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BBN, Neutrinos and Nuclear Astrophysics

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Big Bang Nucleosynthesis (BBN) theory describes the formation of light isotopes in the first minutes of cosmic time. Their abundance only depends on the baryon density, on particle physics and on nuclear astrophysics, through the competition between the universal expansion rate and the yields of the relevant nuclear reactions. The baryon density [1,2] and the observed abundance of light isotopes [3,4] are presently known with high accuracy, making the knowledge of BBN nuclear processes a major source of uncertainty to compute the primordial nuclide abundances. As the expansion rate depends on the number of active neutrino families (and any other relativistic species), the comparison between computed and observed abundances of light isotopes allows to constrain the existence of "dark radiation", i.e. sterile neutrinos or any relativistic species beyond those known (in Standard Model, photons and three neutrino families). Presently, the BBN theory constraints the number of neutrino families in excellent agreement with the complementary results from the Cosmic Microwave Background (CMB) experiments, providing a suggestive, but still inconclusive, hint of the presence of dark radiation.
In this presentation, it will be shown that a renewed study of few key reactions of the BBN chain, possibly with the existing LUNA accelerator or with proposed underground facilities, is essential to improve the accuracy of computed abundances of light isotopes, providing the BBN theory a powerful probe of physics beyond the Standard Model [7]. In particular, the accurate measurement of the D(p,γ)3He reaction at BBN energies (50-500 keV), allows to substantially improve the constraints on the number of neutrinos species and/or on the lepton degeneracy in the neutrino sector [7,8].

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