Nondegenerate internal squeezing: An all-optical, loss-resistant quantum technique for gravitational-wave detection

James W. Gardner[a,b], Min Jet Yap[a,b], Vaishali Adya[a,b,c], Sheon Chua[a,b], Bram J. J. Slagmolen[a,b], and David E. McClelland[a,b]

[a] *Centre for Gravitational Astrophysics, The Australian National University, Acton, Australian Capital Territory 2601, Australia.*

[b] *OzGrav-ANU, The Australian Research Council Centre of Excellence for Gravitational Wave Discovery, The Australian National University, Acton, Australian Capital Territory 2601, Australia.*

[c] Now at *The Department of Applied Physics, KTH Royal Institute of Technology, Roslagstullsbacken 21, Stockholm SE-106 91, Sweden.*

The detection of kilohertz-band gravitational waves promises discoveries in astrophysics, exotic matter, and cosmology [1]. At kilohertz frequencies, e.g. 1–4 kHz, interferometric gravitational-wave detectors are limited by the quantum nature of light [2].

In this theoretical study using an analytic Hamiltonian method, we show that our proposed technique [3] of using quantum squeezed light generated directly inside the detector with distinct frequencies is tolerant to detection losses unlike previously proposed schemes for quantum enhancement [4]. We also show that this all-optical technique is feasible for sensitivity improvements of gravitational-wave detectors in a broadband fashion when combined with an optimal readout scheme. This broadband sensitivity could increase the astrophysical range of future detectors to the observable universe.

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