S1-2: The effect of turbulence in free-space synchronization, using second-order quantum interference.

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Abstract: Recently, the Hong-Ou-Mandel (HOM) effect, which incorporates second-order quantum interference, has been used for remote synchronization of clocks with a synchronization stability of less than a picosecond [R. Quan, et al., Sci. Rep. 6, 30453 (2016)]. However, this implementation has only been demonstrated over a few kilometers. When such a synchronization protocol is implemented over longer distances, the effect of the channel may start to deteriorate the second-order quantum interference in the HOM effect. For instance, if the channel is the atmosphere (see for instance [J.-D. Deschenes, et al., Phys. Rev. X 6, 021016 (2016)]), turbulence may affect the quantum interference observed in the HOM effect.

Here we investigate the effect of turbulence on the HOM effect. In our experiment, turbulence is simulated for weak scintillation conditions by a single phase screen and the input state is prepared with spontaneous parametric down-conversion. We consider various scenarios allowing for different variations of the synchronization protocol. The experimental results, which agree with our theoretical calculations, show that for symmetric input states under particular conditions (in a one-sided turbulence channel) the HOM effect is independent of the scintillation strength. This result follows from a combination of the fact that the HOM dip is only observed if the input state is symmetric and the fact that a one-sided turbulent channel does not convert a symmetric state into an anti-symmetric state. In view of these results, it should be possible to use second-order quantum interference to synchronize remote clocks over longer distances.