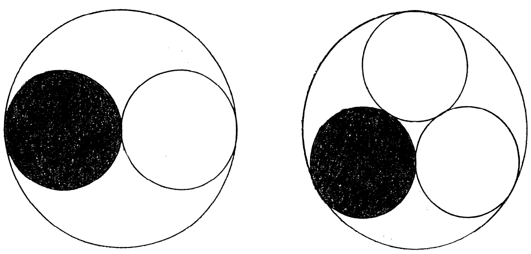
Muon to Proton Mass Ratio, Geometric Volume Ratios, and an Overview of the Particle Zoo

Carl R. Littmann
25 Washington Lane, Apt.313, Wyncote, PA 19095
e-mail: carllittmann@earthlink.net

This article discusses the muon to proton mass ratio and nearly equal volumetric ratios in simple patterns. Those volumetric ratios arise when equal small spheres are closely packed inside larger spheres. We compare that to other particle mass ratios and corresponding sphere volume ratios – where spheres are packed around smaller ones; not inside of them. We discuss several aspects of all above relationships, related realities and analogies for our key 'particle zoo creatures'. We explore some possible implications beyond analogies.

1. Introduction

Let us start be displaying Tables I, II, III below; and each with a brief description of its content. Those tables will introduce the subject and illustrate our general approach. Table III will serve as a helpful overview of the entire subject, and also will show additional relationships.



Case 'A' $r_1 / R = 0.5/1.0$ Case 'B' $r_2 / R = 0.46410/1.0$

Table I. The Muon analogy (using spheres <u>inside</u> of spheres)

A proton has a mass equivalent to **1836.1527** electron masses (m_e). So let us regard the two big spheres shown in **Table I** as each having a volume of 1836.1527 cubic units. Next, we calculate the **average** volume of the **shaded** spheres in that table and note the results**:** $1836.1527\ [(r_1)^3 + (r_2)^3] / 2\ (R^3) =$ **206.5332** m_e for our estimate of the muon mass. Compare that to the empirically known mass of the muon⁻ (or antimuon⁺): **206.7683** m_e. (See Ref. [1] and [2] for sources of empirical values used in Table I and Table II, respectively.)

2. Discussion of the Tables and their History

In Table I, our 206.5332 m_e muon estimate is not quite the 206.7683 m_e empirical value, but only a fraction of an electron off. In fact, it would have been closer had we chosen for our large enclosing sphere, the neutron, 1838.6841 (m_e), instead of the proton, 1836.1527 (m_e), or some value between the proton and neutron. However, in our simple treatments, we attempt <u>no</u> specific doublet or dynamic or other refinement; we leave the geometric result 'in the raw'. (Some others have also attempted to addressed some particles masses in the 'particle zoo'). [3-4]

The particles presented in the Tables I, II, and III, the main subject of this paper, are so basic and of such great importance that their existence was established before 1950! During 1950, investigative equipment and methods advanced; and many more particles were discovered, and the masses of some previous particles were determined more precisely.

It seems appropriate to separate the <u>Table I</u>, for the muon, from <u>Table II</u>, for several reasons: Historically, the muon (Table I) initially fooled the scientific community. It did not turn out to be classifiable as a 'meson'; and it had properties quite different from most particles. [5]

Note also that by constructing those analogies shown in Table II, we had 'used up' all the basic patterns involving 'spheres *outside* of spheres, i.e., spheres surrounding spheres, but not inside of them.[6-7] Although that method had yielded good analogies for Pions, Mesons, and Protons; there were simply no more basic patterns left there to try to match the muon. So recently, by resorting to 'combinatorics' involving spheres *inside* of spheres; a rather well fitting analogy for the muon's mass was finally found!

