

EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT NEUTRAL PI-MESONS, BUT WERE AFRAID TO ASK

by Mark Creek-water Dorazio, 26 Oct 2018; email mark.creekwater@gmail.com

SUMMARY [i.e., “Abstract”]

In this essay the writer presents evidence that one can describe the forces and energies inside the neutral pi-meson in a semi-classical way, with no reference to “quarks” --- which have never been observed in a physics lab. This evidence is based on the work of Ernest Sternglass (PhD, Cornell University, 1953) ----- as this writer could never have figured any of it out, as he has no formal training in astro- or nuclear- physics.

KEY WORDS: angular momentum, electron, electron-positron pair, magnetic field strength, magnetic moment, Neddermeyer, pi-meson, positron, “quarks,” spin-one, spin-zero, Sternglass;

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“The aim of science is to make difficult things understandable in a simpler way; the aim of poetry is to state simple things in an incomprehensible way” ---Paul Dirac, Ref.#8.

INTRODUCTION

Ernest Sternglass (1923-2015) studied under George Gamow, Richard Feynman, Hans Bethe, and Philip Morrison, earning BS (1944), MS (1951), and PhD (1953) at Cornell University. He says that “in [my] model, all matter [is] composed of charged electrons and positrons, including the quarks in the nucleons and mesons” [p.211, Ref.#1]. Note that nobody has ever observed any "quarks" in a physics lab [pp.322-324, Ref.#2; p.67, Ref.#3; p.292, Ref.#4].

PROLOG

The writer wishes to acknowledge the many hours of hard work which he spent during the past ten years doing calculations similar to the ones which appear in this essay, which resulted in total failure, so that the successful attempt described here is especially gratifying. He wishes to state that finding a way to express Sternglass’s pi-meson theory mathematically, and according to the known laws of physics, in a way which works, and is understandable to anyone who knows basic algebra, geometry, and calculus, feels like a wonderful accomplishment, and he hopes that the reader might feel similarly interested in this unique interpretation of Sternglass’s theory. HINT: it’s about magnetics. Until the writer discovered an accurate math-formula for

the magnetic forces between dipoles, which happened only recently, he was unable to solve the problem in a satisfactory way.

Sincerely, mark.creekwater@gmail.com, Phoenix, Arizona, 8 July 2019.

Part 1: SUMMARY OF THE CURRENT UNDERSTANDING

According to the so-called “standard model of particle physics,” ---(which provides the generally accepted explanation for the structure of tiny objects like pi-mesons)--- neutral pi-mesons are supposed to be composed of so-called “quarks” ----- which nobody has ever observed in a physics lab, an assertion which many PhD-holders would argue with, despite the fact that other PhD-holders admit that it’s true. See Refs. #2, #3, & #4. In fact, Murray Gell-Mann, the inventor of quark theory *****{SEE END-NOTE 1, below}**, said early and often, in many different ways, that the “quarks” in his model might not be real objects, but merely “mathematical figments”:

“Even after the *New York Times* had [featured] quarks in [a] 1967 article, Gell-Mann was quoted as saying that the quark was likely to turn out to be merely a ‘useful mathematical figment’ ” [p.292, Ref.#4].

He also said that: **“It is fun to speculate about the way quarks would behave if they were ... real” and “A search for stable quarks ... at the highest energy [particle-]accelerators would help to assure us of the non-existence of real quarks” [p.323, Ref #3].**

"Maybe these 'kworks,' as Murray called them, (he had the sound in his head before he found the spelling in [Finnegan's Wake, by James] Joyce), were just interesting mathematical figments. 'It is fun to speculate,' he wrote, 'about the way quarks would behave if they were physical particles of finite mass (instead of purely mathematical entities). . . . A search for stable quarks . . . would help to reassure us of the *nonexistence* of real quarks.' ... He assumed these weird things would not be found" [Ref.#2a].

The main idea here is that the standard model is probably incorrect to offer “quarks” as real objects, and that it’s much more probable that they are composed of speedy electrons and speedy positrons, as Ernest Sternglass [Ref.#1] says. The standard model has been wrong before, and almost certainly is wrong about its explanations of structures based on “quarks,” explanations which are ugly and illogical. It’s much more logical and beautiful to say that

pi-mesons, as well as protons & neutrons, and all the other tiny objects which physicists study, are composed of speedy electrons and speedy positrons, which are known to exist. If one wants a fancy word for “speedy” --- it’s *relativistic*.

Every high-school science-student knows that all the different kinds of atoms are composed of only three [3] things: protons & neutrons & electrons. By saying that protons & neutrons are composed of electrons & positrons, Sternglass has merely reduced the number of fundamental entities in our universe from three [3] to two [2]. This is a simple idea, and any open-minded scientist can easily understand it.

