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# Quantum Gravity Effects on Oscillation Parameters in a Four Flavor Framework

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## Abstract

We consider the effects of Planck scale operators on four flavour neutrino mixing (Planck scale effects) leads to an effective  $SU(2)_L \times U(1)$  invariant Lagrangian involving, neutrino and Higgs fields. On symmetry breaking, the rise to correction to the neutrino masses and mixing. We investigate the dimensional operators coming from Planck scale Physics on neutrino oscillation in a four flavor framework. We find that most of the parameters are not altered but we get the interesting result that for certain values of the Majorana (the atmospheric neutrino mixing angle) goes significantly above 45 degrees. Hence these values of the Majorana phases are disallowed by data.

**Keywords** Quantum gravity · Neutrino oscillation · Four flavor framework

## 1 Introduction

A Review of the phenomenology of quantum gravity is given in [1]. In recent year the subject of quantum gravity phenomenon has rapid growth [2] complementary to theoretical work. One of the main challenge in neutrino physics is to explain the explicit form of the neutrino mixing and mass pattern. The successful achievements of solar, atmospheric, reactor and accelerator neutrino experiments, there are experiment anomalies that cannot be explained with the standard three neutrino frame work. In particular the presence of sterile neutrinos points in neutrino physics. The LSND and MiniBooNE results indicates the presence of one or two sterile neutrino state [3–6]. The quantum mechanical phenomenon of neutrinos, propagating in gravitational field has been discussed by many author [7]. The outline of the article is as follows. In Section 2, we discuss about the four flavour neutrino mixing. In Section 3, we briefly discuss about neutrino oscillation parameter due to Planck scale effects. In Section 4, numerical results. In Section 5, we present our conclusions.

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