A high efficiency reconciliation method for free-space CV-QKD based on rate compatible codes

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Introduction

Recently, continuous-variable quantum key distribution (CV-QKD) protocols [1] have been studied based on Gaussian distribution in free-space [2]. However, the transmittance fluctuation caused by atmospheric turbulence effects may introduce excessive noise and the secret key rate is limited by the excess noise and reconciliation efficiency. In order to obtain a stable secret key rate, it is necessary to obtain a stable reconciliation efficiency under the fluctuation of SNR. Here, we report a high efficiency reconciliation method based on rate compatible codes such as rateless codes [3, 4].

CV-QKD system over free-space channel
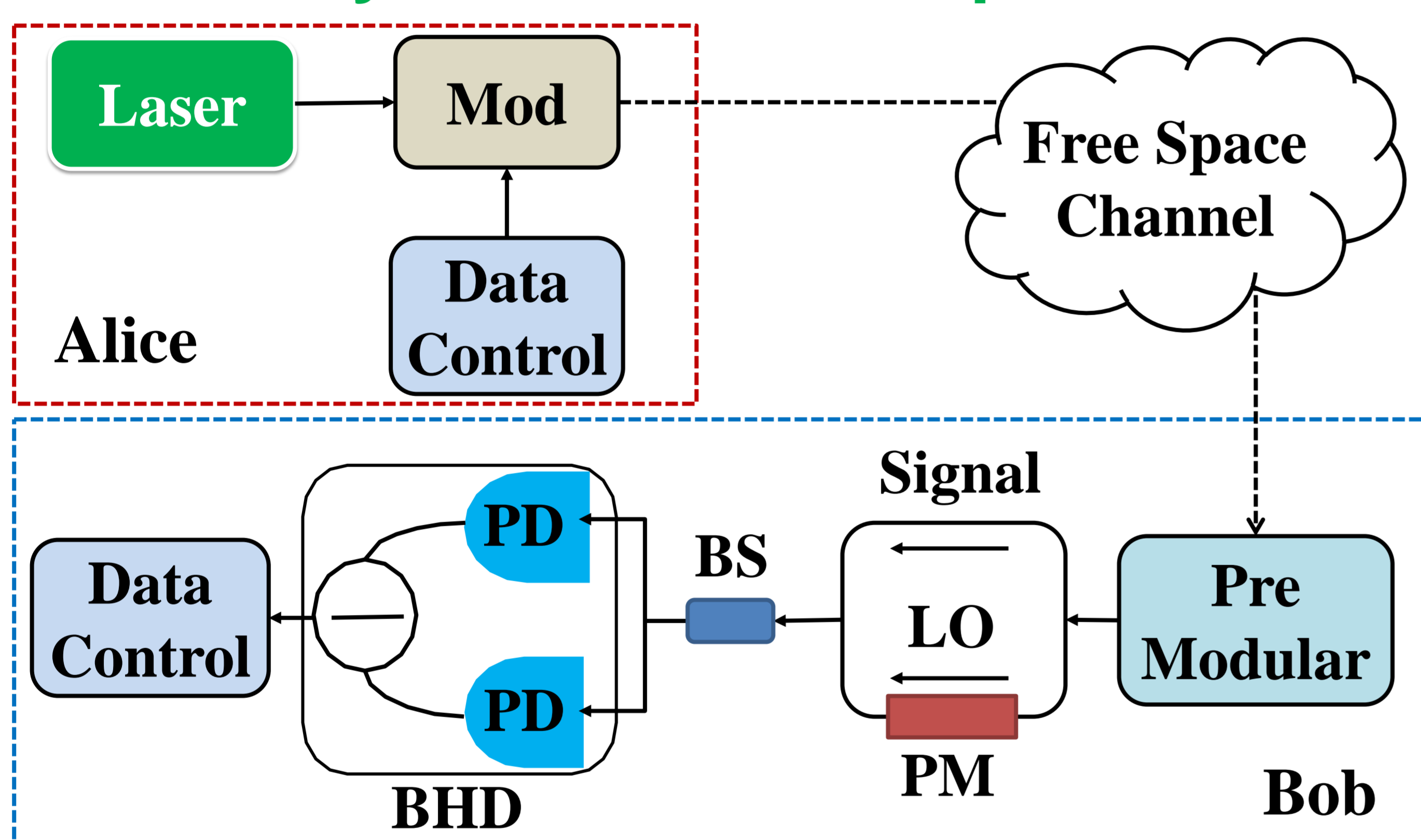
Mod, modulation; **Pre Modular**, Preprocessing Modular; **BS**, beam splitter; **PM**, phase modulator; **LO**, local oscillator; **PD**, photodetector; **BHD**, balanced homodyne detector.
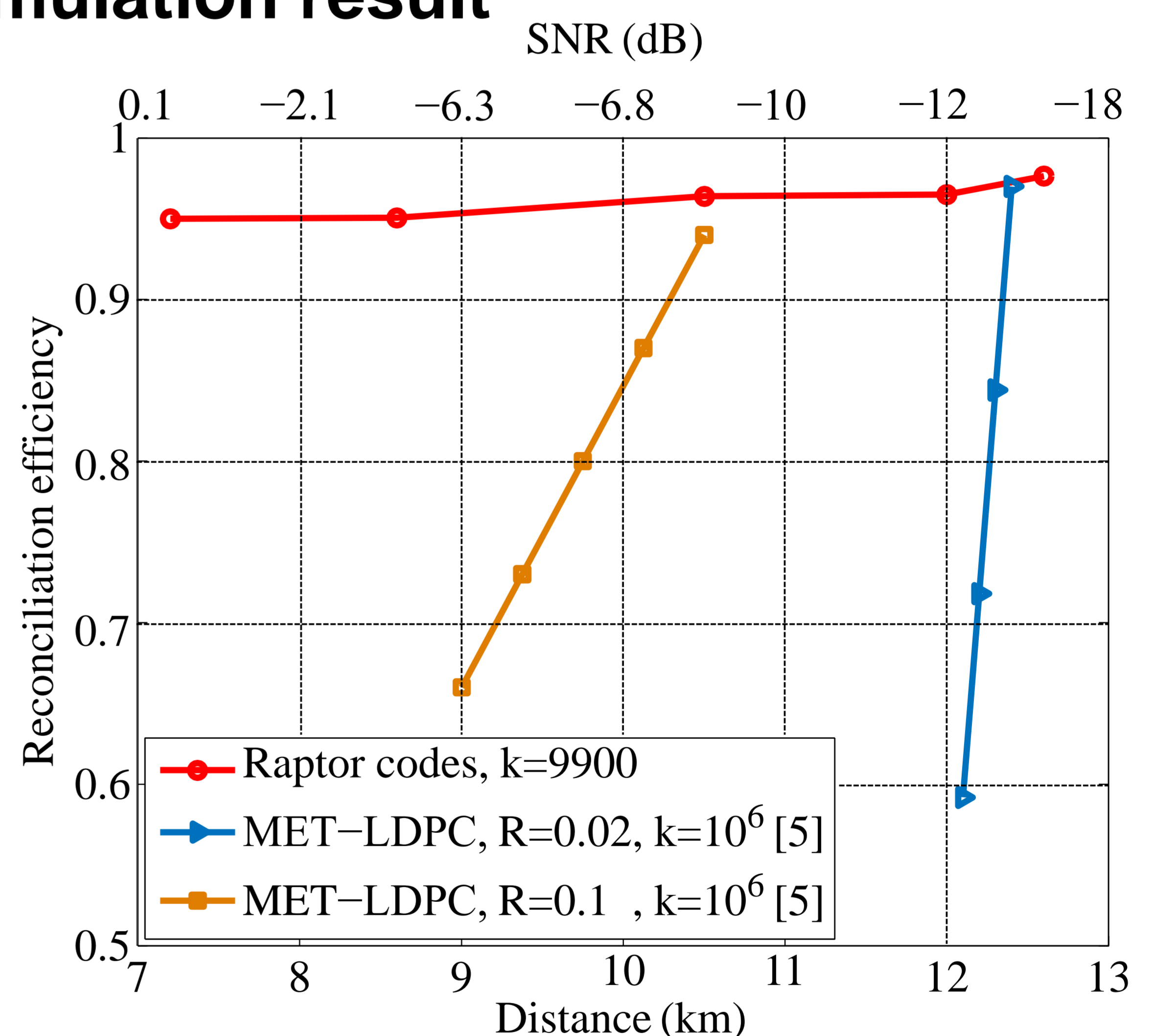
