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Effects of sterile neutrino and extra-dimension on big bang nucleosynthesis

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By assuming the existence of extra-dimensional sterile neutrinos in the early universe, we investigate the sterile neutrino effects on the big bang nucleosynthesis (BBN) and constrain some parameters associated with the sterile neutrino properties. First, for cosmic expansion rate, we take into account effects by a five-dimensional bulk and intrinsic tension of the brane embedded in the bulk, and constrain a key parameter on the extra dimension by the observational element abundances. Second, effects of the sterile neutrino traveling on or off the brane are considered. In this model, the effective mixing angle between the sterile and an active neutrino depends on energy, which may give rise to a resonance effect on the mixing angle. Consequently, reaction rate of the sterile neutrino can be drastically changed during the cosmic evolution. We estimated abundances and temperature of the sterile neutrino by solving the rate equation as a function of temperature until decoupling of the sterile neutrino and found that the relic abundance of the sterile neutrino is maximized for a characteristic resonance energy. Finally, some constraints related to the sterile neutrino, mixing angle and mass difference, are discussed in detail with the comparison of our BBN calculations corrected by the extra-dimensional sterile neutrino to observational data on light element abundances.

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