Attempts at Systematizing the Masses of the Elementary Particles - Focus on 3.6 GeV. *

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Regularities among the masses of the known elementary particles are investigated by comparing them with n-tiples of a numerical value. Particular emphasis is put on 3.6 GeV, which defines a hypothetical relation between the W-boson and the apparent cosmological expansion rate. It is found that the $b\bar{b}$ and $c\bar{c}$ mesons appear close to the resonance axis whereas the proton and the neutron appear shifted by $\pi/2$ off resonance. This is the first time that a quantitative theory may suggest an explanation of the absolute scaling of the mass of stable matter. The paper also presents a computer program that may be used as a research tool for investigating the masses of the elementary particles irrespective of theoretical bias.

1 Introduction

The origin of the masses of the elementary particles is one of the most tantalizing problems in modern physics. The problem remains a thorn in the side to the Standard Model in that the elusive Higgs particle not yet has been found. The Standard Model further confronts, for example, the fact that even the mass of the commonest particle, the proton, not easily can be constituted by quark masses. Even if the Higgs particle were discovered the absolute scaling of the masses of the elementary particles would remain unexplained. In the past, the discoveries of various limited theoretical frameworks in which some particle masses could be predicted have given a rewarding harvest, exemplified by the Yukawa theory and the 8-fold way. These theories do however not prescribe general methods for predicting *absolute* masses but only predict the relative masses of a biased selection of particles. It is not just that more than 170 elementary particles have been discovered whose absolute mass scaling remains unsettled but comprehensive countermeasures against the clouds currently piling up over the Standard Model are due. It is time to decide whether to go 'beyond' the Standard Model or to stay on this side. The present paper presents results of a comprehensive analysis of the masses of the elementary particles, which are ordered around n-tiples of numerical values such as to reveal, from an unbiased perspective, corroborative links to the Standard Model as well as hints on new research venues.

2 Background and Strategy of the Investigation

This piece of research was incited by the finding that a geometrized distance, $\Delta\bar{q}$ could be factorized out of the Bohr condition for the orbiting electron (1),

$$m_{Planck} = \frac{\Delta\bar{q}}{2\pi}\frac{2g_0}{Ampere} \ , \tag{1}$$

where g_0 is the quantum of magnetic charge, $g_0 = ec/2\alpha$, and this distance turned out to be in phase with the W boson according to

$$M_W = A\ (\Delta\bar{q})^2 + B_1\ \pi\ (\Delta\bar{q})^2\ C \tag{2}$$

where M_W is the rest mass of the W-boson, $B_1 = 1/9$ and C is identified with $(sin\theta)^2$ with θ being the electro-weak mixing angle. With $\Delta\bar{q}^2 = 45\ GeV$ the last term above expresses the energy contribution of an axial current to the mass of the W-boson amounting to 3600 MeV.

The rationale for the approach described was originally to search for resonance conditions between on the one hand the cosmological expansion rate and on the other, a) the commonest stable matter (hydrogen) and b) the fundamental elements of transition between matter and energy states (the W- and Z-bosons). As long as the Higgs particle not has been found an unbiased search for a universal tuning frequency is fully legitimate and it should be remembered that before the Standard Model was launched and immediately cemented in the public mind the amount of 40 GeV up to 60 GeV was in the focus of interest for a short time (2). Eq. (1) and (2) suggest that the amount of 3.6 GeV should be given some further attention (cf. ref. 3). Hence, the strategy of this research is to examine all the elementary particles with respect to this amount of energy. A computer program has therefore been developed, which may also be used for investigating arbitrary approach-specific regularities among the masses of the elementary particles without theoretical bias.

At the outset, it may be rightfully questioned if all the particles should be given equal statistical weight in the examination. Most of the known elementary particles represent excited states produced in particle accelerators and may have comparatively little relevance to the average mass-containing volume element of the universe. Therefore, stable particles may be chosen to provide results with more corroborative (or refuting) weight than those that are not stable. On the other hand, in a particle production scenario involving consecutive events any one of the 170+ particles may turn out to hold the key to a correct interpretation.

