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Small-mass Neutrinos, Massless Neutrinos, and Gauge Transformations

Neutrino oscillation experiments presently suggest that neutrinos have a small but finite mass. This paper will discuss how the E(2)-like subgroup of SL(2,c) can be used to distinguish between massive and massless particles. We will derive a representation of the SL(2,c) group which separates out the two sets of spinors contained therein. One is gauge dependent. The other set is gauge-invariant and represents polarized neutrinos. We show that a similar calculation can be done for the Dirac equation. In the large-momentum/zero mass limit, the Dirac spinors can be separated into large and small components. The large components are gauge-invariant, while the small components are not. These small components represent spin-1/2 non-zero mass particles. If we renormalize the large components, these gauge-invariant spinors again represent the polarization of neutrinos. If neutrinos are to have mass, then they should not be invariant under gauge transformations.

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