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Type-II Seesaw Triplet Scalar Effects on Neutrino Trident Scattering

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In Type-II seesaw model, an electroweak triplet scalar field Δ with a non-zero vacuum expectation value (vev) v_Δ is introduced to facilitate the generation of small neutrino masses. A non-zero v_Δ also affects the W mass through the electroweak ρ parameter, making it to be less than 1 as predicted by standard model (SM). The component fields in Δ come along introduce additional contributions to reduce the SM rare neutrino trident scattering cross section. These fields also induce new processes not existed in SM, such as $l_i \to \overline{l_j} l_k l_l$ and $l_i \to l_j \gamma$. There are severe constraints on these processes which limit the effects on neutrino trident scattering and the ρ parameter and therefore the W mass. The newly measured W mass by CDF makes the central value of ρ parameter to be larger than 1, even larger than previously expected. Combining neutrinoless double beta decay, direct neutrino mass and oscillation data, we find a lower limit for v_Δ as a function of the triplet scalar mass m_Δ, $v_\Delta > (6.3 \sim 8.4)\mathrm{eV}(100\mathrm{GeV}/m_\Delta)$. To have significant effect on ρ in this model, v_Δ needs to be in the range of a GeV or so. However this implies a very small m_Δ which is ruled out by data. We conclude that the effect of triplet vev v_Δ on the W mass can be neglected. We also find that at 3σ level, the deviation of the ratio for Type-II Seesaw to SM neutrino trident scattering cross section predictions is reduced to be below 1, but is restricted to be larger than 0.98.

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