

REFEREE REPORT ON 2109.00767v1

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The lecture notes “Sterile Neutrinos as Dark Matter Candidates” represent an introduction to the topic of sterile neutrino dark matter, including a clear discussion of the general framework of flavor oscillations and sterile neutrino production in the early universe, and a brief discussion of the associated phenomenology. They are pedagogical, accurate and well written. I therefore recommend their publication in SciPost Physics Lecture Notes after the following minor comments have been addressed:

- After Eq. (15), the precise requirement for the expansion is $m_j^2 - m_k^2 \ll E^2$ rather than $|m_j - m_k| \ll E$, as is correctly stated later on in the third point of page 4.
- Before Eq. (23), “and other SM particle freeze out” \rightarrow “and other SM particles freeze out”.
- After Eq. (25), perhaps clarify that that scaling of the energy is only valid for still relativistic sterile neutrinos.
- In the first paragraph of page 8, it would be instructive to stress that the previously derived rates are small compared to the age of the Universe. It may be illustrative to normalize Eqs (38) and (39) to keV masses / small mixings for that.
- At the beginning of page 8, “the DM velocity dispersion implies Doppler broadening” \rightarrow “the DM velocity dispersion induces Doppler broadening”.
- At the beginning of page 8, perhaps move the sentence “Searches for such signatures have been carried out, and results will be discussed below.” to the end of the paragraph.
- End of page 8, it would be good to spell out MSW.
- In the discussion of the “Shi-Fuller” mechanism, the important fact about the effective potential induced by a nonzero lepton asymmetry (V_D) is that it is positive, as compared to the one generated by lepton-symmetric matter V_T . In size, V_D does not necessarily need to be much larger than V_T . In fact, V_T is already sizable enough to be important for the Dodelson-Widrow production mechanism. I understand that the

author may not want to get into details about this, but the way the discussion is currently phrased makes the reader believe that the matter potential is negligible unless there exists a large lepton asymmetry in the early universe, which is not the case. A small rephrasing around the end of page 8 would help avoid confusion.

- Last paragraph of section 5, “at the time structure formation starts” → “at the time when structure formation starts”.
- Last paragraph of section 5, “for other production mechanism” → “for other production mechanisms”.
- First paragraph of section 6, “telescope data has led to” → “telescope has led to”.