If, in Table I, we had attempted to closely fit 4 spheres inside the large sphere, by arranging those small spheres in a square-shaped planar pattern; a slippage or swiveling of small spheres out of the pattern would have occurred. Note, even six such equally small 'virtual' spheres could be symmetrically enclosed in the large sphere (and with a better appearance from a three-dimensionally standpoint). So it is not surprising, for the contemplated case of only '4 **planar**' spheres enclosed, that they would all slip around, migrating toward a more efficient tetrahedral arrangement, and that excess 'wiggle room' would result. Of course, a 'swiveling around' could also occur for the closely packed two-sphere case and three-sphere case, but their sphere patterns and combinatorics would remains intact! (There is, of course, nothing wrong with an aesthetic close-packed tetrahedral layout – but that would be a different class, an advanced complexity, i.e., a riveting up to a three dimensional non-planar layout, in our 'combinatorial game'.)

My present opinion is that (despite the super-success and usefulness of the tetrahedron and other advanced constructs in more complicated chemical and physics applications) – still, at the most elemental level, 'nature' prefers using the most basics of 'simplices', (i.e., alternate spelling: 'simplexes').

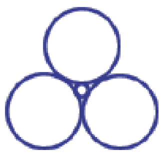
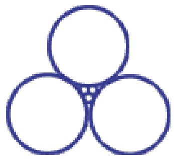
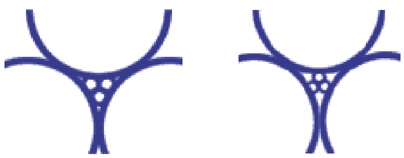
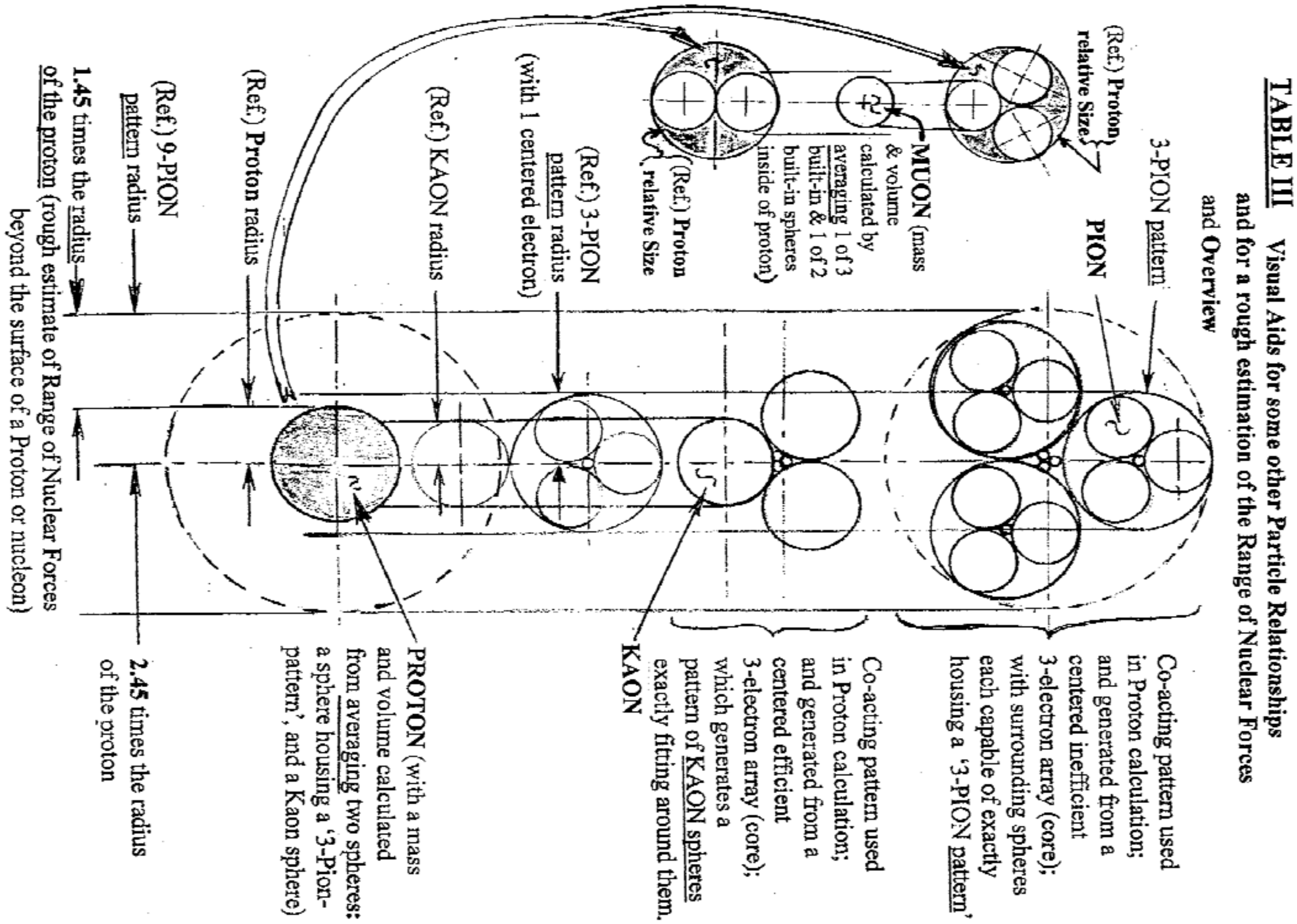
Geometric Pattern(Centers of coplanar spheres)	**Volumetric Ratio** (See pattern)	**Particle Mass Ratio** (to electron)	**Actual Avg.**
 **Case 'C'** R/r = 6.4641	1 large sphere to 1 small sphere (centered in the pattern): **270.10/1**	**Pion$^+$** or Pion$^-$: 273.13/1 **Pion^o** : 264.14/1	**270.13/1**
 **Case 'D'** R/r = 9.89898	3 large spheres to 3 small spheres (all three smaller spheres are also the same size): **970.00/1**	**Kaon$_s$^{o}** or Kaon$_L$^{o} : 973.92/1 **Kaon$^+$** or Kaon$^-$: 966.04/1	**969.98/1**
Close Up Views  **Case 'D'** R_1/r = 9.89898 & **Case 'E'** R_2/r = 13.9282	$[3(R_1)^3 + 3(R_2)^3]/6r^3$ = **1836.00/1**, i.e. 6 equal small spheres with radius r, 3 intermediate size spheres with radius R_1 as in case D, and 3 large spheres with radius R_2 (case E)	**Proton** or anti- proton: 1836.15/1 **Neutron** or anti-neutron: 1838.68/1	**1837.42/1**

