U04a Big Bang Nucleosynthesis with an Inhomogeneous Primordial Magnetic Field Strength

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Big Bang Nucleosynthesis (BBN) agrees well with the observational abundances of light elements ^{2}H, ^{3}He and^{4}He except for 7Li. We find that the abundances of these elements can be affected strongly by a stochastic primordial magnetic field (PMF) whose strength is spatially inhomogeneous. We assume an uniform total energy density with a large-scale stochastic PMF and a gaussian distribution of field strength. We show that in such case, the effective distribution function of particle velocities averaged over domains of different temperature is deviates from the Maxwell-Boltzmann (MB) distribution. This deviation is related to the PMF energy density ρ_{Bc} and fluctuation parameter σ. We perform BBN network calculations taking account the PMF strength distribution, and deduce the elemental abundances as functions of baryon-to-photon ratio η, ρ_{Bc}, and σ. We find that the fluctuation of the PMF reduces the ^{7}Be production and enhances ^{2}H production. We analyze the averaged thermonuclear reaction rates compared with those of a single temperature, the charged particles reaction rates are very different. Finally, we constrain the parameters ρ_{Bc} and σ for our fluctuating PMF model from observed abundances of ^{4}He and ^{2}H. In this model, the ^{7}Li abundance is significantly reduced. We also discuss the possibility that the baryon-to-photon ratio decreased after the BBN epoch. In this case, we find that for η larger than the present-day value, all light elements can be consistent with observational data.