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Detecting planetary-mass primordial black holes with resonant electromagnetic gravitational-wave detectors

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The possibility to detect gravitational waves (GW) from planetary-mass primordial black hole (PBH) binaries with electromagnetic (EM) detectors of high-frequency GWs is investigated. We consider two patented experimental designs, based on the inverse Gertsenshtein effect, in which incoming GWs passing through a static magnetic field induce EM excitations inside either a TM cavity or a TEM waveguide. The frequency response of the detectors is computed for post-newtonian GW waveforms. We find that such EM detectors based on current technology may achieve a strain sensitivity down to $h \sim 10^{-30}$, which generates an EM induced power of 10^{-10} W. This allows the detection of PBH binary mergers of mass around $10^{-5} M_\odot$ if they constitute more than 0.01 percent of the dark matter, as suggested by recent microlensing observations. We envision that this class of detectors could also be used to detect cosmological GW backgrounds and probe sources in the early Universe at energies up to the GUT scale.

This reasearch leads to an accepted publication in Physical Review D. More info: https://arxiv.org/abs/2012.12189

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