High efficiency reconciliation method
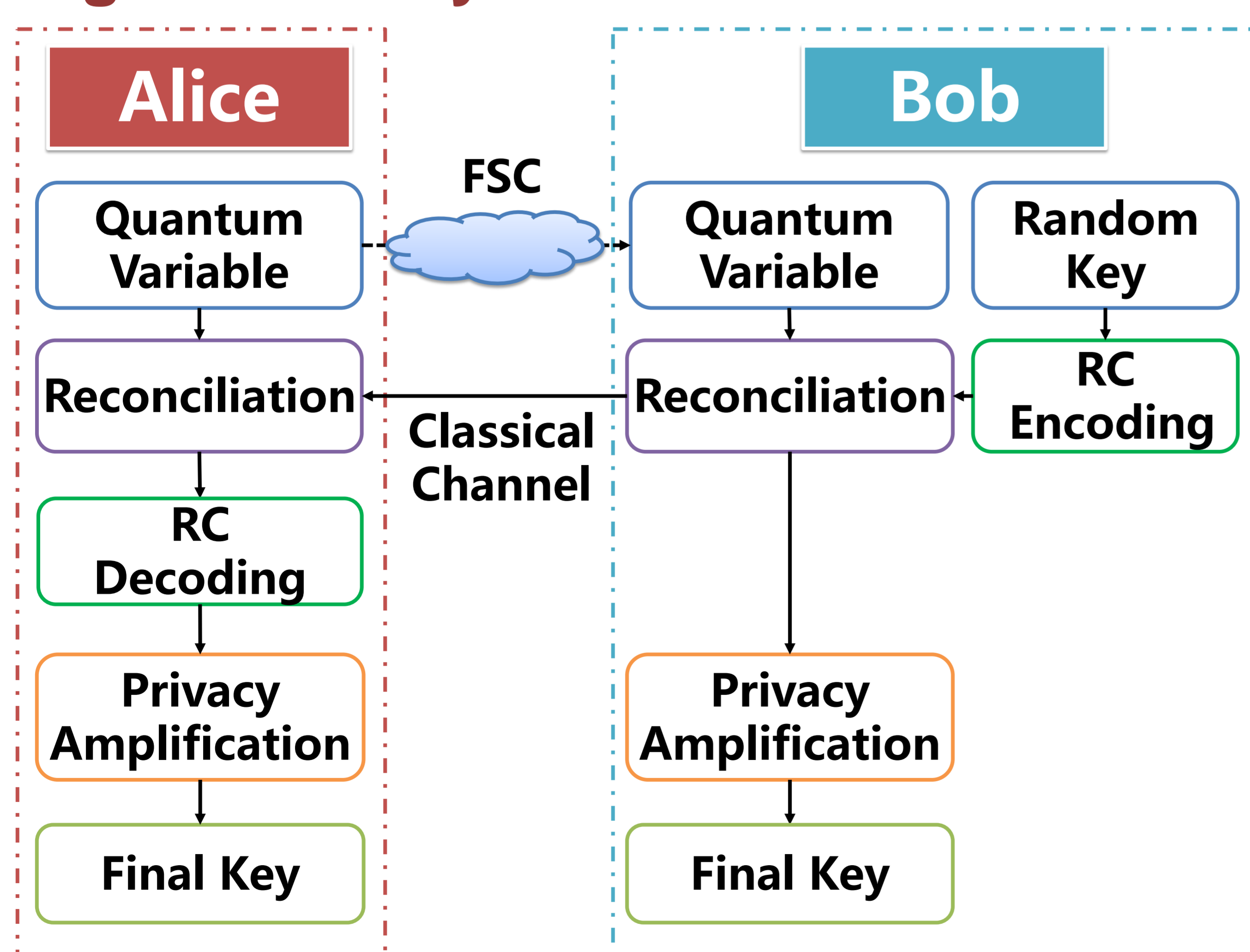
After Bob measures quantum states sent from Alice through FSC, he uses his own quantum variable and RC encoded words to calculate the side information using reconciliation algorithm and send it to Alice through the classical channel. Then Alice obtains the random raw key through reconciliation and RC decoding steps. The privacy amplification is used to distill the final key. **FSC**: free space channel; **RC**: rateless codes.

