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Sterile Neutrino Dark Matter from Scalar Decay: General Features, Subleties and Related Issues

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Sterile neutrinos in the keV range are among the most promising candidates for dark matter. We investigate in detail a model that extends the Standard Model by a scalar singlet S and sterile neutrinos N_i.
The scalar couples to the Standard Model via a Higgs portal coupling, the size of which determines whether or not the scalar singlet S enters thermal equilibrium in the early Universe. Sterile neutrinos N_i on the other hand couple to the scalar via a Yukawatype interaction and also mix with active neutrino sector in general.
We present both analytical and numerical methods to solve the corresponding Boltzmann equations on the level of distribution functions, from which all relevant information can be extracted. We explore the paramter space of this setting by imposing limits from cosmological observations like the relic abundance, the effective number of neutrinos, or considerations of structure formation. Exploiting the distribution functions obtained, we show that some previous estimates on structure formation present in the literature can be refined considerably, opening up possibilities to address recent issues on structure formation on small scales. By comparing numerical computations to analytical estimates already present in the literature, we gain a deeper insight on the validity of some assumptions that have been made so far.

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