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BBN Photodisintegration Constraints on Gravitationally Produced Vector Bosons

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Gravitational production of massive particles due to cosmic expansion can be significant during the inflationary and reheating period of the Universe. In this work, we focus on the gravitational production of light vector bosons that couple feebly to the Standard Model (SM) particles. Due to the very feeble coupling, the light vector bosons never reach thermal equilibrium and if the Hubble scale at the end of inflation is above 108 GeV, the gravitational production can overwhelm the thermal production via freeze-in mechanism by many orders of magnitude. As a result, much stronger constraints from the Big Bang Nucleosynthesis (BBN) can be placed on the lifetime and mass of the vector bosons compared to the scenario where
only thermal production is considered.1 As an example, we study the sub-GeV scale dark photons which couple to the SM only through kinetic mixing and derive constraints from the photodisintegration effects on the light element abundances relevant at the end of the BBN when the cosmic age was around 3 hours.

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