3 Methods (Graphs and Software Description)

Graphs were produced using the software MassQuantizer 1.0 from www.scienceandresearch developmentinstitute.com, which distributes rest masses of about 170 elementary particles from the year 2002 listings available at http://pdg.lbl.gov (4) around n-tiples ($n = 0, 1, .$) of an arbitrary numeric value expressed in MeV. The distance from $n - 0.5$ to $n + 0.5$ on the x-axis, where n is the n-tiple of the arbitrary numerical value or the value shown to the upper left in the program window is cut into 21+1+21 segments covering ±3 S.D.

units around the integer. The elementary particles are ordered into columns at the segment corresponding to their masses expressed in n-tiples of the numerical value shown in the program window, except for the central column at the location of the integer, which is reserved for best fit. Those particle falling out of the 99.7 % confidence level of ± 3 S.D. units around the quantization value are counted in the 21:st segments. The fine structure of this quantization scheme may be examined by dividing by 2 or by integers (or an arbitrary value) whereby any group of selected particles can be traced visually into finer quantizations and/or given an average numerical value with variance. Particles having a mass less than ($< n - n/2$) or more than ($> n + n/2$) with n equal to the numerical value shown, may be identified visually. Division of the square root (or squares) of the masses by $\sqrt{n}$ (or n^2) followed by displaying in the program window the particles' distribution around the quantization value chosen is also possible. The weight (importance) of the data in a column may be estimated by reference to particle mass, possible existence of a dominant path of decay, particle half life, and full width gamma. Strange, charmed, and bottom particles and those constituted in part by any specified quark and or its antiquark may also be identified in a single click. The software, which is non-commercial, may be downloaded from www.scienceandresearchdevelopmentinstitute.com/cosmoa.html together with a separate tutorial explaining these and some other built-in features.

4 Results and Discussion

The distribution of the elementary particles around n-tiples of 3600 MeV is first shown in Fig. 1. The graph indicates a minimum of particles at these n-tiples, suggesting that identifiable particles may avoid resonance at n times 3600 MeV. However, there is a conspicuous clustering of $c\bar{c}$ and $b\bar{b}$ mesons around n times 3600 MeV, subsequently herein denoted the 'resonance' frequency. Because of the crude quantization value compared to the masses of the known particles one should be aware of trivial results arising from the limited distribution of the known mass values *per se* (as illustrated by setting the Quantizer at a higher value, e.g. 7200 MeV, and observing the sharp peak). Any mass position or mass clustering must be regarded as trivial until it can be explained in a conceptual framework, which preferably should be quantitative. The $c\bar{c}$ and $b\bar{b}$ mesons are, like all classical mesons, constituted by quarks and antiquarks. They are therefore candidates for possible production by vacuum fluctuations, notwithstanding their distinction from the Planck-Heisenberg scales. In the present theoretical framework their position around the resonance frequency can be anticipated if one surmises that vacuum fluctuations at the Planck-Heisenberg scale may be reinforced by interaction with the resonance particles. Ultimately, such a mechanism may rely on the energy provided by the apparent cosmological expansion, which is several orders of magnitude greater than the Planck-Heisenberg scale. The feature that the $c\bar{c}$ and $b\bar{b}$ mesons are based on second generation quarks may also contribute to their stability at resonance, however without explaining their clustering.

