Experimental Challenge to the Cosmological Li Problem in the Big-Bang Model

Shigeru KUBONO[ab]

[a]*RIKEN Nishina Center, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan,*
[b]*Center for Nuclear Study, University of Tokyo, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan*

The primordial nucleosynthesis (BBN) right after the big bang is one of the key elements that support the big bang model. The BBN is well known that it produced primarily light elements, and explains reasonably most of the elemental abundances. However, there remain some interesting and serious questions. One is the over production problem of ^{7}Li, called the cosmological Li problem. The BBN simulations using recent detailed micro-wave background measurements explain most light elements including D, ^{4}He, etc, but the ^{7}Li abundance is over predicted roughly by a factor of three. The problem resides either in nuclear reaction cross sections which are not know well, unknown physics, or astronomical observations.

Recently, there have been significant progresses reported on nuclear cross sections [1, 2, 3], especially for the destruction process of ^{7}Be, which is considered to be the main producer of ^{7}Li in BBN. The primordial ^{7}Li is considered to have been produced mostly by the electron capture of ^{7}Be in the late stage of BBN. Thus, the question for nuclear physics side is whether ^{7}Be is overproduced or less destructed in the BBN model [1]. The least investigated reaction was ^{7}Be(n,α)^{7}He. Direct measurements were reported by measuring the ^{7}Be(n,α) reaction with neutron beams for the s-wave component [2], and by the time-reverse reaction ^{4}He(α,n)^{7}Be for the p-wave component [3]. In total, the ^{7}Be(n,α)^{7}He cross sections has been identified to be not large enough to destroy ^{7}Li to explain the overproduction of ^{7}Li in BBN. This conclusion is supported by the following efforts such as the experiments using the Trojan Horse method.

I will extend my discussion on other possible destruction reactions of ^{7}Be, which are also being investigated. One is to revisit the main destruction reaction ^{7}Be(n,p)^{7}Li. Nuclear reactions of ^{7}Be with t and ^{3}He are also under investigation, although these reactions seem less probable.

Another interesting question for the BBN is the heavy element synthesis. This would affect the first star generation. Some possible reaction channels that lead to production of the CNO elements will be also touched in the talk.

References

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