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Heisenberg-limited measurement of single photon Kerr nonlinearity

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Improving the precision of measurements is a significant challenge for the scientific community. Quantum metrology provides ways to overcome the standard quantum limit (SQL) of 1/\sqrt{N} and to reach the fundamental Heisenberg limit (HL) of 1/N.It has been suggested that both quantum entanglement and nonlinear interactions are important resources for quantum metrology, which can result in a HL. However, the difficulty to fabricate large-scale entangled states and the fragility of such states make it challenging for quantum-enhanced schemes to surpass classical techniques in practical applications. Meanwhile, the role of high order nonlinear effect for precision enhancement is also under debate, since it contains a N^2 interaction item. In this work, we firstly experimentally demonstrate entanglement-free methods to attain HL with a linear Hamiltonian.
The resource here is simply coherent beam with N more than 10^6, and the ultimate precision can be 10^(-10) rad when estimate single photon Kerr coefficient.

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