The 115 GeV signal from nuclear physics.

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Abstract

In some nuclear models, neutron magic numbers intersect the neutron drip line for nuclei having about 123, 187 and 264 nucleons. These masses corresponds, in GeV, to 115, 175 and 246. Reversing the argument, it can be said that a study of the neutron drip line predicts the existence of three physical scales at 115 GeV, 175 Gev and 246 Gev.

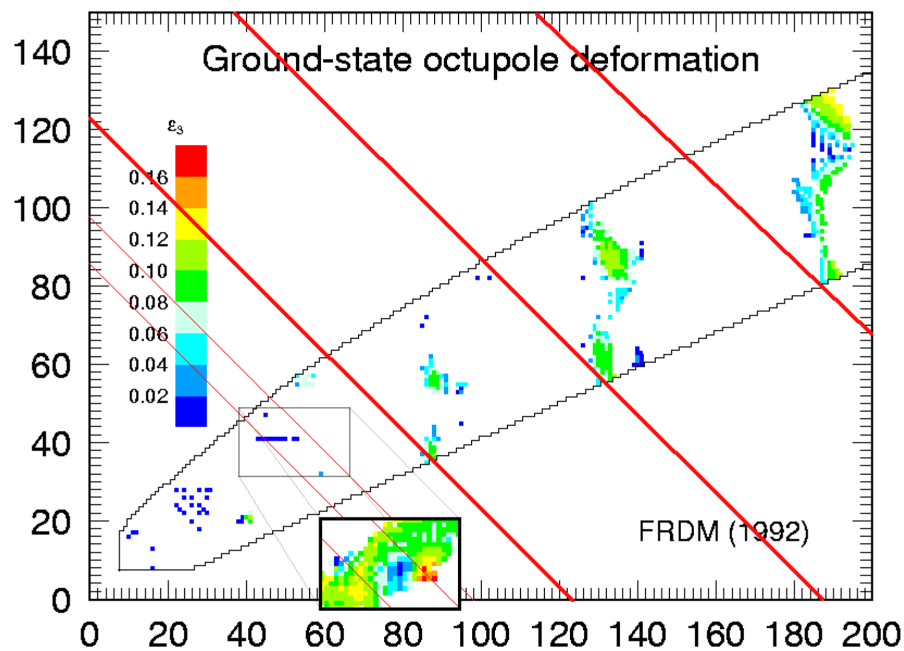

Figure 1: figure 10 of [3], plus an inset of figure 20. We translate between GeV and atomic mass units via the conversion constant $1\text{u.} = 0.9315\text{GeV}$. The only addition to the original plot are the diagonal isobars, at M_W, M_Z, 115 Gev, M_t and 246 Gev.

At the drip line, neutrons from the shell closure are very weakly bound, so it is not astonishing that the rest of the nucleus can appear to them as a single particle. In [2], we examined some empirical evidence for this kind of effect, looking for a physical justification of the strong enhancement of spin-orbit coupling in doubly magic shells. The idea was that models do not taking into account the electroweak scales should show an increase of its error when calculating nuclei around them. So we look for, and found, strong error near the mass values of W and Z.

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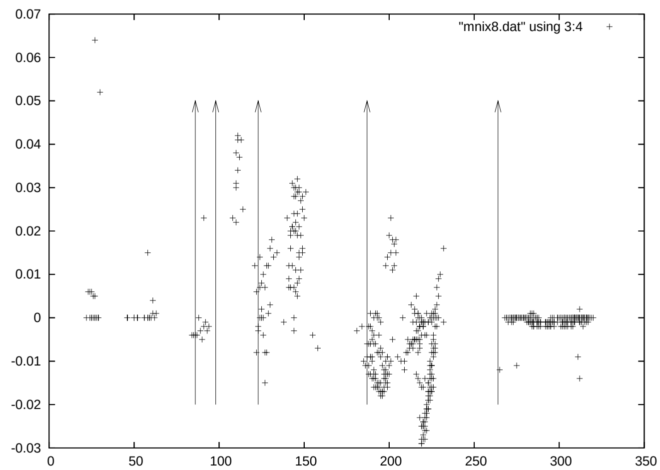

Figure 2: values of ϵ_6 discarded in the FRDM when using instead the deformation parameter ϵ_3. Note the qualitative difference in the signal of electroweak vacuum.

