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Massive sterile neutrinos in the Early Universe: from thermal decoupling to cosmological constraints

We consider heavy sterile neutrinos ν_s with mass in the range $10\,\mathrm{MeV}\ m_s\ m\ 135\,\mathrm{MeV}$, which are thermally produced in the Early Universe, in collisional processes involving active neutrinos, and freezing out after the QCD phase transition. Notably, if these neutrinos decay after the active neutrino decoupling, they generate extra neutrino radiation and contribute to entropy production: they alter the value of the effective number of neutrino species N_{eff} and $^4\mathrm{He}$ production. We provide a detailed account of the numerical solution of the exact relevant Boltzmann equations. Finally, we also identify the parameter space allowed by current Planck satellite data and forecast the parameter space probed by future Stage-4 ground-based CMB observations, expected to match or surpass BBN sensitivity, improving the existing constraints on the sterile neutrino parameter space in both cases.

Primary authors: MASTROTOTARO, Leonardo (Università degli Studi di Salerno - INFN, Sezione di Napoli, Gruppo collegato di Salerno); SERPICO, Pasquale (LAPTh - CNRS & Univ. Savoie (FR)); MIRIZZI, Alessandro (University of Bari); NINETTA, Saviano (INFN Napoli)

Presenter: MASTROTOTARO, Leonardo (Università degli Studi di Salerno - INFN, Sezione di Napoli, Gruppo collegato di Salerno)

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