Table II The Pion & Kaon and Proton analogies using spheres <u>outside</u> of spheres



In Table II for case 'C', it can be shown by calculations that that 3-Pion pattern would *exactly* fit inside any one of the very large spheres shown in case 'E'. That is shown in greater detail near the top of Table III.

But the size of those large spheres was *originally* chosen using a simpler criterion: So that when each was directed inline with each touching electron in the 3-electron core (a most inefficient packing) – that those three large spheres would then barely extend around that '3-electron pattern'. (See Table II, case 'E'). However, it was also noticed, finally - many years later, that the '3-pion pattern' would also fit exactly inside each of those large spheres. Thus, in hindsight, the largest '3-sphere pattern' could have also been generated by using 3 of the '3-pion pattern'.

Where our analogy for an empirical particle required us to *average two* large spherical volumes, we also note this: The empirical particle represented does, in fact, have spin, i.e., the proton and muon each have 'spin ½ '.

For each particle analogy in this paper; at least one pattern, having *an equilateral triangular array* of spheres, was required. An eminent mathematician noted that an equilateral triangle exemplifies the simplest structure in two dimensions -- from a combinatorics viewpoint [8].

Notice the great extension of the largest pattern shown in Table III. It extends appreciably beyond the proton's surface. That pattern was one of the two we needed in our calculation of the proton mass; and that is also the pattern that can *exactly* enclose 3 sets of the '3-pion pattern'. It is interesting that H. Yukawa predicted the existence of a particle (later to be called the pion) to explain how one nucleon could extend its nuclear force to a distant nucleon -- 1.4 fm away [9]. Perhaps the '9-pion pattern' in Table III infers something like that.