Sternglass’s model of the neutral pi-meson is just about the simplest model imaginable, much simpler than the standard model’s model of the same object. He says that the neutral pi-meson is composed of a relativistic electron-positron pair, in which the e and p rotate [i.e., orbit] around each other in a very tight orbit while moving at almost the speed of light. If the idea of an e and p orbiting around each other at almost the speed of light seems too weird, then one can visualize the system as a very rapid oscillation of electrical energy, with the understanding that electrons & positrons are nothing but pure electrical energy.

Note that this orbiting ep-pair is NOT positronium, as the e and p in positronium move at less than 1/100 the speed of light, and also the e and p are much farther apart in positronium.

As they orbit around each other, they also spin. Everything in physics spins. A bit of thought reveals that there are AT LEAST two ways for these spinings to happen: the e & p can spin in the SAME direction, or they can spin in OPPOSITE directions. According to Sternglass’s model, the **Electron-Positron Pair Model of Matter**, they spin in the same direction in the known version of the neutral pi-meson, the “spin-zero” neutral pi-meson, and they spin in opposite directions in a theoretical “unknown” “spin-one” version of this same object. See *****END-NOTE 2, below**.

He discusses both of these possibilities on pages 151-153 in Ref.#1, and says that one of his co-workers found evidence during the 1960s for the actual existence of the “unknown” spin-one pi-meson. “[Seth] Neddermeyer gave a paper on recent cosmic ray experiments [involving collisions between mesons and] electrons in carbon targets. He interpreted these results as possibly indicating that in the course of these collisions a neutral particle was formed similar to the neutral [pi-meson], but with a net angular momentum

[i.e., a total of orbital angular momentum and spin angular momentum] of one quantized reduced Planck unit [h], instead of zero" [p.151, Ref.#1].

See Figure 1, below, for an illustration of this idea.

*****END-NOTE 1: Another researcher [Zweig] in the same university physics department where Gell-Mann worked had a similar theory, in which he called the tiny objects "aces" instead of "quarks."**

*****END-NOTE 2: Murray Gell-Mann once said that, in particle physics, "everything not forbidden is compulsory" [Ref.#9].**

"Everything not forbidden is compulsory." This surprising idea was "coined by physicist Murray Gell-Mann as a basic law of quantum mechanics. Any interaction between sub-atomic particles not expressly prohibited by some natural law must be assumed to be probable (the soft version) or must be inevitable (the hard version)." [Ref.#9]

<https://clevesblog.callisoncreative.com/2010/03/15/everything-not-forbidden-is-compulsory/>

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**Part 2: CAN ONE CALCULATE THE FORCES BETWEEN THE ELECTRON & POSITRON IN A STERNGLOSS.COSMO.SYST ??**

This writer has spent many hours during the past ten years, (ever since he discovered a little book by Ernest Sternglass [Ref.#1]), doing some very interesting calculations which are related to Sternglass's model of the neutral pi-meson. Note that this is the simplest model imaginable, being a single electron and a single positron which orbit around each other, each moving at approximately 99.99999% of the speed of light. These electrons and positrons are known as *relativistic* electrons and positrons, because they move so fast. As already mentioned, such a system is NOT positronium, because the e & p in positronium move at a speed which is less than 1/100 the speed of light, and also because the e & p in positronium are much farther apart.

All of the equations in this essay are about the *relativistic* ep-pairs in Sternglass's model, which he calls "cosmological systems" --- regardless of how large or small they are. In his book he details "Masses, sizes, and rotational periods of cosmological systems predicted by the electron pair model of matter [p.234, Ref.#1]. Note that when he says "electron pair" he is referring to

electron-positron pairs. The only difference between the two is their electric charge. The electron carries a negative charge, while the positron carries a positive charge.

In Sternglass's model ---{and also in the model presented here, which is derived from Sternglass's model}--- the neutral pi-meson consists of a relativistic electron & positron orbiting around each other at almost the speed of light, as already mentioned. As Sternglass explains it, there is a relativistic increase in the attractive electric force between the two tiny objects, because, **"in the high-energy states, the electromagnetic fields of the electron[-positron] pair become so highly compressed as a result of their relativistic motion that the forces holding them in equilibrium become the 'strong force' of nuclear theory."** [p.186, Ref.#1].

This means that there is **"no upper limit to the energy or mass of the allowed electron-positron states, because the attractive force kept increasing with the repulsive centrifugal force, as the relativistic mass increased ... as the velocity approached the speed of light"** [p.135].

