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Implications of Dark Photon Dark Matter for Gravitational Waves

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The well-studied graviton-to-photon conversion process provides an intriguing method to observe early universe gravitational wave sources. However, these effects are suppressed when considering magnetic fields present in the early universe, due to the presence of the Standard Model plasma. In contrast, a dark magnetic field would induce a graviton-to-dark photon conversion process, but not be subjected to these suppression effects, greatly enhancing the probability of conversion. In the presence of a dark magnetic field, the Gravitational Waves generated in the early universe - such as from inflation, phase transitions, and topological defects - would be partially converted to dark photons, with possible polarisation dependent and/or anisotropic suppression of the Gravitational Waves depending on the properties of the dark magnetic field. Additionally, the dark photon can play the role of dark matter if it has a small mass, with the dark photons generated from the conversion process for different gravitational wave sources leaving imprints on the dark matter power spectrum. Thus, providing a unique array of correlated observational signatures.

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