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GENUINE, MATTER-INDUCED AND INTERFERENCE COMPONENTS OF CPV, TRV, CPTV ASYMMETRIES FOR NEUTRINO OSCILLATIONS

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This work represents the culmination of the solution for the historical problem of the contamination of matter effects in the discrete CP, T, CPT asymmetries for neutrino propagation. The goal is accomplished in terms of a basis of three independent components: genuine CPT-even, matter-induced T-even, interference

CP-even. Independent of the theoretical framework for the dynamics of the active neutrino flavors, $A(\text{CP})=A(\text{CP},\text{T})+A(\text{CP},\text{CPT})$, $A(\text{T})=A(\text{T},\text{CP})+A(\text{T},\text{CPT})$, $A(\text{CPT})=A(\text{CPT},\text{CP})+A(\text{CPT},\text{T})$ for the three independent experimental asymmetries. For even a T-symmetric matter, A(T) is affected by matter due to quantum interference. For the effective

Hamiltonian written as the sum of free mass propagation plus the matter potential for electron-neutrinos, the three components have definite parities under the baseline L, the matter potential “a”, the imaginary part $\sin(\delta)$ of the PMNS mixing matrix and the hierarchy “h”=+-1 in the neutrino mass ordering: A(CP,T) is odd in L and $\sin(\delta)$ plus even in a and h, A(CP,CPT) is even in L and $\sin(\delta)$ plus odd in a and h, A(T,CPT) is odd in all L, $\sin(\delta)$, a and h.

The last interference component contains then terms like $a \cdot \sin(\delta)$.

The independent measurement of the three asymmetries could only be made in neutrino factories and atmospheric neutrinos. For present terrestrial accelerator sources of muon-neutrinos and antineutrinos, the two components of the appearance CPV asymmetry A(CP) can be disentangled, at a fixed baseline, by energy dependence. At the DUNE baseline, the higher energy region above the first oscillation node provides a dominant matter-induced A(CP,CPT) component. On the contrary, there is a “magic energy” E around the second oscillation maximum in which the fake A(CP,CPT) component has a first-rank zero whereas the genuine A(CP,T) component has a maximum (proportional to $\sin(\delta)$). With a modest energy resolution $\Delta E \sim 200$ MeV an effective zero remains.

Primary authors: Prof. BERNABEU, Jose (University of Valencia and IFIC); Mr SEGARRA, Alejandro (University of Valencia and IFIC)

Presenter: Prof. BERNABEU, Jose (University of Valencia and IFIC)

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