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A dark clue to seesaw and leptogenesis in a pseudo-Dirac singlet doublet scenario with (non)standard cosmology

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We propose an appealing alternative scenario of leptogenesis assisted by dark sector which leads to the baryon asymmetry of the Universe satisfying all theoretical and experimental constraints. The dark sector carries a non minimal set up of singlet doublet fermionic dark matter extended with copies of a real singlet scalar field. A small Majorana mass term for the singlet dark fermion, in addition to the typical Dirac term, provides the more favourable dark matter of pseudo-Dirac type, capable of escaping the direct search. Such a construction also offers a formidable scope to radiative generation of active neutrino masses. In the presence of a (non)standard thermal history of the Universe, we perform the detailed dark matter phenomenology adopting the suitable benchmark scenarios, consistent with direct detection and neutrino oscillations data. Besides, we have demonstrated that the singlet scalars can go through CP-violating out of equilibrium decay, producing an ample amount of lepton asymmetry. Such an asymmetry then gets converted into the observed baryon asymmetry of the Universe through the non-perturbative sphaleron processes owing to the presence of the alternative cosmological background considered here. Unconventional thermal history of the Universe can thus aspire to lend a critical role both in the context of dark matter as well as in realizing baryogenesis.

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