Big Bang Nucleosynthesis

Alain Coc

Centre de Sciences Nucléaires et de Sciences de la Matière (CSNSM)
CNRS/IN2P3, Université Paris Sud 11, Orsay, France

Primordial nucleosynthesis (or BBN) is one of the three observational evidences for the big bang model. It is very special as it involves only a dozen main nuclear reactions and because, contrary to stellar models, within the *standard* BBN model, the thermodynamic conditions can be calculated from first principles, that can be tested in that way. Hence, it is possible to accurately calculate the abundances of the produced "light elements": D, ^{3,4}He and ^{7}Li, using the baryonic density of the Universe deduced from the analysis of the cosmic microwave background anisotropies (WMAP and Planck satellites). Even though they span a range of five orders of magnitude, there is indeed a good overall agreement between ^{4}He, D and ^{3}He primordial abundances, either deduced from observation or from BBN calculations. However, there is a tantalizing discrepancy of a factor of ≈3, between the primordial ^{7}Li abundance deduced from observations of halo stars, and the BBN calculations. Solutions to this problem have been proposed, involving stellar physics (observational bias, surface depletion), non standard BBN models (variation of constants, relic particles,....), or nuclear physics (extra reactions, resonances or neutron sources).
In spite of this lithium problem, BBN remains a valuable tool to probe the physics of the early Universe as it is, when we look back in time, the last milestone of known laboratory physics. It can hence be used to test deviations from standard theories. In particular we studied how extensions of General Relativity, the variation of fundamental constants or *mirror* particles could affects primordial nucleosynthesis up to CNO isotopes, seeds of the first generation of stars.