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### **Twisted photon entanglement through turbulent air across Vienna**

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For photons with spatial structures, the influence of turbulent atmosphere is an active field of studies. Even though there is a lot of effort in the analytical or numerical analysis and lab-scale experiments, it is surprising that there are no long-distance outdoor experiments targeting that question. Thus in 2014, we performed the first experiment in a real-world scenario, where we transmitted classical information encoded in OAM-modes at a distance of 3 kilometers across the city of Vienna [1]. Here we will present the results of our follow-up experiment, which brings our investigation to the quantum level [2]. Specifically, we will present how we were able to verify quantum entanglement of photons that were transmitted over the same turbulent link of 3 kilometers across Vienna. In the experiment, we started with polarization-entangled two-photon states. The first photon is transformed into an OAM-state, and sent to a telescope at the roof of our institute 3040 meters away. There we use special slit-masks to measure superposition-bases of OAM. The photons after the mask are detected with single-photon detectors, and recoded as time-stamps. Its sisterphoton is measured at the sender. By comparing the time-stamps and the mask positions, we can measure visibilities in two mutual unbiased bases, which are sufficient to apply an entanglement witness. We show that our results cannot be produced by separable states, thus verify entanglement of OAM in a long-distance real-world scenario.

[1] Krenn, M., Fickler, R., Fink, M., Handsteiner, J., Malik, M., Scheidl, T., Ursin, R., Zeilinger, A., Communication with spatially modulated light through turbulent air across Vienna. NJP, 16(11), 113028 (2014).line line [2] Krenn, M., Handsteiner, J., Fink, M., Fickler, R., Zeilinger, A, Twisted photon entanglement through turbulent air across Vienna. PNAS, 112(46), 14197-14201 (2015).