Very Important: Real particles seem to maintain their unique mass values for some time, as if they were largely determined by patterns in space -- instead of actually being wedged in on all sides by other real (gross) particles to constrain and maintain their size. It seems possible that 'space' itself may have 'structure'; perhaps even shifting between patterns. In his later years, Heisenberg serious entertained the concept of 'quantized space' [10].

3. Conclusions

The tables shown in this paper display different size spheres in simple patterns. And those different volumes rather closely correspond proportionately with the different masses of important particles -- particle masses known by the end of 1950. This treatment does not attempt to make adjustments for multiplets or other factors that might improve its accuracy.

This article's main merit is hopefully its simplicity, its constructive use of basic geometric structures, and its implications for future uses of combinatorics. And for further exploring the implications that even 'space', itself, might have structure.

4. Miscellaneous Closing Comments

If the volume of a sphere in a basic pattern implies the existence of a particle that is not itself directly (empirically) detected (see Table II, case 'E'); it may be due to the following: That pattern's sphere may also be an ideal fit for an alternate set of particles or particle pattern that is even more basic. Therefore, when a sufficient mass is in the region of the 'ethereal spherical pattern', the particle production process 'defaults' or 'short circuits' to form the smaller, more stable particles, instead. (See Table III, top). Having voiced that speculation and other speculations; it is realized that still more details or further understanding of the action would be desirable.

The above treatment uses to some extent, directly or indirectly, implicitly or explicitly, some concepts pioneered long ago. Those ranges from Huygens' ethereal space filled with spheres – to Bohr's 'liquid-drop model' of the nucleus, with its uniform density assumption [11].

The fact that my article was presented sooner than otherwise, and to an audience more open-minded than otherwise, was facilitated by much hard work by others, including many NPA'ers and their stimulating papers and comments, too numerous to detail. And I am very grateful for all the help.

References

[1] Laboratory of 'NIST' (National Institute of Standards and Technology) CODATA Internationally recommended values of the Fundamental Physical Constants, go to the following link: http://physics.nist.gov/cuu/Constants/Index.html and click category 'Atomic and nuclear'.

[2] R. H. Dalitz, C. Goebel, "Meson", McGraw-Hill Encyclopedia of Science and Technology, 7th ed., Vol. 10, p 662, (McGraw-Hill Inc., New York and other cities, l992).

[3] G. L. Ziegler, I. I. Koch, "Prediction of the Masses of Charged Leptons", Galilean Electrodynamics 20 (4) 114-118 (2009).

[4] R. A. Stone, Jr., "The 4 PI Quantization of Fundamental Particle Mass", Apeiron 16 (4) 475-484 (2009) Note, others no doubt have also attempted to address the masses in the 'particle zoo', but the last two references are just some examples.

[5] "Muon", http://www.wikipedia.org (Wikipedia, the free encyclopedia).

[6] C. R. Littmann, "Particle Mass Ratios and Similar Volumetric Ratios in Geometry", J. Chem. Inf. Comput. Sci. 35 (3) 579-580 (1995).

[7] C. R. Littmann, "Why some Particle Mass Ratios Nearly Equal Geometric Pattern Ratios", Proceedings of the NPA 5 (1) 130-136 (2008).

[8] H. Robbins, R. Courant, What is Mathematics?, topic 3 in Appendix for Chap IV (Oxford University Press, New York, 1941).

[9] L. Pauling, General Chemistry, The Forces between Nucleons, Strong Interactions, 25-3, pp. 809-813 (Dover Publications, Inc., Mineola, N.Y., 1988).

[10] The New Columbia Encyclopedia, 4th ed., p. 1217, heading: 'Heisenberg, Werner' (Columbia University Press, New York and London, 1975).

[11] Note that the possibility that aether consists of material spheres is discussed in: Christiaan Huygens's *Treatise on Light* (1678), English rendering by S. P. Thompson, 1912, University of Chicago Press, (Project Gutenberg eBook, book #14725, released 1-18-2005) http://www.gutenberg.org/etext/14725 (Also, Osborn Reynolds, of 'Reynolds Number' fame, strongly advocated that 'all space was filled with spheres' in his book, The Sub-Mechanics of the Universe, Pub. for the Royal Soc. of London, Cambridge University Press, 1903).