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Impact of Semi-annihilation of Z3 Symmetric Dark Matter with Radiative Neutrino Masses

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We investigate a Z3 symmetric model with radiative neutrino masses at two loop level. A particle which can be Dark Matter in the model is either of a Dirac fermion or a complex scalar as a result of unbroken Z3 symmetry. In addition to typical annihilation processes of Dark Matter, semi-annihilation processes give an important effect when the relic density is calculated together with some experimental restrictions. A different Dark Matter phenomenology from Z2 radiative neutrino models is expected. Interesting signatures in Dark Matter searches are also discussed.

Summary

We have considered a model that neutrino masses are radiatively induced with Z3 symmetry.
The neutrino masses are generated at two-loop level and the certain neutrino mass scale has been derived with reasonable coupling strength. The model includes two kinds of DM candidates which are a Dirac fermion and a complex scalar of mixture of inert doublet and singlet. Semi-annihilation processes are important to reduce the relic density effectively in the early universe for both of DM. In particular for the Dirac DM the annihilation channel is suppressed by the strong constraint og LFV. However the DM relic density can be compatible with the observed value due to the existence of the semi-annihilation. Semi-annihilations give a considerable effect for the complex scalar DM too. The scalar DM has required to be the singlet dominant from the view point of direct detection.

The model potentially has some detectable signatures of Z3 symmetric DM by indirect detection and collider search for the Dirac DM case. Two monochromatic neutrinos are
emitted from both of the annihilation and semi-annihilation channels if these cross sections are same order of magnitude. Then double peak of neutrino flux would be detected by neutrino detectors such as IceCube. In addition, different edges in the invariant
mass distribution of the charged boson decay would be seen at collider experiments.
The Z3 symmetry we have considered here could be interpreted as a remnant symmetry of an extra U (1) symmetry.

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