SNR under different transmittance
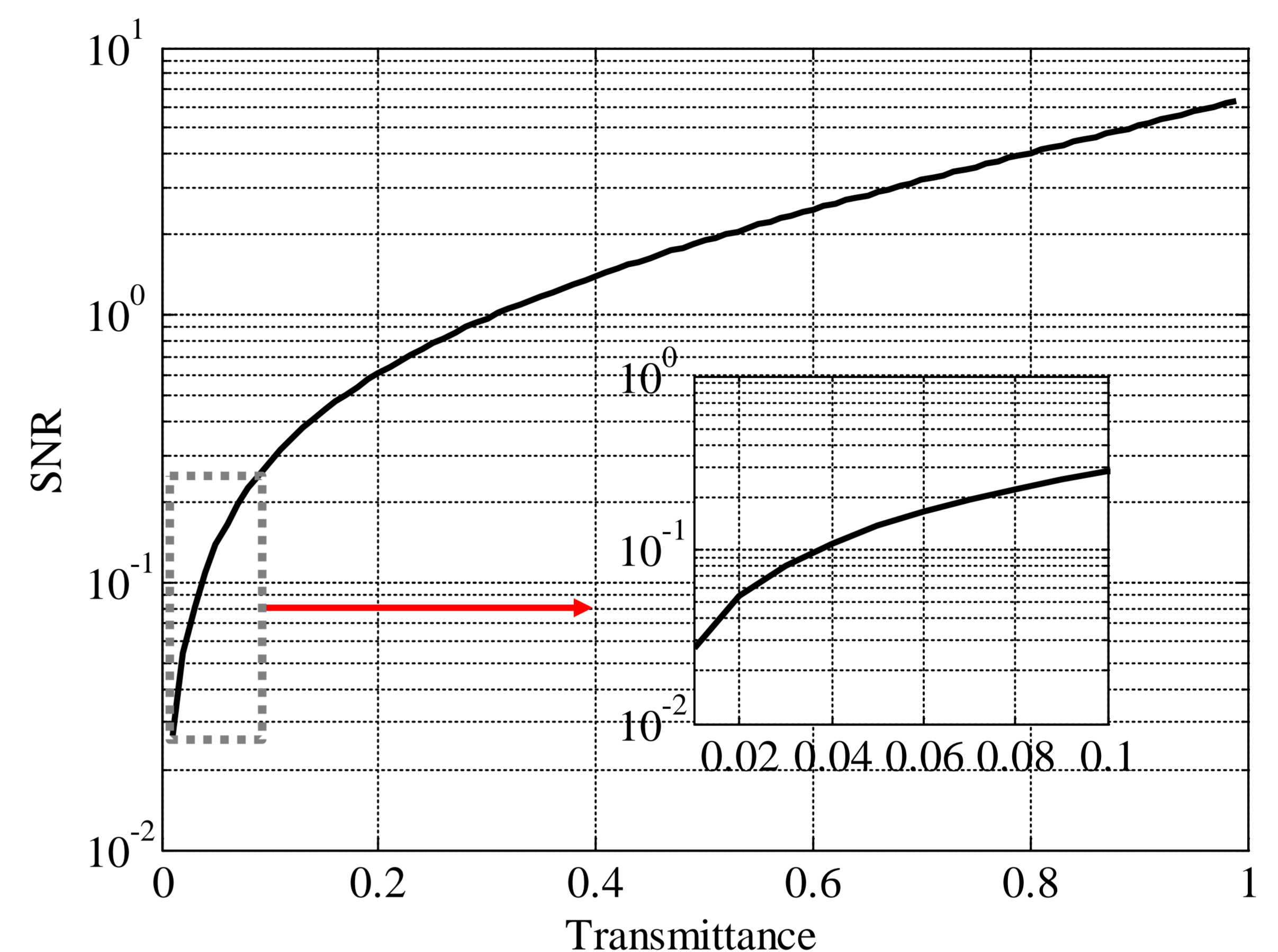
In the free-space channel, the influence of atmospheric turbulence makes the transmittance fluctuate more than that in the optical channel. Transmittance affects the SNR, which in turn affects information reconciliation performance.

Simulation result

The efficiencies of the proposed method are larger than 95% in the range of SNR from -16 to 0 dB. The fixed-rate error-correcting codes [5] will reduce the reconciliation efficiency and the secret key rate.

Conclusion

We propose a high efficiency reconciliation method for CV-QKD system over free-space channel whose transmittance changes due to beam extinction and turbulence effects. The simulation results show the proposed method can achieve stable reconciliation efficiency within a wide range of SNR.

Reference

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