One can obtain the approximate strength of the electric force between the e and p in the pi-meson with the idea that, ***if one ignores the tiny magnetic force***, then the (attractive) electric force must be equal to the (repulsive) centrifugal force in order for the system to be stable. Centrifugal force is given by a simple math-formula which appears in every physics book in the entire known universe:

**$F(\text{cent}) = M.v.v / R$** , where " $M$ " is the mass of the system, " $v$ " is the velocity of the e and p as they orbit around each other, and " $R$ " is the radius of the system, defined as the distance between the center of the electron and that of the positron. However, as Sternglass details in his book, Einstein suggested ---(in one of his 1905 essays !!)--- that, for *relativistic* systems: **"to avoid an asymmetry in the force calculation for charges in motion with respect to each other, one has to calculate it as measured by an observer at rest with respect to one or the other charge"** [p.116, Ref.#1].

This stipulation changes the math-formula in a way which gives a centrifugal force which is twice as large. This is because, if one imagine riding on one of the two tiny orbiting objects in an ep-pair and observing the movement of the other, one sees it moving at a speed of, not  $c$ , but two times  $c$ , given that  $2.c$  is their speed WITH RESPECT TO EACH OTHER, because they are always moving in opposite directions. So one uses  $2.c$  as the velocity. Plus, because the only charge which is moving ---(from the point of view of the observer riding on the other charge)---

has a mass of only HALF that of the pair, one uses  $M/2$  as the mass. So the math-formula becomes:

$$F(\text{cent}) = (M/2).(2c).(2c) / R = 2.M.c.c / R \quad (\text{Eqn.1}).$$

Note that the mass  $[M]$  of the neutral pi-meson is known. Using numeric values  $M = 2.4055E-25$  gram,  $c.c = 8.9875E20$  cm.cm/sec.sec, and  $R = 0.7312E-13$  cm, one obtains  $F(\text{cent}) = 5.913E9$  dynes for the spin-zero neutral pi-meson. Note that the numeric value of the radius here is calculated on the basis of the fact that the orbital angular momentum of the object (defined as mass x velocity x radius) is equal to one reduced Planck's constant [ $h\text{-bar}$ ], i.e.,  $1.0546 \times 10^{-27}$  gram.(cm/sec).cm. So that  $R = h\text{-bar} / (M.2c)$ , again using  $2c$ , not  $c$ , for velocity, as explained above.

To develop a math-formula to calculate the attractive electric force between the e and p in the *relativistic* ep-pair, one takes the expression for the electric force between an electron and a positron and multiplies it by the force-increase factor (mentioned above) which comes into play because of the great [i.e., *relativistic*] velocity of the orbiting objects. *In the case of the pi-meson*, this force-increase factor  $[F/F]$ , as Sternglass explains [p.142, Ref.#1], is approximately equal to the relativistic increase in the mass of each of the orbiting objects. Because the mass of the pi-meson is approx. 137 times the total rest-mass of the e & p which compose it, this force-increase factor  $[F/F]$  is approx. 137, the inverse of the fine-structure constant.

{Note that  $F/F$  is approximately equal to the relativistic increase of the system's mass only in the case of the pi-meson, and not in the cases of other Sternglass.cosmo.systs}

The expression for electric charge between an electron & a positron is given, in every physics textbook in the entire known universe, as:

$F(\text{electric}) = K.Q.Q / R.R$ , where " $K$ " is Coulomb's electrostatic constant, " $Q$ " is the electric charge of an e or p, and " $R$ " is the distance between them. Including the force-increase factor for the relativistic systems, mentioned above, one obtains:

$$F(\text{electric}) = F(r) = (137.036).K.Q.Q / R.R \quad (\text{Eqn.2}).$$

Using numeric values  $K.Q.Q = 2.3071E-19$  gram.cm.cm/cm/sec.sec, and  $R = 0.7312 \times 10^{-13}$  cm, one obtains  $F(\text{elec.}) = 5.913E9$  dynes, which exactly matches the centrifugal force calculated above. So the attractive electric force balances the repulsive centrifugal force, ***if one ignores the tiny magnetic force.***

### Part 3: CALCULATING THE SEVERAL KINDS OF ENERGIES IN THE NEUTRAL PI-MESON

If one knows how the attractive electric force between an orbiting electron & positron in a pair changes as their distance apart ---(represented here as " $r$ ")--- changes, then one can calculate the so-called "potential energy" [ $E(pot)$ ] represented by this electric attraction. This is the amount of energy needed to separate the two objects, given that they are held together by an attractive electric force. One imagines getting between the two objects and pushing them apart until they are at opposite ends of our universe. The math-equation for this "thought experiment" involves only a bit of easy calculus:

