

REPORT ON JCAP_052P_0219

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TITLE: Linking Scalar Dark Matter and Neutrino Masses with IceCube 170922A

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Referee report

The article studies the bounds that can be derived on the coupling of neutrinos to a light scalar and a right-handed neutrino by comparing the mean free path of the high energy IceCube-170922A neutrino event with the distance between the source and the detector. The model that they consider is of interest for various reasons, making the bound worth elaborating. However the following issues should be addressed before the article becomes suitable for publication.

The cosmological lower bounds from BBN and CMB on scalar mass need to be elaborated on. Authors in sect 5.7 have briefly mentioned these bounds but more emphasis on these bounds in the introduction, in sect 3.3.3 and in figures is required. Another key issue is the maximum bound found in Ref. [40]. This bound needs to be explained more clearly and the conflict with the value in Table 4.1 should be explained. Ref [40] reports an observational upper bound of $\sim 10^{46} \text{ erg/sec}$ which is consistent with (and weaker than) the constraint from the cascade emission consideration. Is the value reported in Table 4.1 an upper bound or a measurement? If it is the latter, then there is an inconsistency. Relevance of these bounds on the mean free path argument should be made more clear.

In addition to the above points, some minor but important changes are required that I list below. 1) The second sentence of the fourth paragraph of the introduction (starting with “This is a coincidence” needs to be edited.

2) The symbol ψ appearing in Eq. (2.1) needs to be defined.

3) In the first line of sect 2.2, a reference for the 23 % is required.

4) In sect 3.2, the emphasis on the Majorana nature of N_i is required.

5) Recently it has been shown that for DM mass lighter than few GeV, the value of annihilation cross section to obtain the right relic abundance is a bit different from 1 pb so the numerical values in section 3.3.1 should be updated.

6) After Eq (3.10), there is a discussion of naturalness which is not valid as the smallness of the splitting compared to the δ_i masses can be explained by an approximate lepton number conservation. This argument can be invoked in sec 5.3, too.

7) A and B in sec 3.3.2 should be defined. First sentence in sect 3.3.2 is misleading and may be interpreted as neutrino decay.

8) In the first line of page 8, the powers of 2 are redundant.

9) CMB bounds should be added to Sec 3.3.3.

10) In the first paragraph of sec 4, the 5th sentence should be modified to “When a muon neutrino interact with ice via charged current interactions,”

11) Sect 5.2.1 is confusing and contains contradictory claims about the ratios of the cross sections. Moreover the interference of the t -channel and s -channel amplitudes should be discussed.

12) The argument in the line after Eq (5.14) is not convincing.

13) In sec 5.5, instead of simultaneous, it is better to write the same.

14) In the first paragraph of sect 5.7, the following phrases need to be edited “to see the separate the constraint and “different to” \rightarrow “different from”.

15) In the last sentence of sect 5.8, the authors should replace “mean free path” with “optical depth” because “mean free path” is a local concept inversely proportional to the number density.

16) In the figures, the line marked with “ K^+ decay” is in fact Eq (3.9). The horizontal line comes from “ K^+ decay”.

17) The format that the references appear looks non-standard.

With kind regards,

The referee