Big Bang Nucleosynthesis with Time-dependent Quark Mass

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The standard Big Bang nucleosynthesis (BBN) model predicts primordial abundances of hydrogen, helium and lithium. This prediction agrees well with astronomical observations except for ^{7}Li.

Recent observations have estimated the primordial abundances precisely [e.g. 1]. Comparing these observational results with the theoretical prediction allows us to explore beyond-standard physics [2]. In particular, BBN is sensible to quark mass variations, because they change nuclear binding energies. Effects of the quark mass variations on BBN have been studied by some authors [3-5], but roles of the ^{7}Be$(n,p)^7$Li resonant reaction have been ignored. In this talk, we report that this reaction significantly decreases the abundance of ^{7}Li when the quark mass variation is negative, because a resonance at $E = 0.33$ MeV contributes to the reaction rates at the BBN temperature.

In addition, we report that the cosmological lithium problem can be solved if the quark mass was ~ 1.5 % larger than the present value, although this conclusion assumes that the resonance energies are independent of the quark mass variation. In order to prove this solution, theoretical studies on the binding energies of excited states are desirable [6].

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