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Fitting NOvA and T2K data with the revamped A_4 symmetry model for the poorly constrained neutrino oscillation parameters

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The Standard Model is widely accepted as one of the most successful predictive theories of Physics, providing insight into the fundamental building blocks of the universe. Over the last few decades this model has shown signs of incompleteness, most of which are attributed to Neutrinos. Within the confines of the standard model a discrepancy exists related to vanishing Neutrino masses, which contradicts the experimental observation of Neutrino Oscillation [arXiv:hep-ph/0211168]. Neutrino oscillation depends on 7 parameters (3 mixing angles θ_{12}, θ_{23}, θ_{13}, a Dirac Phase due to CP violation δ_{CP}, and the 3 mass states m_1, m_2, m_3). Values of the parameters θ_{12}, θ_{13}, Δm^2_{21}, $|\Delta m^2_{32}|$ are well determined whilst θ_{23}, δ_{CP} and the mass Hierarchy, whether ($m_1 < m_2 < m_3$) or ($m_3 < m_1 < m_2$), remain poorly determined \cite{Status}. The goal of this research is to make use of the Revamped BMV (Babu-Ma-Valle) model [arXiv:1305.6774] to attempt a constrain of the poorly determined parameter values of δ_{CP} and θ_{23} using data from the NOvA (NuMI off-axis ν_e Appearance) and T2K (Tokai to Kamioka) experiments. The Revamped BMV model makes use of a supersymmetric model under A_4 symmetry first proposed in Ref.[arXiv:hep-ph/0206292]. However, the original model resulted in a vanishing θ_{13}, which has been proven to be non-vanishing by experiments RENO [arXiv:1003.1391], Daya bay [arXiv:1501.04991] and Double Chooz [arXiv:1205.6685]. We begin by building up Neutrino Physics from a brief history to the Standard physics of oscillation in a vacuum and in matter. The analysis using data from NOvA and T2K experimental results are then run through the General Long Baseline Experiment Simulator (GLoBES), which is a dedicated Linux/OS software for simulation and analysis data of long baseline neutrino experiments. We identify how the current Standard Model constraints the aforementioned parameters so as to have a comparative analysis of the constraining ability of both models. Exploring the physics of the new model suggested in Ref.[arXiv:1305.6774v1] in order to obtain the new mixing matrix in terms of the new parameters. This analysis was performed numerically due to the complexity involved in solving for the analytic expressions of the new physics. The analysis of $\Delta\chi^2(\theta_{23}, \delta_{CP})$ suggest better constraints can be obtained for the NOvA experiment in 3σ region, the T2K experiment has no visible difference in both models. The combined (NOvA+T2K) analysis is driven by the new model's effect on the NOvA data. The new model fundamentally constraints the poorly determined parameters the same way, with the only exception being in the 3σ region.

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