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Teleporting into high dimensions

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By exploiting entanglement as a resource, information can be conveyed between two destinations with quantum teleportation. Here, the non-locality between an entangled pair of entities allows one to transmit information by employing the entangled pair as a channel between two destinations. Indirect (Bell) measurements, between one of the entangled entities and a state one desires to transmit then allows the information to be conveyed to the other party, moderated by classical communication. From the fragility of the quantum-mechanical nature being exploited, the technique is largely of interest across a variety of quantum information tasks and forms a salient toolbox from quantum computing to security and quantum networks.

While being demonstrated with continuous, discrete and hybrid approaches in addition to multiple degrees of freedom in a single photon, the highest dimension achieved to date is limited to three-dimensions. These increased dimensions, however, requires an ancillary photon pair for every increase in dimension. Consequently, it comes at the cost of complex, resource intensive experiments which challenges the scalability of the scheme. Here, in lieu of the traditional linear implementation of the entangling step for teleportation, we employ a non-linear approach, allowing us to side-step the scalability issue. We implement a teleportation scheme with photons whereby teleportation is achieved without ancillary photons and demonstrate teleportation beyond this 3-dimensional mark. Furthermore, we show that on-demand teleportation of spatial states is possible with the freedom that allows the user to choose the types of spatial modes from orbital angular momentum to the pixel basis.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

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