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Backaction evading impulse measurement with mechanical quantum sensors[1] SOHITRI GHOSH, University of Maryland, College Park, DANIEL CARNEY, University of Maryland, College Park and Fermilab, PETER SHAWHAN, University of Maryland, College Park, JACOB TAYLOR, University of Maryland, College Park and NIST — The fundamental limitation in quantum measurement of any observable arises from the measurement added noises, one of the major contributions being from backaction noise. To improve force or impulse sensing beyond the standard quantum limit (SQL), we need to reduce or eliminate the backaction noise. Building on previous works by the gravitational wave community, here we present a continuous measurement protocol using a double-ring optomechanical cavity by coupling an optical field to the momentum of a small mirror. We demonstrate how this protocol with experimentally relevant parameters can lead to significant backaction noise evasion, yielding measurement noise below the standard quantum limit over many decades of frequency. For examples, we discuss the application of this protocol in measuring small impulse transfers through instantaneous and long range interactions, especially in the context of pressure calibration and detection of heavy dark matter particles respectively.

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