The so-called "principle of zero" has been applied to various processes and has brought attractive results. It is an interesting problem, whether or not the principle reflects any truth of the interactions of hadrons and thus enables one to have an insight into the sub-hadronic structure of matter.

Among the authors, Gatto et al. and Cabibbo et al. have applied the principle to the quadratic divergences in the mass differences between hadron unitary multiplet, caused by weak vector boson field, and have succeeded in expressing the Cabibbo angle in terms of the symmetry breaking parameters, which, when appropriately determined, can reproduce the observed angle. On the other hand, Segre has shown, using a sort of "schizon" model, that the logarithmic divergences in the mass differences between isomultiplets by weak bosons can be cancelled with that by the photon, if $\epsilon^2 = g^2$ is assumed, though he has disregarded the quadratic divergences at all.

The purpose of this note is to show that, when the quadratic divergences in the "weak" mass differences are made finite, the logarithmic ones in the weak and electromagnetic mass differences cannot be made so, with the charged weak currents and bosons only, hence neutral ones seem to be needed, and after the introduction of the latter, in fact, the principle holds and determines a set of rather natural values of quantities.

We separate, in the lowest order self-energy by a weak boson with mass $M$, the quadratically and the logarithmically divergent parts, applying Bjorken's method, and find the former to be the same as Eq. (2) in reference 3) and the latter to be the sum of the following three terms:

$$A = -g^2 \int d^4x e^{ikx} \langle j_i \bar{w}(x), j_i w(0) \rangle$$
$$B = -g^2 \int d^4x e^{ikx} \langle [i j_i \bar{w}(x), j_i w(0) \rangle$$
$$C = -\langle \Delta \rangle (g^2/M^2)$$

The time derivatives can be calculated with the strong Hamiltonian, which we assume to be the sum of kinetic and mass terms, the equal-time commutaters of kinetic term with current components being evaluated by means of the trick of Nussinov and preparata.

Now, the principle of zero imposes on the quadratic divergence the condition that $A$ must be proportional to the unit matrix, which is reduced to

$$\alpha = \beta \epsilon^2 = \gamma s^2,$$
\begin{align}
\alpha (3\beta e^2 + 3\tau s^2 - \alpha^2) - \beta (3\alpha^2 - \beta^3)c^2 \\
+ (4\alpha - \beta) X/3 = 0, \tag{5}
\end{align}

\begin{align}
3\alpha^2(\beta e^2 - \tau s^2) - \beta^3 c^2 + \tau s^2 \\
+ (\beta - \gamma) X/3 = 0. \tag{6}
\end{align}

These must hold simultaneously; but this is impossible, since the consistency of (5) and (6) requires, using (4), that $c^2 s^2 = 3/2$.

The difficulty is found also in the baryon models with integral charge, thus it looks like a somewhat general feature of the charged weak currents and bosons.

One might expect, then, that neutral current and boson such as used in reference 6) improve the situation as they contribute to the self-energy differently from the charged current and boson. If we add the current:

\begin{align}
j_a^N = (a/2) \left\{ (\bar{\rho}_a \rho_a) - (\bar{\rho}_a \rho_a) \right\} \\
+ (\bar{\lambda}_a \lambda_a) + b(\bar{\lambda}_a \lambda_a),
\end{align}

where $ab = cs$, and the neutral boson with the same mass as the charged one, in conformity with $|\Delta I| = 1/2$ non-leptonic weak interaction without dynamical octet enhancement, the coefficients in Eqs. (5) and (6) become much complicated. The consistency of them, being a complicated algebraic equation of $a$, is found to be satisfied with $a^2 = 0.286$ and $X = 3.36\alpha^2$, when computed numerically with $s^2 = 0.05$ as an input. These values determine $\alpha$ (the bare urproton mass) to be about $50$ BeV, using the relation $\rho^2/M^2 = G_F/\sqrt{2}$, and the $SU(3)$ symmetry breaking ratio $c \equiv -0.62$ in the notation of reference 5), together with that of $SU(2)$, $(\alpha - \beta)/(\alpha + \beta) \equiv 0.048$.

Thus we can say that the principle of zero, when applied to both the quadratic and logarithmic divergences in the lowest order mass differences of hadron unitary multiplet, necessitates the existence of neutral current and boson, at least with our assumptions. Moreover the resulting values of quantities seem to be not so far from those supposed from the picture of hadron interactions which is generally accepted nowadays. The details of calculation and further discussions will be published elsewhere.

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8) S. Nussinov and G. Preparata, Phys. Rev. 175 (1968), 2180.
9) Z. Maki, Prog. Theor. Phys. 31 (1964), 331. Other literatures are quoted in reference 2).