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Relativistic and spectator effects in leptogenesis with heavy sterile neutrinos

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For leptogenesis with heavy sterile neutrinos above the Casas-Ibarra bound, asymmetries produced by relativistic sterile neutrinos at early times can be relevant in the case of weak washout or if the asymmetry is partly protected from washout by being transferred to partially equilibrated spectator fields. We thus study the relevance of relativistic effects for leptogenesis in a minimal seesaw model with two strongly hierarchical sterile neutrinos. Starting from first principles, we derive a set of relativistic momentum averaged Boltzmann equations to compute the final B-L asymmetry at order one accuracy for various initial conditions. Assuming fully equilibrated spectator fields, we find that relativistic corrections lead to a sign flip and an enhancement of the final asymmetry for weak washouts and a vanishing initial abundance of sterile neutrinos. As an example for the effect of partially equilibrated spectators, we consider b-Yukawa and weak sphaleron interactions for sterile neutrinos with masses $5 \cdot 10^{12}$ GeV. For strong washouts and a vanishing initial abundance of sterile neutrinos, this can give another sign flip and an absolute enhancement of the final asymmetry by up to two orders of magnitude relative to the cases with either negligible or fully equilibrated spectator interactions.

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