Manipulation and certification of high-dimensional entanglement through a scattering medium

Baptiste Courme*[1], Patrick Cameron[2], Daniele Faccio[2], Sylvain Gigan[1], and Hugo Defienne[1]

[1]1Laboratoire Kastler Brossel, ENS-Universite PSL, CNRS, Sorbonne Universite, College de France, 24 rue Lhomond, 75005 Paris, France – 1Laboratoire Kastler Brossel, ENS-Universite PSL, CNRS, Sorbonne Universite, College de France, 24 rue Lhomond, 75005 Paris, France – France
[2]School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, UK – United Kingdom

Abstract

High-dimensional entangled quantum states improve the performance of quantum technologies compared to qubit-based approaches. In particular, they enable quantum communications with higher information capacities or enhanced imaging protocols. However, the presence of optical disorder such as atmospheric turbulence or biological tissue perturb quantum state propagation and hinder their practical use. Here, we demonstrate a wavefront shaping approach to transmit high-dimensional spatially entangled photon pairs through scattering media. Using a transmission matrix approach, we perform wavefront correction in the classical domain using an intense classical beam as a beacon to compensate for the disturbances suffered by a co propagating beam of entangled photons. Through violation of an Einstein-Podolski-Rosen criterion by 988 sigma, we show the presence of entanglement after the medium. Furthermore, we certify an entanglement dimensionality of 17. This work paves the way towards manipulation and transport of entanglement through scattering media, with potential applications in quantum microscopy and quantum key distribution.

*Speaker