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Why neutrinos are different

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Quarks and leptons, the fundamental building blocks of matter, are grouped into three "generations", that is three sets of particles with identical interactions but hierarchically different masses. The mysterious nature of the charged fermion mass matrix has not been clarified by the evidence for neutrino masses, quite to the contrary: distinctly different patterns emerge for the quark and the lepton sector, where the minute neutrino masses are associated with very large mixing, in opposition to the nearly diagonal and hierarchical Cabibbo-Kobayashi-Maskawa matrix. We have previously suggested a way to derive the fermion mass matrix in the frameworks of a model with two extra space dimensions, where a single fundamental generation gives rise to three generations in the three-dimensional world. Three-dimensional fermions appear as zero modes trapped in the core of a topological defect, and the hierarchy of masses and mixings is produced by wave function overlaps in extra dimensions. A generation number corresponds to the projection of the angular momentum and so, it has geometrical nature.

In this talk we show that, putting all building blocks together, we get a successful explanation of very different hierarchical patterns of masses and mixings of both charged fermions and neutrino by means of one and the same mechanism operating in a realistic model. We present a fit of all known parameters of the mass matrices through a smaller number of free parameters of the model and give falsifiable predictions for future experiments.

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