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Beyond the Standard Model: Probing Modular Symmetries in High-Energy Neutrino Oscillations with DUNE, T2HK, and T2HKK

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The focus of our study is to investigate neutrino mass models that arise from discrete non-abelian modular symmetry groups. These symmetries offer a promising theoretical approach to understanding neutrino phenomenology and involve multiple free parameters. Specifically, we examine models based on the A_4 modular symmetry and explore how the non-trivial transformation of Yukawa couplings impacts the flavor structure of the neutrino mass matrix. Our analysis demonstrates that the resulting mixing angles and CP-violating phase are consistent with the current oscillation data within a 3σ range.

We assume three such models and evaluate the potential of the DUNE and T2HK/T2HKK experiments to probe these models using best-fit values. Furthermore, we analyze how the determination of CP phase and atmospheric angle values is impacted by these models. To provide a more comprehensive understanding of the implications of our findings, we conduct a comparative study of DUNE and T2HK/T2HKK by performing a comprehensive parameter scan of the CP phase and atmospheric angle, independent of the fit.

Our research offers valuable insights into the impact of discrete non-Abelian modular symmetry groups on neutrino phenomenology. By exploring the implications of these models, we contribute to a deeper understanding of the underlying mechanisms that govern neutrino mass. This work has important implications for the broader field of particle physics and for future experiments seeking to probe the properties of neutrinos.

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