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Hans A. Bethe Prize Talk: Big Bang Nucleosynthesis and probes beyond the Standard Model

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Big bang nucleosynthesis provides a window to the physics of the universe just seconds after the big bang. Its predictions of the light element abundances of D, ^4He , and ^7Li can be compared with observational determinations. Over the last several years, significant progress has been made in the determinations of deuterium and helium abundances and most importantly results from Planck measurements of the microwave background have provided precise values for the baryon density of the universe, a key input used in abundance predictions. These predictions are also sensitive to the conditions when the temperature of the universe was ≈ 1 MeV or $\approx 10^{10}$ K. Using inputs from the standard model of cosmology and particle physics yields excellent agreement between theory and experiment. Thus deviations from the standard model such as the number of particle degrees of freedom (often parametrized as the number of neutrino flavors) or the constancy of physical constants can be tested.