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Abstract

The Standard Model (SM) of particle physics has been tremendously successful in explaining fundamental particles and their interactions. It can explain three of the four fundamental interactions in nature (weak nuclear interaction, strong nuclear interaction, and electromagnetic interaction) except gravity. A major milestone in particle physics this decade must have been reached in 2012 with the finding of the 125 GeV neutral boson at the Large Hadron Collider (LHC). This significant discovery declares (confirms) the SM as the most effective theory to date in terms of the number of experimental evidence (findings) that support its predictions.

However, the SM is not a complete theory. Despite its remarkable achievements, SM is still unable to explain several phenomena, including the small neutrino mass, dark matter, lepton flavor violation, and the universe's baryon asymmetry (BAU). There are still unresolved fundamental theoretical issues in SM, including the strong-CP problem, the gauge coupling unification, the hierarchy problem, and the flavor question. As a result of these unsolved problems, it provides enough motivation to look beyond the SM (BSM). Also, there are reasons to assume physics beyond the Standard Model (BSM) based on experimental data on neutrino masses and mixing from several neutrino oscillation experiments as well as cosmology, astrophysics, and other related fields. The construction of BSM scenarios often involves extending with the extension of SM particle sector, scalar, and fermions.

Various neutrino oscillation experiments have confirmed the massive nature of the neutrinos. The neutrino oscillation parameters have been precisely calculated by these experiments. Numerous BSM frameworks have been proposed to explain the neutrino mixing patterns and the origin of neutrino masses. Various phenomena like Lepton Flavour Violation (LFV), Lepton Number Violation (LNV), the existence of Dark Matter and Baryon Asymmetry of the Universe (BAU) can also be explained using the BSM physics. One of the most important questions in particle physics is whether the neutrinos are four-component Dirac fermions or two-component Majorana fermions. This question is intimately related to the conservation of lepton numbers. There are various process that arises in BSM frameworks. One such process that appears in several BSM frameworks is neutrinoless double beta decay (NDBD/$0\nu\beta\beta$). Lepton number (LN) conservation is broken in a hypothetical decay mode of some atomic nuclei when two neutrons concurrently change into two protons inside the nucleus, producing only electrons and no neutrinos.

The main attempt to search for $0\nu\beta\beta$ decay is to measure the effective Majorana neutrino mass,

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Phenomenology of Neutrino Masses and Mixing with Discrete Flavour Symmetry in the context of the latest neutrino oscillation data

by Animesh Barman

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