**$E(pot, electric) = \text{integrate } F(r) \text{ with respect to } r, \text{ as } r \text{ varies from } R_s \text{ to infinity}$**  (Eqn.3), where " $R_s$ " is their initial distance apart, and " $F(r)$ " is an expression of the attractive force between them, in terms of their distance apart [Eqn.2]. After combining Eqn.2 and Eqn.3 and doing the integration, one obtains:

$$E(pot, electric) = - (137.036).K.Q.Q / R_s.$$

Using numeric values  $K.Q.Q = 2.3071E-19$  gram.cm.cm/cm.sec.sec and  $R_s = 0.7312E-13$  cm, i.e., 0.7312 fermi, one obtains a numeric value of (- 4.324E-4 erg). Note that there is a minus-sign involved here, as one can verify by looking into any elementary physics textbook. Ironically, the total energy-content of this system is considered to be zero when the electron & positron are at opposite ends of our universe, and negative (less than zero) for all other situations. Note that, if one does not include the minus-sign, then one will probably obtain an incorrect result, as this writer can testify to from many previous unhappy experiences. :- ( :- (

So the correct expression is:

$$E(pot, electrical) = \text{approximately } (-137.036).K.Q.Q / R_s = \text{approx. } (- 4.324E-4 \text{ erg}).$$

{Note that the numeric value for  $R_s$  given above is based on the idea that the object's orbital angular momentum is equal to one reduced Planck's constant, as already mentioned}

Regarding the total energy-content of this kind of system, there are two additional contributions. One is the system's so-called "kinetic energy" [ $E(kin)$ ], and the other is the potential energy due to magnetic forces between the e and p in the system. In the case of the pi-meson, this magnetic potential energy is tiny when compared with the kinetic energy and one can ignore it, for now. {We will consider it later}

The numeric value for the kinetic energy of a relativistic system is given by:

$E(kin) = (rest-mass).c.c.(the\ Lorentz\ mass-increase\ factor) - (rest-mass).c.c$  [Eqn. 2.8, p.45, Ref.7], where "(rest-mass" is the rest mass of an electron plus that of a positron, given that the system is composed of an electron and a positron; and "(the Lorentz mass-increase factor)" is approx. 137.036, given that the mass of the system is approx. 137.036 times the rest mass of the two objects which compose it, an electron & positron.

Using numeric values  $(rest-mass) = 2 \times (9.1094E-28\ gram)$  and  $c.c = 8.9875E20\ cm.cm/sec.sec$ , one obtains a numeric value of approx.  $2.211E-4\ erg$  for  $E(kin)$ . This is not quite half of the  $E(pot)$ , mentioned above, because there is also a potential energy due to the *magnetic* force, which we detail below, in Part 5.

#### **Part 4: IS THERE ANOTHER KIND OF NEUTRAL PI-MESON ??**

The above discussion is regarding the neutral pi-meson which is "known" to science, ever since its discovery in 1947. However (as already mentioned in Part 1), in Sternglass's model, there is a second kind of neutral pi-meson, which is slightly more massive than the "known" one. In this system (according to Sternglass) the electron & positron which compose it spin in **opposite** directions, so that the angular momenta due to these spins point in opposite directions, and cancel each other. This means that the total angular momentum of this system is equal to the orbital angular momentum, making it a "spin-one" system.

Likewise, in the "known" neutral pi-meson, the e & p spin in the **same** direction, so that the angular momenta point in the same direction and add. This means that the spin angular momenta cancel the orbital angular momentum, so that the total angular momentum of the system is zero, making it a "spin-zero" system. See Figure 1, below, and/or the illustrations on p.152, Ref.#1.

If Sternglass's ideas are correct, then the magnetic force between electron & positron in the spin-zero system is attractive, while that between the e & p in the spin-one system is repulsive.

Sternglass details this in the discussion on pages 151-153 in Ref.#1, saying that a colleague of his, Seth Neddermeyer, **"gave a paper [in June 1963 at Stanford University] on recent cosmic ray experiments in which the positive mu-mesons with a mass of about 207 electron masses, a net angular momentum or spin of 1/2 of a reduced Planck unit, and seven billion electron volts' worth of energy showed an anomalous behavior in collisions**

with electrons in carbon targets. He interpreted the results as possibly indicating that in the course of these collisions a neutral particle was formed similar to the neutral [pi-meson], but with a net angular momentum of one quantized reduced Planck unit [ $h\text{-bar}$ ], instead of zero." See Figure 1, below, for an illustration.

