Abstract

"Constraints on neutrino mixing from matrix theory"

key words: neutrino, mixing mechanism, matrix theory, convex geometry

One of the long-standing puzzles in neutrino physics concerns the number of neutrino flavours in nature. So far the existence of three types of active neutrinos has been established. However, it is crucial to ascertain if more neutrino flavour states exist. Such neutrinos are dubbed sterile as their weak interaction with ordinary matter is below available detection limits. Nonetheless, sterile neutrinos can mix with active neutrinos leaving visible imprints in the form of a deviation from the unitarity of the Standard Model neutrino mixing matrix. Thus, studies of non-unitarity of the mixing matrix are crucial in understanding neutrino physics.

We develop a novel approach of studying neutrino mixing matrices based on matrix theory. It has been built on quantities known as singular values and the notion of contractions. Based on that we define a region of physically admissible mixing matrices as a convex hull over experimentally determined three-dimensional unitary mixing matrices. We study the geometrical properties of this physical region by measuring its volume expressed by the Haar measure of the singular value decomposition and exploring its internal structure corresponding to a different number of sterile neutrinos.

We show how to identify unitarity-breaking cases based on singular values and construct their unitary extensions yielding a complete theory of minimal dimensionality larger than three through the theory of unitary matrix dilations. Using that we find stringent constraints on active-sterile neutrino mixings in models with three active and one sterile neutrino states.