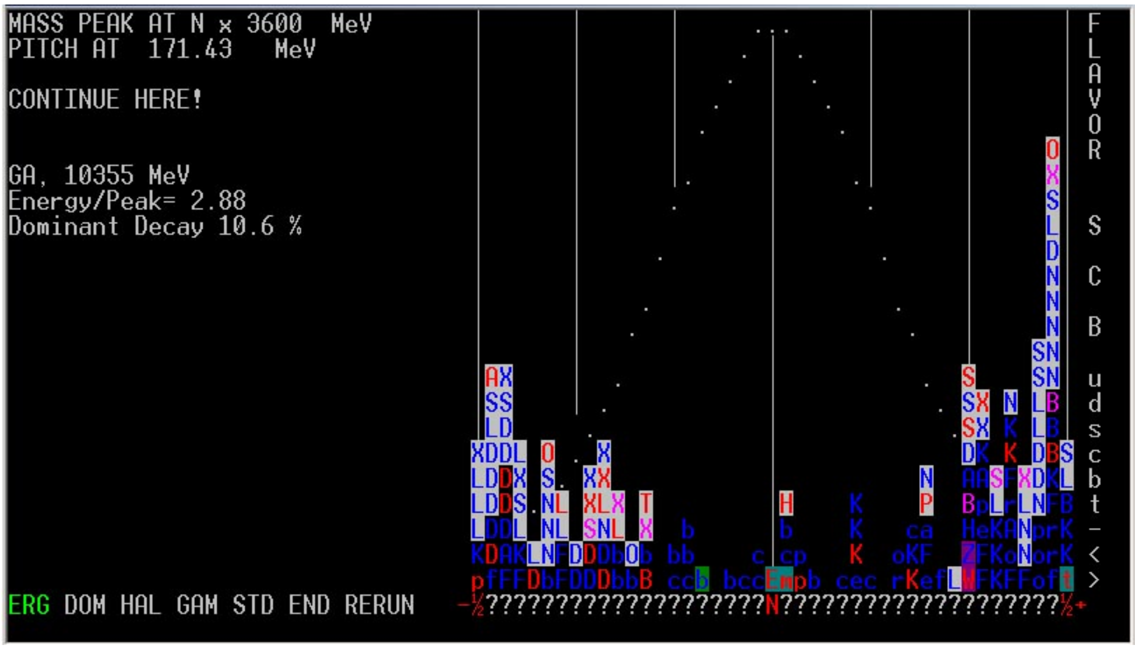

Figure 1: Distribution of the masses of elementary particles around n-tiples of 3600 MeV ($n = 0, 1, .$). Charged particle symbols are in red, neutral ones in blue, particles which appear in both charged and neutral forms may also be represented by a purple symbol. Leptons appear on blue background, baryons on white, mesons on black, and resonance particles on purple background. Baryon symbols indicate first sound in Greek alphabet except for proton (P) and neutron (N). 'c' indicates $c\bar{c}$ meson, 'b' indicates $b\bar{b}$ meson, light unflavored mesons are represented by capital for Roman or regular letter for first sound in Greek alphabet ($p = \pi, f = \phi$, D= charmed, K= strange mesons). The positions of Deuterium (A), Tritium (T) ions, and α particles (H) are also indicated. The screen was printed at the moment of identifying one of the $b\bar{b}$ mesons, which appears in green.

Furthermore, the electron, the μ lepton, and the π meson appear close to resonance on account of their light masses (close to $n = 0$). If one disregards the particles mentioned above, the resonance frequency appears quite devoid of known particles. In the present theoretical framework, the reason may be that resonance with the apparent expansion rate precludes the existence of particles having a measurable life-time unless they are stabilized by vacuum fluctuations. Identifyable particles may instead be anticipated off the resonance axis.

Since the $c\bar{c}$ and $b\bar{b}$ mesons appear distributed around the resonance frequency (at $1.01 \pm 0.13 (n = 9)$ and $2.84 \pm 0.12 (n = 12)$, respectively) in contrast to the rest of the particles they are removed from the chart before proceeding to the next finer quantization level, 1800 MeV (Fig. 2). Charmed mesons, which are clustered around $-0,66 \pm 0.08$ (n=22, excluding the B meson at 6400 MeV), are also removed before proceeding. At 1800 MeV a peak appears at (n-0.07), primarily because of mass clustering near 1700 MeV but this region also accommodates some of the heavy B-mesons at $n = 2.91 \pm 0.17$. Among the charged unflavored mesons, the $\pi(1800)$ remains at the resonance position at even finer quantizations (900 and down 112.5 MeV). It is the only unflavored meson that is listed as an exclusively charged particle, which is remarkable given that Eq. (2) defines resonance with the charged

