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Neutrino Masses and Mixings in SU(6) Model Based on S_4 Symmetry

Gayatri Ghosh
Department of Physics
PDUAM Eraligool Assam University

Abstract:
The quest to understand the origin of neutrino masses and the observed neutrino oscillations has led to various theoretical frameworks. In this research paper, we explore the SU(6) model based on the S_4 symmetry as a viable approach to explain neutrino masses and mixings. We investigate the construction of the model, discuss the role of S_4 symmetry in generating neutrino masses, and analyze the resulting neutrino mixing patterns. Additionally, we examine the constraints imposed by experimental data and outline future prospects for testing the model's predictions. Our findings demonstrate the potential of the SU(6) model with S4 symmetry in shedding light on the fundamental nature of neutrinos.

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I. Introduction

Neutrino oscillation experiments have established that neutrinos have non-zero masses and exhibit flavor mixing, in contrast to the earlier assumption of being massless and flavor-conserving. This discovery calls for an extension of the Standard Model (SM) to accommodate neutrino masses and mixing. The SU(6) model based on S4 symmetry provides an intriguing framework for understanding the origin of neutrino properties.

The SU(6) Model and S4 Symmetry
The SU(6) model extends the gauge symmetry of the SM and introduces additional fermionic and scalar fields. S4 symmetry, a discrete group of permutations, plays a crucial role in generating the observed neutrino masses and mixings. We discuss the gauge structure, field content, and the symmetry breaking pattern of the model.

Neutrino Mass Generation
We present the mechanism by which the SU(6) model with S4 symmetry generates neutrino masses. The introduction of right-handed neutrinos, along with the Higgs and scalar fields, allows for the implementation of the seesaw mechanism. We derive the neutrino mass matrix and analyze its properties.

Neutrino Mixing Patterns
The S4 symmetry in the SU(6) model leads to specific patterns of neutrino mixing. We calculate the Pontecorvo-Maki-Nakagawa-Sakata (PMNS) matrix elements and discuss the implications for the observed mixing angles and CP violation in neutrino oscillations. We compare the predictions of the model with experimental data.

Constraints from Experimental Data
We examine the compatibility of the SU(6) model with S4 symmetry with the latest experimental data from neutrino oscillation experiments, neutrinoless double beta decay searches, and cosmological observations. We discuss the parameter space allowed by the data and the implications for the model.

Future Prospects and Phenomenology
We outline possible experimental tests and future prospects for the SU(6) model with S4 symmetry. This includes the study of lepton flavor violating processes, precision measurements of neutrino mixing angles, and searches for new particles associated with the model. We discuss the potential implications for ongoing and future experiments.

II. Conclusion

In this research paper, we have explored the SU(6) model based on S4 symmetry as a framework to explain neutrino masses and mixings. We have discussed the construction of the model, the generation of neutrino masses, and the resulting mixing patterns. By comparing the model's predictions with experimental data, we have assessed its compatibility with observations. Our findings highlight the potential of the SU(6) model with S4 symmetry in providing insights into the nature of neutrinos and the fundamental laws of particle physics.