As the top quark will generate a family of mesons about 175 Gev, it was natural to extend the search to look for it. And also, of course, for the signal hinted at ALEPH some years ago, at 115 GeV. After all, W, Z and H are bosons able to interact with the nucleon, causing radiative corrections.

The main clue came from 1992 FRDM. It shows error at W,Z, but the fit at other energies is right. But studying the model, we learn that the additional precision is got from a series of microscopic corrections and shape corrections. Figure 1 shows all nuclei where a extra correction ϵ_3 is applied. We have taken directly the plot from [3], only adding the diagonal isobars. Neutron dripline is exactly the one drawn by the original authors ten years ago.

It seems surprising the apparition of the 246 GeV scale, for which no boson is expected: it is simply the vacuum expected value of the Higgs field. Examining ϵ_3 does not help, but a plot (figure 2) of the corresponding values of ϵ_6 -the parameter that is substituted by ϵ_3- shows qualitative differences between this scale and the others.

At W and Z the above parameters play no role; because of this, we were able to notice directly the error in the discrepancy plot.

It seems worth to look the errors in other mass models. We present some of them in the next figures, with a short comment. They come from [4], via the data tables available online in [1]. From twelve models examined, at least one third show distinctive signals for standard model masses in a straight way; some others can need additional filtering or they are too noisy. We expect signal in this kind of plots when the model is unable to take into account the existence of the very massive particles we are looking for. If the model adjust empirically in the area corresponding to some signal, we can miss it. And if the model has a very good adjust, we need to look for signals in the model parameters, as happens in FRDM. A plausible method is to try to evaluate model parameters by fitting to a restricted range of mass, say $g_>(m)$ for all masses greater than m, $g_<(m)$ for all nuclei smaller than m, or even some narrow range, say $g_{+10}(m)$ between m and $m + 10$ etc.

All the plots are in function of the atomic mass A. Five vertical lines are drawn as reference, at W, Z, 115GeV, Top and 246GeV.

For comparison, we show in the last figure the error plot from the FRDM, to confirm that it is excessively noisy in the low area and excesively corrected in the high. Another interesting plot, not showed here, for this model is the calclulated ground-state microscopic energy. This parameter presents multiple peaks, but the greatest ones clearly correspond to our numbers.

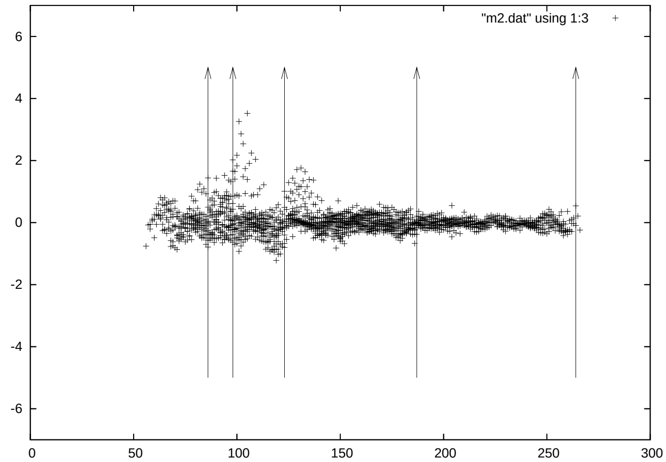

Figure 3: error in mass prediction for a model from G. Dussel, E. Caurier, and A.P. Zuker

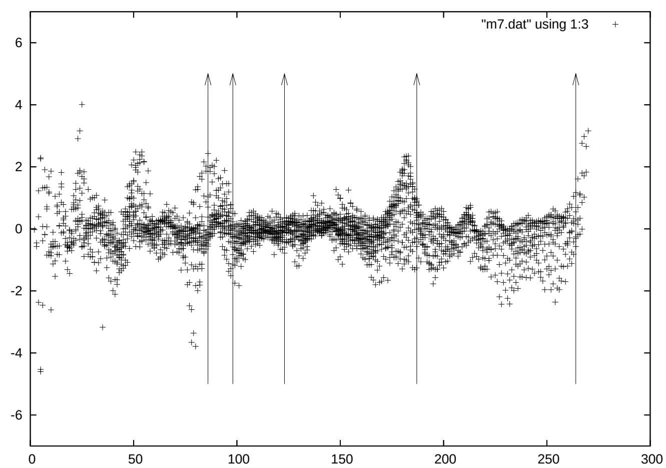

Figure 4: error in mass prediction for a model from Takahiro Tachibana, Masahiro Uno, Masami Yamada, and So Yamada.

