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Constraining gravitational-wave backgrounds from conversions into photons in extragalactic magnetic fields

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High-frequency gravitational waves may provide a unique signature for the existence of exotic physics. The lack of current and future gravitational-wave experiments sensitive at those frequencies leads to the need of employing different indirect techniques. Notably, one of the most promising ones is constituted by graviton-photon conversions in magnetic fields. Our research focuses on the conversion of a gravitational-wave background into photons inside the magnetic fields of the M82 starburst galaxy and the M87 giant elliptical galaxy. By numerically solving the equations of motion of the graviton–photon system, we compute the expected electromagnetic signal generated by the conversions. This signal is then compared with the observed photon flux from the two galaxies. Requiring that the converted-photon signal does not exceed the observed flux yields a constraint on the amplitude of the gravitational-wave background. In our analysis, we use observational data from the NuSTAR high-energy telescope, which operates in the 3–80 keV band; consequently, our bound applies to gravitational waves within the corresponding frequency range. With this techiques, we improved the existing bounds in literature by about two orders of magnitude.

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