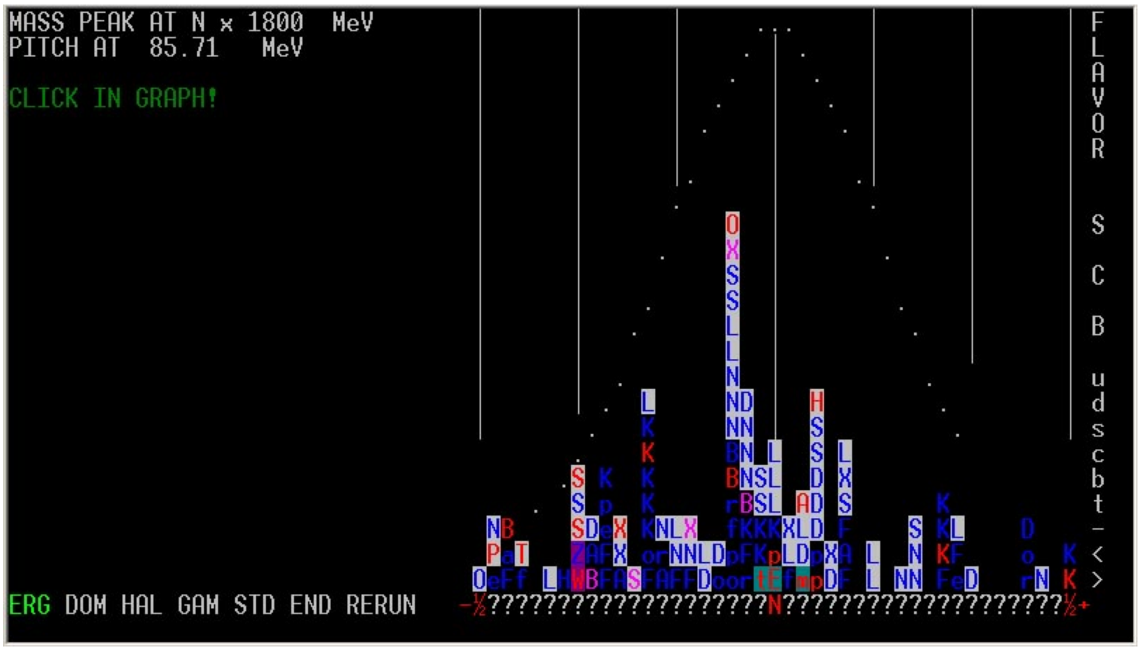

Figure 2: Distribution of the masses of the elementary particles around n-tiples of 1800 MeV (n=0, 1,..). The notations are the same as in Fig. 1.

W-boson. Moreover, the W- and Z-bosons recur jointly at finer quantization values when dividing by 2.

Next, the Mass Quantizer is reopened and set for calculations of square roots of the masses divided by 60. The rationale for such an approach is that the physical units in the geometry provided by the background theory (8) can be assigned to the laboratory frame or a space-like separated frame whereby the unit of mass is squared into the laboratory frame from the yonder frame: Resonance may not necessarily exist only in the laboratory frame but may also have its origin in the space-like separated frame, which is involved in all physical observations (5). The detection of a mass in the laboratory frame requires another mass. Consequently, square roots (or squares) of the masses of the elementary particles may be the appropriate entity to compare with a reference quantization value. For example, in order to detect a mass, $\tilde{m}$, in the laboratory frame, where the 'tilde' sign indicates that the unit relates to the space-like separated frame it may first be referenced to a standard mass, $\tilde{1}$ according to $\tilde{m}\tilde{1} = \overline{m\ 1}$ where the bar indicates the laboratory frame and only thereafter compared with a reference value, E_{Ref}, according to

$$n = \frac{\overline{m\ 1}}{1\ E_{Ref}}\ . \tag{3}$$

In order to access the frame indicated by the tilde from the expression above it is possible to take the square root (because the frame assignment of any units, a,b, is related by $\tilde{a}\ \tilde{b} = \overline{a\ b}$, ref 6). These arguments suggest that square roots of the energy values may be appropriate entity to compare. A more concrete argument may be obtained directly from Eq. (2), where the axial contribution to the current and to the mass of the W-boson appears squared. The squared form of Eq. (2) therefore implicates that the square roots of the

