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The Basis Invariant Flavor Puzzle

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Content :

The Standard Model (SM) flavor puzzle is obscured by the possibility of different choices of basis and parametrization. However, it is clear that physical observables cannot depend on such arbitrary and unphysical choices. Hence, a new and un-observed vision on the flavor puzzle is offered by formulating it in a basis invariant language. In order to achieve this for the SM quark sector, we use the Hilbert series to construct the full ring of basis invariants. Furthermore, we construct a complete basis of orthogonal invariants for this ring, using the simple and intuitive technique of birdtrack diagrams. This yields a set of ten independent CP-even invariants, corresponding to the ten independent physical parameters of the SM quark sector. An eleventh, CP-odd invariant - the well known Jarlskog invariant - is related to the CP-even invariants by an algebraic relation of the invariant ring (a syzygy), which takes a particularly compact form for our orthogonal invariants. Since all relevant data in the quark sector is available at precision, we can "measure" the invariants. We will see that hierarchical masses and hierarchical CKM elements correspond to strongly, positively correlated invariants. Hence, the (quark sector) flavor puzzle can be rephrased as to why the, a priori independent, basis invariants are so strongly correlated. Likewise, a new solution to the flavor puzzle would be given by an explanation for the observed strong correlations.

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