ORIGIN OF MASS SPECTRUM FOR FERMION GENERATIONS. NEW MECHANISM

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Enormously different (5—6 orders of magnitude) masses of fermion generations evidence the existence of some internal structure which does not manifest itself directly in the standard Yukawa couplings. The same situation takes place for the hierarchy of mixing matrix elements (the KM-matrix). Besides, it is just the Yukawa mechanism for fermion mass generation which gives rise to the problem of the strong CP violation in QCD.

One can proceed from the assumption that the fermion hierarchy is related with the subsequent orders developed according to some proper perturbative scheme with the parameter $g^2/(4\pi)^2 \sim 10^{-2}$, $g^2 \sim 1$. It is possible to show that the KM matrix hierarchy (besides the mass one) naturally appears if

— the condensate of the 4-th fermion generation exists,

— the perturbation series is developed by the exchange of a new neutral vector bozon Z'.

A new mechanism is proposed capable to produce the condensate, and other necessary properties, through the strong interaction in fermion — vector boson system. In principle there is no need here in the Higgs fundamental scalar.

For the quark system the model can explain or naturally includes:

—mass and KM-matrix hierarchies;

—the relation $M_W^2 = M_Z^2 \cos^2 \Theta_W$ and the experimental restriction $|m_t' - m_b'| < 200\,GeV$ for particles of the 4-th generation;

— large differences $m_t/m_b \sim 20$, $m_c/m_s \sim 10$—15;

— the appearance of the CP-violation without its strong violation in QCD;

— the masses $M_Z \sim (1$—$3)\ TeV$, $m_4 \sim 1\ TeV$.

The new strong interaction in the (1—3) TeV region would be the principal experimental consequence of the scheme at high energies. At low energies, the model predicts unusual properties for neutral transitions between flavors. The transitions with lightest flavor participation: (1←→2) and (1←→3), are either automatically suppressed or can be made small (the same with (1←→4) and (2←→4) transitions). This fact corresponds to experimental data. But transitions between adjacent heavy flavors cannot be made small. Thus one has the relation $<B_s \mid \overline{B}_s> (10^3 - 10^4) <B_d \mid \overline{B}_d>$.

The enhanced neutral transitions can also influence the decays of the type $B \to K\pi$, $B \to K\rho$. New contributions could exceed the standard ones: BR $\sim 10^{-5} - 10^{-6}$.

Significant differences between quark and lepton system and interactions (massless neutrinos, the absence of a mixing matrix) seem to require essential changes when constructing a similar mechanism for leptons.

References

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