Self-guided tomography for high-dimensional entangled states

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High-dimensional (discrete variable) quantum states are a valuable resource for quantum information processing [1, 2]. When compared to qubits, they carry more information per particle and are more robust to noise in quantum communication protocols. Although it is often important to characterise resource states in an experiment, conventional tomography is ineffective for high-dimensional states because the number of required measurements scales poorly with increasing dimension. Self-guided tomography takes a different approach to reconstructing the state to the conventional methods. Instead of making measurements of the unknown state over a complete set of basis states, it is an optimisation-based algorithm that iteratively updates a guess of the true state by estimating the gradient of the distance to the true state [3]. Self-guided tomography has been shown to be more robust to noise than conventional tomography and to provide a better estimate of the unknown state for the same number of copies of the state [4, 5]. However, the choice of distance measure is critical for the algorithm's success and depends on the class of states being characterised. In this work, we aimed to test self-guided tomography for high-dimensional entangled states. We built an apparatus to generate photon pairs entangled in orbital angular momentum and perform arbitrary projective measurements onto two-photon orbital angular momentum states. This enables the testing of self-guided tomography, paving the way for future work on this project. Initial results showed the distance measure for separable states to be not suitable for entangled states. Here, I will introduce momentum modes of light and how they can be generated and measured, and I will discuss the algorithm behind self-guided tomography and where its advantages lie.

References

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