By adding one additional term, to express the tiny contribution of the magnetic force, one can develop an "equation of state" for the neutral pi-meson:

$$E(\text{total}) = E(\text{kinetic}) + E(\text{potential, electric}) +/- E(\text{potential, magnetic}) \quad (\text{Eqn.4}).$$

As already mentioned, in the known pi-meson the mag.force is attractive, while in the unknown one it's repulsive, as Sternglass details on pages 151-153 of Ref.#1. So, in the case of the spin-zero neutral pi-meson (the known one), the numeric value of  $E(\text{pot, mag})$  carries a minus-sign, to match the minus-sign on the  $E(\text{pot, elec})$ , because both are due to attractive forces. Conversely, in the case of the "unknown" spin-one neutral pi-meson, the numeric value of  $E(\text{pot, mag})$  carries a plus-sign.

## Part 5: CALCULATING THE FORCES MORE ACCURATELY

As above, one calculates centrifugal force as:

$$F(\text{cent}) = 2.M.c.c / R \quad (\text{Eqn.1}).$$

In the case of the theoretical "spin-one" system, " $M$ " and " $R$ " are unknown, but are related by the orbital angular-momentum condition  $M.v.R = h\text{-bar}$ .

I.e.,  $R = (h\text{-bar}) / (2c.M)$ , where, as already mentioned,  $v = 2.c$ , because the e & p move at approximately that speed with respect to each other.

Also as above (see Eqn.2), one can calculate the attractive electric force between the e & p in the pair as:

$F(\text{elec}) = (FIF).K.Q.Q / R.R$ , which should almost balance the centrifugal force. Almost, because there is a small magnetic force, which adds to or subtracts from the centrifugal force to balance the attractive electric force. In the case of the known spin-zero neutral pi-meson, the magnetic force is attractive, so one subtracts it from the centrifugal force.

So one has, for the spin-zero system:

$$F(\text{elec}) = F(\text{cent}) - F(\text{mag}), \text{ i.e.}:$$

$$FIF.K.Q.Q / R.R = 2.M.c.c / R - F(\text{mag}) \quad (\text{Eqn.5}).$$

Using a magnetic-force formula for the force in terms of the distance apart, one has:

$$F(\text{mag}) = (3.75) \cdot [ 3 \cdot (\text{mag.permeability}) \cdot Q \cdot Q \cdot c \cdot c / 4 \cdot (\pi) \cdot 16 \cdot (R)^2 ] \cdot (\text{delta}),$$

where “delta” is a parameter determined by a complicated 4-term expression, involving cross-products and dot-products, to account for how the orientations of the magnetic moments associated with the electron & positron in the system affect the forces between them. In the simplest case, where the spin axes and (therefore) the magnetic moments of the e and the p are parallel, “delta” is 1.0. See Appendix 1 for a derivation of the above formula, which was (during 2019) given *incorrectly* on at least two internet-sites !!

Assuming the simple case where the spin axes and magnetic momenta of the electron & positron are parallel, one has:

$$FIF \cdot K \cdot Q \cdot Q / R \cdot R = 2 \cdot M \cdot c \cdot c / R - (3.75) \cdot [ 3 \cdot (\text{mag.permeability}) \cdot Q \cdot Q \cdot c \cdot c / 4 \cdot (\pi) \cdot 16 \cdot (R)^2 ]$$

(Eqn.5a).

Eqn.5a implies:

$$FIF = \{ 2 \cdot M \cdot c \cdot c \cdot R - (3.75) \cdot [ 3 \cdot (\text{mag.permeability}) \cdot Q \cdot Q \cdot c \cdot c / 4 \cdot (\pi) \cdot 16 ] \} / K \cdot Q \cdot Q$$

(Eqn.6).

Plus, one reckons that the mass and radius of the system must be related by the orbital-angular-momentum condition  $M \cdot v \cdot R = \hbar$ . This implies:

$$M \cdot R = (\hbar) / (2 \cdot c) \quad (\text{Eqn.7}), \quad \text{where } v = 2 \cdot c, \text{ because (as already mentioned) the e and p move at almost twice the speed of light with respect to each other.}$$

Solving Eqns. 6 & 7 simultaneously for FIF reveals that:

$$FIF = \{ c \cdot (\hbar) - (3.75) \cdot [ 3 \cdot (\text{mag.permeability}) \cdot Q \cdot Q \cdot c \cdot c / 4 \cdot (\pi) \cdot 16 ] \} / K \cdot Q \cdot Q$$

(Eqn.7).

