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Constraining Reheating Dynamics with Gravitational Waves

In the standard Big Bang model, Reheating follows inflation but precedes Big Bang Nucleosynthesis (BBN), marking the transition from the inflationary epoch to the hot Big Bang. During inflation, the universe expands exponentially due to the inflation field's energy. After inflation, as the field oscillates, it transfers energy to other particles, forming a hot, dense plasma. This phase depends on parameters like inflaton mass, self-coupling, and radiation field coupling, represented by the equation of state (EoS) and the reheating temperature Tre. Our understanding of this process remains incomplete despite advances in cosmological observations.

The past decade has witnessed the rise of gravitational waves (GWs) in observational cosmology, starting with LIGO-Virgo's 2015 detection of GWs from distant binary black hole mergers. This era includes the recent discovery of a stochastic GW background in the nano-Hertz range using Pulsar Timing Arrays, posing challenges in identifying sources beyond known astrophysical binaries but promising insights into early universe mysteries.

Cosmologists have long studied stochastic gravitational waves, especially primordial stochastic gravitational waves (PSGWs). PSGWs, believed to originate from quantum vacuum fluctuations amplified during inflation, confirm the inflationary paradigm and offer insights into high-energy physics.

Secondary gravitational waves (SGWs) can arise from a time-varying anisotropic stress-energy tensor in the early universe, carrying valuable information about cosmic dynamics and source characteristics. Our research specifically investigates SGWs generated by electromagnetic fields, with a primary focus on their role in inflationary magnetogenesis during Reheating. This study aims to demonstrate how SGWs can effectively constrain both inflationary and reheating dynamics, in addition to refining inflationary magnetogenesis models.

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