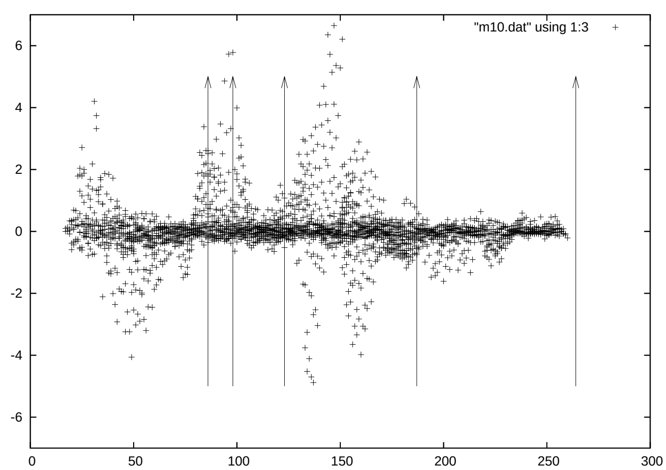

Figure 5: error in mass prediction for a model from P.J. Masson and J. Janecke

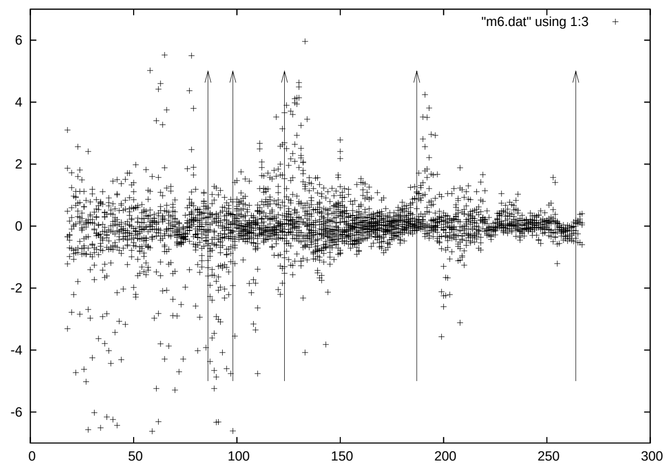

Figure 6: error in mass prediction for a model from L. Satpathy and R.C. Nayak

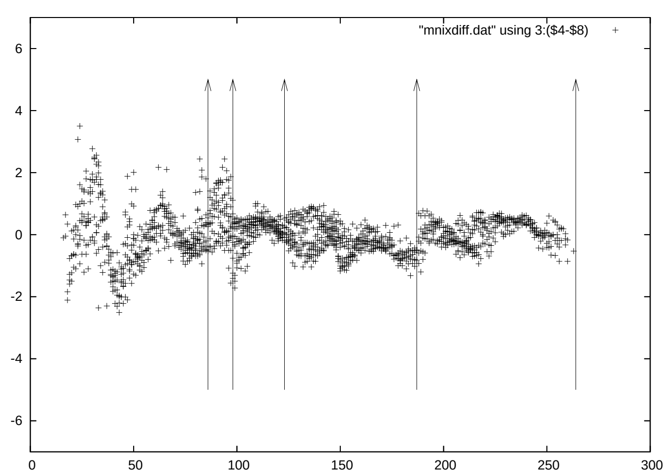

Figure 7: error in mass prediction for the FRDM model

Lacking still of a theoretical model, we are unable to say if this empirical analysis is a prediction of the Higgs or just a prediction of an anomaly in the background when detecting energies in the 115 GeV area. In the later case, the -nuclear- physics at the detectors would be the one to blame.

Other explanations could be fit. For example, it could happen that the same mathematical symmetry breaking acts in nuclear physics and, for different causes, in elementary particle physics. Then the only remaining coincidence would be the one between the end of the stability islands and the electroweak vacuum. Even if this is the case, it should be matematically worth to examine the mechanism in nuclear physics, because it includes both the electroweak bosons and top quark mass values in a same unifying schema.

References

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[2] A. Rivero *Standard Model Masses and Models of Nuclei* http://arxiv.org/abs/nucl-th/0312003

[3] P. Möller, J. R. Nix, W. D. Myers, W. J. Swiatecki *Nuclear Ground-State Masses and Deformations* Atom.Data Nucl.Data Tabl. 59, 185-381 (1995) http://arxiv.org/abs/nucl-th/9308022

[4] VV. AA., Atom.Data Nucl.Data Tabl. 39, 185 (1988)