PRIMORDIAL NUCLEOSYNTHESIS WITH THE COSMIC MICROWAVE BACKGROUND: PROBING THE EARLY UNIVERSE AND PARTICLE PHYSICS*

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Big bang nucleosynthesis (BBN) has taken a new role in cosmology, in light of new precision measurements of the cosmic microwave background (CMB). Recent CMB anisotropy data yield a wealth of cosmological parameters; in particular, the baryon-to-photon ratio $\eta = n_B/n_\gamma$ is measured to high precision. Fixing the value of η removes the single free parameter in the simplest version of BBN, which assumes standard particle physics and a conventional early universe (weakly interacting dark matter, radiation dominance). Moreover, non-standard BBN scenarios, which are characterized by η along with additional parameter(s), now are much more tightly constrained. The impact of the CMB results on particle physics beyond the Standard Model, and on non-standard cosmology, will be illustrated through several examples in which BBN constrains:

1. the effective number of relativistic neutrino species;
2. the decays of massive unstable particles such as a gravitino, and
3. models for an evolving cosmic dark energy component.

Prospects for improvement of these bounds via additional astronomical observations and nuclear experiments will be discussed.

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