Review of: "Explaining the W-boson Mass in the Context of the Supersymmetric 331 Model"

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Potential competing interests: No potential competing interests to declare.

In its current form, the article is insufficient. The article is structured in only two sections: an introduction and conclusions. The introduction contains, in addition to the introductory material, all the original research by the author, and thus it proves difficult for readers to separate the state-of-the-art in the field from the new results.

The introductory material is excessively short. While brevity is a virtue, this introduction does not provide the necessary context to readers that might not be familiar with the topic at hand. Some of the ideas that the introduction may include are:

- Role of the mass of the W boson in the electroweak sector of the SM: relation with Z mass and Weinberg angle, independent determinations of the Weinberg angle from Z-pole observables or the Fermi constant. This would make clear the importance of this discrepancy (if confirmed by other experiments).
- Brief discussion of the experimental set-up at CDF.
- Brief discussion of the procedure used in Ref.2 to obtain a theoretical prediction for the mass of the W boson.
- Comparison with the previous experimental result.
- Other proposed explanations for the discrepancy.

Now the author justifies the need for a New Physics model using the popular sentiment that the SM cannot be a fundamental theory. The author only provides one example of the problems of the SM, that of the number of fermion generations. A citation should be provided.

The author then introduces the 3-3-1 model. This model is presented as a potential solution to the problem of the number of generations, however this problem is never mentioned again. The author should include a short comment about how the number of generations is explained in this model. Also, this model should be better explained in general: the author does not provide a Lagrangian, the charges of the SM particles under the 3-3-1 group or how these charges are related to those of the usual $SU(2)_L \times U(1)_Y$ group.

Once presented the 3-3-1 model, the author introduces its supersymmetric version, MSUSY331. It is somewhat perplexing that the author states that it was “presented recently”, although the oldest reference provide is 30 years old (and published just one year after the original 3-3-1 model), and the newest reference is 21 years old. Again, no Lagrangian or

superpotential is presented in the article. The sextet $S^{'}$ is introduced as a required to cancel out the chiral anomalies of the superpartners of the anti-sextet S, even though the text did not define previously the anti-sextet$S$.

The relation between equations (4) and (5) is not clear. The use of the word “where” connecting both equations should be used if equation (4) used symbols later defined in (5), but this is not the case. Instead, the author should explain that the fields S, T, Φ_S and H_2^{--} belong to the corresponding representation. Φ_S is identified as the SM Higgs, and T is provided with a citation (although a short explanation of its physical interpretation should be added). No comment is made about H_2^{--}.

Equation (6) is the main equation of the article, describing “the change in the [squared] masses of the gauge bosons”. One assume that the word “change” is meant to be interpreted as a change respect to the SM expressions, although this is not explicitly stated. Despite the importance of this equation, no derivation or justification is provided, the equation is presented as is. Perhaps the derivation would have been more evident if the Lagrangian and superpotential were present in the article. In addition, equation (6) introduces three new variables v_{σ_1}, $v_{\sigma_1^{'}}$ and $v_{\sigma_2^{'}}$, that are not defined anywhere in the text (in fact, five variables, if we include the gauge coupling g and the Weinberg angle θ_W). The three v_σ's appear to be the vev of some of the scalar fields introduced in the text, but the correspondence between field and vev is not evident.

And we finally arrive to equation (8). From equation (6) one can conclude that the mass of the gauge bosons in MSUSY331 should be

$$M_W = \frac{g}{2}\sqrt{v_\Phi^2 + v_{\sigma_1}^2 + v_{\sigma_1^{'}}^2 + v_{\sigma_2^{'}}^2/2}$$

$$M_Z = \frac{g}{2\cos\theta_W}\sqrt{v_\Phi^2 + 2v_{\sigma_1}^2 + 2v_{\sigma_1^{'}}^2 + v_{\sigma_2^{'}}^2/2}$$

The right-hand side of equation (8) is never explained in the text. It seems to be of the order of magnitude of $\Delta M_X = M_Z - M_W$. However, using the latest PDG value for M_Z and the CDF value for M_W, one obtains $\Delta M_X = 10.75\text{GeV}$. The left-hand side of equation (8) corresponds to

$$\frac{4}{g}\sqrt{\delta M_W^2}$$

It is not clear the meaning of this quantity or why it should be equal to 11.19 GeV. In any case, the quantity in the left-hand side is not equal to ΔM_X in MSUSY331.

The article ends abruptly after equation (8) (and some ultra-short conclusions). The author does not discuss what are the consequences of the claim he made. If the values of v_{σ_1}, $v_{\sigma_1^{'}}$ or $v_{\sigma_2^{'}}$ are non-zero, then M_Z also receives a MSUSY331 contribution. In turn, this could affect other Z-pole observables, the determination of the SM Higgs vev, the Yukawa couplings, etc. The result is given in terms of three different vevs, and therefore the author should discuss if there is any way of disentangling the contribution of each vev (for example, by adding more observables with different dependency on

the vevs).

At this point, the review is significantly longer than the original article. I think that is quite clear that there are too many issues to be solved before the article can be published.