Report

On CKM Mixing & CP Breaking in Leptonic Sector

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Abstract

TGD predicts that CKM mixing for quarks is induced by topological mixing of partonic 2-topologies with genus $g = 0, 1, 2$ (genus g is the number of handles attached to sphere) having always Z_2 global conformal symmetry. For higher genera Z_2 symmetry is present only for special values of conformal moduli and the handles would form the analog of free many-particle state, which would explain the absence of higher fermion generations as elementary particles. The model predicts CKM mixing also for leptons and the $\mu - \tau$ anomaly for Higgs decays would have explanation in terms of CKM mixing. Neutrino mixing would correspond to topological mixing and the recent indications for CP breaking in neutrino mixing support the view that CP breaking for CKM matrix is quite generally induced by that for topological mixing.

Keywords: CKM mixing, CP breaking, TGD, lepton, quark, neutrino.

Cabibbo-Kobayashi-Maskawa (CKM) matrix (see http://tinyurl.com/zxay2f5) is 3×3 unitary matrix describing the mixing of D type quarks in the couplings of W bosons to a pair of U and D type quarks. For 3 quarks it can involve phase factors implying CP breaking. The origin of the CKM matrix is a mystery in standard model.

In TGD framework CKM mixing is induced by the mixing of the topologies of 2-D partonic surfaces characterized by genus $g = 0, 1, 2$ (the number handles added to sphere to obtain topology of partonic 2-surface) assignable to quarks and also leptons [1, 3].The first three genera are special since they allow a global conformal symmetry always whereas higher genera allow it only for special values of conformal moduli. This suggests that handles behave like free particles in many particle state that for higher genera and for three lowest genera the analog of bound state is in question.

The mixing is in general different for different charge states of quark or lepton so that for quarks the unitary mixing matrices for U and type quarks - call them simply U and D - are different. Same applies in leptonic sector. CKM mixing matrix is determined by the topological mixing being of form $CKM = UD^{\dagger}$ for quarks and of similar form for charged leptons and neutrinos.

The usual time-dependent neutrino mixing would correspond to the topological mixing. The time constancy assumed for CKM matrix for quarks must be consistent with the time dependence of U and D. Therefore one should have $U = U_1X(t)$ and $D = D_1X(t)$, where U_1 and D_1 are time independent unitary matrices.

In the adelic approach to TGD [4, 7] fusing real and various p-adic physics (correlates for cognition) would have elements in some algebraic extension of rationals inducing extensions of various p-adic number fields. The number theoretical universality of U_1 and D_1 matrices is very powerful constraint. U_1 and D_1 would be expressible in terms of roots of unity and e (e^p is ordinary p-adic number so that p-adic extension is finite-dimensional) and would not allow exponential representation. These matrices would be constant for given algebraic extension of rationals.

It must be emphasized that the model for quark mixing developed for about 2 decades ago treats quarks as constituent quarks with rather larger masses determining hadron mass (constituent quark is identified as current valence quark plus its color magnetic body carrying most of the mass). The number theoretic assumptions about the mixing matrices are not consistent with the recent view: instead of roots of unity trigonometric functions reducing to rational numbers (Pythagorean triangles) were taken as the number theoretic ideal.

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$X(t)$ would be a matrix with real number/p-adic valued coefficients and in p-adic context it would be an imaginary exponential $exp(itH)$ of a Hermitian generator H with the p-adic norm $t<1$ to guarantee the existence of the p-adic exponential. CKM would be time independent for $X_U = X_D$. TGD view about what happens in state function reduction [2, 5, 6] implies that the time parameter t in time evolution operator is discretized and this would allow also $X(t_n)$ to belong to the algebraic extension.

For quarks $X_U = X_D = Id$ is consistent with what is known experimentally: of course, the time dependent topological mixing of U or D type quarks would be seen in the behavior of proton. One also expects that the time dependent mixing is very small for charged leptons whereas the non-triviality of $X_\nu(t)$ is suggested by neutrino mixing. Therefore the assumption $X_L = X_\nu$ is not consistent with the experimental facts and $X_L(t) = Id$ seems to be true a good approximation so that only $X_\nu(t)$ would be non-trivial? Could the vanishing em charge of neutrinos and/or the vanishing weak couplings of right-handed neutrinos have something to do with this? If the $\mu - e$ anomaly in the decays of Higgs persists, it could be seen as a direct evidence for CKM mixing in leptonic sector.

CP breaking is also possible. As a matter fact, one day after mentioning the CP breaking in leptonic sector I learned about indications for leptonic CP breaking (see `http://tinyurl.com/zr8xm26`) emerging from T2K experiment performed in Japan: the rate for the muon-to-electron neutrino conversions is found to be higher than that for antineutrinos. Also the NOvA experiment in USA reports similar results. The statistical significance of the findings is rather low and the findings might suffer the usual fate. The topological breaking of CP symmetry would in turn induce the CP breaking the CKM matrix in both leptonic and quark sectors. Amusingly, it has never occurred to me whether topological mixing could provide the first principle explanation for CP breaking!

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