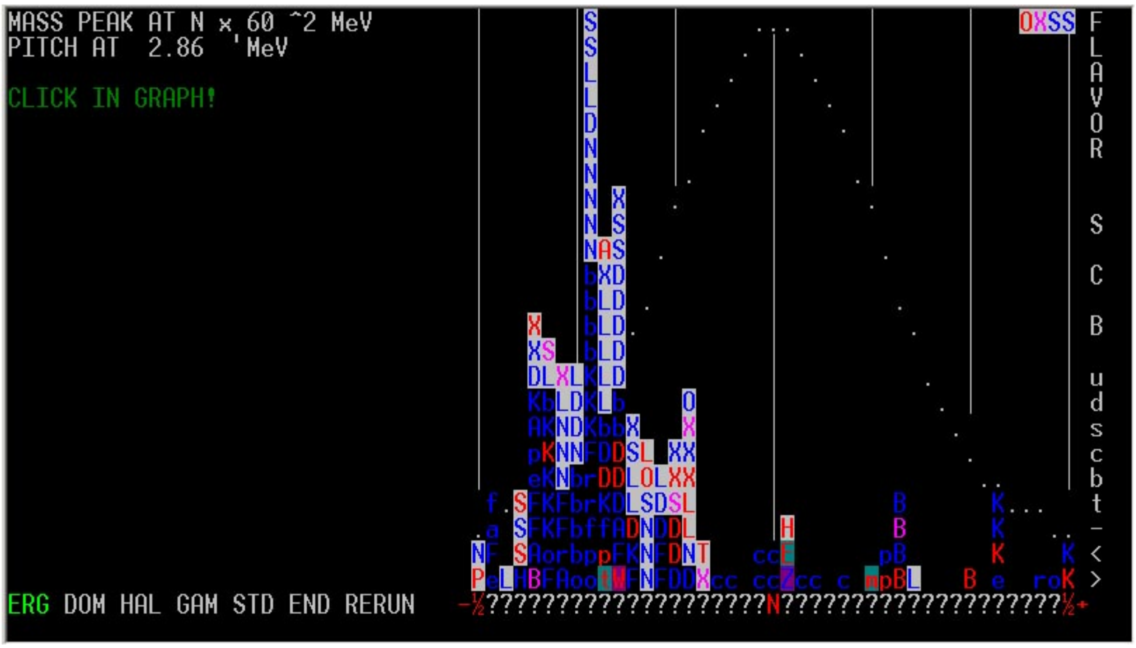

Figure 3: Distribution of the square roots of the masses of the elementary particles around n-tiples of $60\sqrt{MeV}$, $(n = 0, 1, ..)$. The notations are the same as in Fig. 1.

masses should be compared with the square roots of the reference values. These graphs are shown in Fig. 3.

The most noteworthy result of investigating the square roots is that the constituents of stable matter, the proton and the neutron, appear precisely off the resonance axis, where they would be expected if avoiding resonance with the W- and Z-boson (and the apparent cosmological expansion rate in the background theory) is important for maintaining the existence of stable matter. The random chances that any two arbitrary particles would appear shifted by $\pi/2$ off the resonance value in two segments in the graph is $(1/21)$ $(1/21) = 1/441$ and the further chances that the less stable of the two would appear closer to the resonance value is $1/882$. The proton appears at $(0.51)^2$ relative to the chosen tuning frequency, 60^2. If it were precisely out of phase, then $\sqrt{938.3}/61.26 = 0.5$ and the tuning frequency contributed by the far right term in Eq. (2) would be 3753 MeV. Clearly more theory is needed for obtaining a better fit. It is also interesting that the $c\bar{c}$ mesons appear at $1.01 \pm 0.06 (n = 9)$, close to resonance also when calculating the square roots. Their average around resonance persists (with broader variance) from 60^2 MeV down to 7.5^2 MeV. These and other features revealed by the computer program may help defining new areas of quantitative elementary particle research.

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