Using numeric values:  $c = 2.998E8$  m/sec,  $\hbar = 1.0546E-28$  kg.m.m/sec.sec,  $(\text{mag.permeability}) = 4 \cdot (\pi) \cdot E-7$  kg.m/coul.coul (equivalent to newtons per amps squared),  $Q \cdot Q \cdot c \cdot c = 2.3071E-21$  coul.coul.m.m/sec.sec,  $(\pi) = 3.1416$ , and  $K \cdot Q \cdot Q = 2.3071E-28$  kg.m.m.m/sec.sec, one obtains a numeric value of **136.99** 136.42 for FIF, the force-increase factor in the spin-zero pi-meson.

Likewise, one can use a slightly different approach to calculate a numeric value for the force-increase factor associated with the (“unknown”) theoretical spin-one pi-meson in Sternglass’s model, based on Sternglass’s idea that it should match the

relativistic-mass-increase factor of the two objects (a speedy electron & a speedy positron) which compose the spin-one system.

If this be true, then one can say that, for the spin-one system:

$FIF(\text{spin-one}) = M(\text{spin-one}) / [(Me+) + (Me-)]$ , where “Me+” and “Me-” are the rest mass of the electron and that of the positron. Using this with Eqn.6, after reversing the minus-sign in Eqn.6, because in the spin-one system the repulsive magnetic force **adds** to the centrifugal force, one obtains:

$$M(\text{spin-one}) / [(Me+) + (Me-)] = \{ 2.M(\text{spin-one}).c.c.R(\text{spin-one}) + (3.75).[ 3.(mag.permeability).Q.Q.c.c / 4.(pi).16 ] \} / K.Q.Q,$$

which leads to:

$$M(\text{spin-one}) = 2.502E-25 \text{ gram} \text{ and } FIF(\text{spin-one}) = 137.32, \text{ as well as:}$$

$$R(\text{spin-one}) = (h\text{-bar}) / [2.c.M(\text{spin-one})] = 0.7025E-13 \text{ cm.}$$

Please note that these results assume that the spins of the e and p in the system are parallel, as in Figure 1, below. If not, (see Figure 2), then the results are slightly different. For example, if each of the spin-axes of the e and p makes an angle of 35.3 degrees with the radius vector and an angle of 109.4 degrees with each other, as in Figure 2 below, then one calculates a numeric value of approximately **plus or minus (1.66666).(m1).(m2).(R)** for the second part of Eqn.8 (below, in Appendix 1), which leads to: **FIF = 136.86** for the spin-zero and **FIF = 137.45** for the spin-one. This latter condition implies that **M(spin-one) = (137.45).(2).(rest mass of electron) = 2.504E-25 gram** and **R(spin-one) = (h-bar) / [2.(c).(M(spin-one))] = 0.7019E-13 cm.** So it seems there's almost no difference at all, surprising when one considers the difference of more than 45 degrees in the orientations of the e and p in the two cases.

Note that the plus or minus sign in front of the 1.66666 factor above indicates whether the force is repulsive, as in the spin-one object, or attractive, as in the spin-zero object.

In his 1997 book [Ref.#1] and his 1961 essay [Ref.#1a] Sternglass gives 0.7E-13 cm as the approximate radius of either of the neutral pi-mesons, as he seems more interested in presenting his main ideas than in absolute accuracy here. Additionally, one cannot really say for sure exactly how long the system's radius is at any given time, given that the orbit is not perfectly circular, so that the radius must vary around an average length. We treat this issue here only to show how Sternglass's model is explainable in terms of classical physical ideas and mathematical methods. See Appendix 2 for more details.

## CONCLUSION

Sternglass's model of the neutral pi-meson is more beautiful and logical than the standard model's model for the same object, and has the added advantages of being visualizable, and being based on objects which are known to exist, namely, relativistic electrons and positrons. With no reference to "quarks," one can use semi-classical mathematical methods to calculate forces and energies within the neutral pi-meson, both the known spin-zero system and the "unknown" theoretical spin-one system in Sternglass's model, based on the idea that pi-mesons are composed of relativistic electrons and positrons. If there be any errors in the calculations and results presented above, they are probably due to unknown and/or poorly understood relativistic effects which occur in tiny systems such as pi-mesons. Regarding these issues, the writer invites any questions, comments, suggestions, and/or corrections.

