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Coating thermal noise mitigation through multi mode readout

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Coating thermal noise, arising from random Brownian motions of the mirror coating materials, is the main limitation of precision measurements at frequencies below 10 Hz. We proposed a multi cavity transverse mode readout scheme [1] that realises an equivalent thermal noise level of a mesa flat-top beam, which is well known to be efficient at thermal noise reduction compared to a conventional Gaussian beam by effectively increasing the sampling area, yet has technical difficulties in generation. With optimal weightings of different spacial modes, this novel approach allows us to improve the coating thermal noise by a factor of 2.46 with 25 modes and 1.61 with 3 modes in short cavities. In this talk, I will give an overview of this thermal noise mitigation method via compositional Hermite - Gaussian modes. The design of a reference cavity with high thermal noise and the up-to-date experimental progress of the stabilised reference laser will also be presented.

[1] Andrew Wade and Kirk McKenzie. Mirror coating-thermal-noise mitigation using multi-spatial-mode cavity readout. *Physical Review A*, 106(2):023511, 2022.

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