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Detecting High-Frequency Gravitational Waves with Microwave Cavities

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We give a detailed treatment of electromagnetic signals generated by gravitational waves (GWs) in resonant cavities. We show that it is crucial to carry out the signal calculation in a preferred frame for the laboratory, the proper detector frame. The proper detector frame metric is obtained by resumming short-wavelength effects to provide analytic results that are exact for GWs of arbitrary wavelength. This formalism allows us to firmly establish that, contrary to previous claims, cavity experiments designed for the detection of axion dark matter only need to reanalyze existing data to search for high-frequency GWs with strains as small as $h \sim 10^{-22} - 10^{-21}$. We also argue that directional detection is possible in principle using readout of multiple cavity modes.

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