Contribution ID: **25** Type: **Poster Presentation**

Three party reference frame independent quantum key distribution protocol using GHZ states

Tuesday, 4 July 2017 17:10 (1h 50m)

Quantum key distribution (QKD) can be used to securely exchange the secret key between the communicating parties which are conventionally referred to as Alice and Bob. The protocol exploit the laws of quantum mechanics to detect any eavesdropper who tries to gain the knowledge of the key. For most existing QKD protocols, it is essential to have a known reference frame between the communicating parties. For instance, alignment of polarisation states for polarizing encoding and interferometric stability for phase coding. However, unstable fibre communication links or imperfections in the measuring devices may lead to unknown and varying reference frame and has detrimental effects on the states received by Bob. Efforts has been made to tackle potential reference frame misalignment by encoding qubits with larger systems. However, this requires creation and manipulation of many photon entangled states which are very difficult to generate and are very sensitive to losses. Therefore, we present a three party reference frame independent QKD protocol, which can be implemented without any alignment between the sender and the receiver. In our protocol the key is extracted from the measurement of the GHZ states initially shared between the communicating parties. We prove the security of the protocol against collective attacks under one way classical post-processing. Our results shows that the protocol is very robust against these attacks as we obtained an error rate threshold of 18.5%.

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Session Classification: Poster Session 1

Track Classification: Track G - Theoretical and Computational Physics