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Anti-copyright, 26 October 2018, by Mark Creek-water Dorazio, amateur physics/astronomy enthusiast, Chandler, Arizona, USA
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APPENDIX 1: Derivation of the formula for magnetic forces within the pi-meson

{These math-formulas involve both dot-products and cross-products}

In the model presented here, one visualizes the electron & positron which compose the neutral pi-meson as if each were a tiny bar-magnet. At the time when these words were written, Wikipedia gave the following math-formula for the force between two bar-magnets:

$$\mathbf{F}(\mathbf{R}, \mathbf{m1}, \mathbf{m2}) = \{3 \cdot (\text{mag.perm}) / 4 \cdot (\pi) \cdot R^5\} \cdot \{(\mathbf{m1} \cdot \mathbf{R}) \cdot \mathbf{m2} + (\mathbf{m2} \cdot \mathbf{R}) \cdot \mathbf{m1} + (\mathbf{m1} \cdot \mathbf{m2}) \cdot \mathbf{R} - 5 \cdot (\mathbf{m1} \cdot \mathbf{R}) \cdot (\mathbf{m2} \cdot \mathbf{R})\},$$

where " \mathbf{F} " is the force along the radius vector, a plus-sign indicating repulsion and a minus-sign indicating attraction; " mag.perm " is the magnetic permeability of free space, a known constant; " \mathbf{R} " is the radius vector, " R " is the absolute value of the radius vector, and " $\mathbf{m1}$ " and " $\mathbf{m2}$ " are the magnetic-moment vectors of the two objects, an electron and a positron.

https://en.wikipedia.org/wiki/Force_between_magnets

Note that the parameters in **bold** print are vector quantities.

At another internet-site the force between two bar-magnets was given as:

$$F = \{3.(mag.perm) / 4.(pi).R^4\}.\{R(\mathbf{cross}m1)(\mathbf{cross}m2) + (R(\mathbf{cross}m2)(\mathbf{cross}m1) - 2.R.(m1(\mathbf{dot})m2) + 5.R.[(R(\mathbf{cross}m1).(R(\mathbf{cross}m2))]\},$$

where the parameters are defined as above.

https://en.wikipedia.org/wiki/Magnetic_dipole%E2%80%93dipole_interaction

HOWEVER, IT SEEMS THAT BOTH OF THE ABOVE MATH-FORMULAS ARE INCORRECT, AND MIGHT EASILY LEAD A HUMBLE RESEARCHER TO HEARTBREAK.

The correct formula seems to be:

$$F(\mathbf{mag}) = \{3.(mag.perm) / 4.(pi).R^5\}.\{[(m1)\mathbf{cross}(R)]\mathbf{cross}(m2) + [(m2)\mathbf{cross}(R)]\mathbf{cross}(m1) - 2.(m1)\mathbf{dot}(m2).R + 5.[(m1)\mathbf{cross}(R)].[(m2)\mathbf{cross}(R)]/R\} \quad (\text{Eqn.8}),$$

where the first two terms of the second part involve computing the cross-product of a cross-product. Note that, as above, terms in **bold** print are vector quantities.

Using this formula gives, for the simple case in which the spin-axes (and therefore the magnetic moments) of the electron and positron in the system are parallel, a numeric value of $(1.0).(m1).(m2).(R)$ for the second part of the formula, the one which has “dot” and “cross” products in it. Note that in this case the spin-axes and magnetic moments of the electron and positron are at +/- 90-degree angles to the radius vector. Likewise, +/- 45-degree angles give $(1.5).(m1).(m2).(R)$, and zero-degree angles give $(2.0).(m1).(m2).(R)$.

To calculate the magnetic moment of the electron and that of the positron, one uses the textbook example, in which one visualizes a point-shaped electric charge on the surface of a rotating sphere as if it were an electric current [*I*] which traces an area [*A*] as the sphere rotates:

$$m1 = m2 = I.A = [Q/T].[(pi).(R/2).(R/2)] = [Q.c/((pi).R)].[(pi).R.R/4] = Q.c.R/4,$$

where “*Q*” is the electric-charge of an electron or positron; “*T*” is the time needed for the electron or positron to complete one full spin-rotation of 360 degrees; “ $(pi).R$ ” is the distance which the charge must move to complete one full spin, {not $2.(pi).R$, because the spin radius is only HALF the system radius, defined as the distance between the center of the electron and that of the positron}; and “ $(pi).R.R/4$ ” is the area of the circle which the charge traces during one full spin, not $(pi).R.R$, for the same reason. So that $m1.m2 = Q.Q.c.c.R/16$.

Combining this with Eqn.8 gives

$$F(\mathbf{mag}) = [3.(mag.permeability).Q.Q.c.c / 4.(pi).16.(R)^2].(\mathbf{delta}) \quad (\text{Eqn.8b}),$$

where $\mathbf{\delta} = \{[(\mathbf{m1})\mathbf{cross}(R)]\mathbf{cross}(m2) + [(\mathbf{m2})\mathbf{cross}(R)]\mathbf{cross}(m1) - 2.(\mathbf{m1})\mathbf{dot}(m2).R + 5.[(\mathbf{m1})\mathbf{cross}(R)].[(\mathbf{m2})\mathbf{cross}(R)]/R\}$, and $(\mathbf{m1})$ and $(\mathbf{m2})$ are defined as above, and **bold** print indicates vector quantities.

