efficiency and high speed to fulfill the requirement of a practical quantum interface to connect the quantum communication and quantum memory.

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