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Wave Detection Beyond the Standard Quantum Limit via EPR Entanglement YIQIU MA, California Institute of Technology, HAIXING MIAO, University of Birmingham, BELINDA PANG, California Institute of Technology, MATTHEW EVANS, Massachusetts Institute of Technology, CHUNNONG ZHAO, University of Western Australia, JAN HARMS, Universita degli Studi di Urbino "Carlo Bo",, ROMAN SCHNABEL, Institut fur Laserphysik and Zentrum fur Optische Quantentechnologien, YANBEI CHEN, California Institute of Technology — The Standard Quantum Limit in continuous monitoring of a system is given by the trade-off of shot noise and back-action noise. In gravitational-wave detectors, such as Advanced LIGO, both contributions can simultaneously be squeezed in a broad frequency band by injecting a spectrum of squeezed vacuum states with a frequency-dependent squeeze angle. This approach requires setting up an additional long base-line, low-loss filter cavity in a vacuum system at the detector's site. Here, we show that the need for such a filter cavity can be eliminated, by exploiting EPR-entangled signal and idler beams. By harnessing their mutual quantum correlations and the difference in the way each beam propagates in the interferometer, we can engineer the input signal beam to have the appropriate frequency dependent conditional squeezing once the out-going idler beam is detected. Our proposal is appropriate for all future gravitational-wave detectors for achieving sensitivities beyond the Standard Quantum Limit.

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