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High-frequency gravitational wave signals in electromagnetic resonators

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Exploring the vast spectrum of high-frequency gravitational waves (HFGWs) will require a variety of experimental strategies. Among the most promising detectors are electromagnetic resonators like microwave cavities and lumped-element circuits placed in large electromagnetic fields. Such detectors will always respond electromagnetically (Gertsenshtein effect) and deform mechanically at the same time. Both effects on their own depend on the choice of coordinates and are often analysed in special frequency limits, which has led to contradictions and errors in the past.
In our work, we present a set of coupling coefficients which characterise the mechanical and electromagnetic response of resonant HFGW detectors in a coordinate invariant and frequency independent way, and which are furthermore straightforward to obtain numerically. We apply this framework by updating the HFGW sensitivity predictions for existing axion haloscopes and future up-conversion experiments like MAGO.

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