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A proof of principle experiment for frequency-dependent squeezing generation with EPR entanglement: status and plans

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Squeezed light injection, as a method for the reduction of quantum noise, has been already demonstrated in the interferometric GW detectors GEO and LIGO . Recently also Advanced Virgo implemented this solution, and it will join the next observation run (O3), with frequency independent squeezed vacuum injected. This will allow a reduction of the shot noise, which is due to the quantum phase fluctuations of the coherent vacuum at the interferometer output port, with a corresponding improvement of the detector sensitivity in the high-frequency region of the detection band.
Quantum noise is also present, as Radiation Pressure noise (RPN), at low frequencies due to the amplitude vacuum fluctuations affecting the position of the suspended test masses. RPN does not limit the current sensitivity of interferometric GW detectors, as it is covered by technical noises.
However in the next future, when low-frequency technical noises will be reduced, RPN will be relevant for the detector sensitivity.
One of the proposed techniques, to have a broad band quantum noise reduction, is the use of a long external filter cavity, that will allow a frequency dependent rotation of the squeezing angle, starting from the frequency independent squeezed vacuum produced by a degenerate Optical Parametric Oscillator (OPO).
In this talk I will present an alternative method that makes use of quantum correlations of two EPR-entangled beams produced by a non-degenerate OPO, and of their different propagation inside the interferometer. The advantage is that the rotation of the squeezing angle, and then a frequency dependent squeezing, can be obtained with a compact apparatus and without the costs required by the infrastructure for the filter cavity.
A first step towards the implementation in the next generation detectors is to demonstrate the squeezing angle rotation on a table-top experiment with the injection of the two EPR entagled beams in a test cavity.
The proof-of-principle experiment will be based on an optical setup that was developed at EGO to demonstrate frequency independent squeezing in the audio-frequency band. This will be properly modified to have a non-degenerate OPO and a dual homodyne detection system to measure conditional squeezing.

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