However, as a result of several interesting calculations regarding the forces and energies within both the neutral and the charged pi-meson, calculations whose details are too tedious and numerous to mention, this writer has determined that the magnetic-force math-formula as given above is not entirely accurate in the case of the pi-meson, because the distance between the tiny “bar magnets” formed by the spinning electron and positron is so short compared with the size of the “bar magnets.” It seems that the actual magnetic force is greater than that given by the formula, due to a combination of two effects. The first effect which comes into play here is the fact that the system is *relativistic*, which increases the actual force by a factor of approximately 137. The second effect which affects the accuracy of the formula counteracts the first, and is due to the fact that the formula is known to give accurate results only in cases where the distance between the two bar-magnets is large compared to their size, which is not the case here. By a process which one can characterize as “trial and error,” this writer has determined that, for an object the size of a neutral pi-meson, the net effect of the two contrary inaccuracies is that the formula gives a numeric value which is approximately 3.75 times smaller than the actual numeric value of the magnetic force involved.

Therefore, we have inserted a factor of 3.75 into Eqn.8a as a correction:

$$(F(\mathbf{mag}) = (3.75).[3.(\mathbf{mag.permeability}).Q.Q.c.c / 4.(\mathbf{\pi}).16.(R)^2] \cdot (\mathbf{\delta}) \quad (\text{Eqn.8a}).$$

Appendix 2: Regarding the Radius of an Orbiting Electron-Positron Pair

Given that the radius is defined as the distance between the electron and the positron as they orbit around each other, and the fact that the orbit is not a perfect circle, one might expect that the system’s radius is constantly changing by a slight amount, being sometimes slightly larger than its average length, and sometimes slightly smaller.

In Chapter 2, above, the math formulas for the attractive electric force and the repulsive centrifugal force between the relativistic e & p in an orbiting ep-pair are given as:

$$F(\mathbf{electric}) = (137.036).K.Q.Q / R.R$$

$$F(\mathbf{cent}) = 2.M.c.c / R.$$

Notice that the electric force depends on the inverse of the radius squared, while the centrifugal force depends on the inverse of the radius linearly. This means that, if the radius becomes slightly larger, then both of the forces, attractive and repulsive, decrease, but the repulsive force decreases less than the attractive force. So why does the system not fly apart ?? This is because, as the radius increases slightly, the speed of the orbiting e & p decreases slightly, which affects the mass of the system, because the system is *relativistic*, and a slight decrease in the speed causes a large decrease in the system's relativistic mass $[M]$. This causes a sudden decrease in the centrifugal force, as its strength depends directly on the system's mass. So the system does not fly apart. Likewise the system does not collapse as the radius becomes slightly smaller, because a shorter radius means a slightly greater speed and a sudden relativistic increase in the system's mass, which suddenly increases the centrifugal force, preventing collapse.

=====> END OF ESSAY <<=====

REFERENCES

- 1) Sternglass, Ernest, book: *Before the Big Bang* (1997, 2001).
- 1a) Ibid., essay: "Relativistic Electron Pair Systems and the Structure of Neutral Mesons," *Physical Review Journal* v.123 pp.391-398 (1 July 1961).
- 2) Kragh, Helge, book: *Quantum Generations* (1999) pp.322-324.
- 2a) Johnson, George, internet-site: *Discover Science for the Curious* (15 December 2013), <http://blogs.discovermagazine.com/fire-in-the-mind/2013/12/15/idea-grand-ritz/#.Wc7edkuGPrc>
- 3) Ford, Kenneth W., book: *The Quantum World* (2004) p.67.
- 4) Krauss, Lawrence, book: *Quantum Man* (2011) p.292.
- 5) internet-site:
physics.stackexchange.com/questions/81877/force-between-two-bar-magnets
- 6) Dorazio, Mark Creek-water, essay: "Larmor Precession Calculation Shows Connection Between Theoretical Work of Sternglass and Simhony" (2018), <https://www.booksie.com/543018-larmor-precession-calculation-shows-connection-between-theoretical-work-of-sternglass-and-simhony>
- 7) Serway, Moses, & Moyer, book: *Modern Physics* (3rd edition 2005), <http://phy240.ahepl.org/ModPhy-Serway.pdf>
- 8) Kragh, Helge, book: *Simply Dirac* (2016).

9) Callison, Cleve, internet-site:

<https://clevesblog.callisoncreative.com/2010/03/15/everything-not-forbidden-is-compulsory/>

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-----> { please note Figures 1, 2, & 3, below } <-----

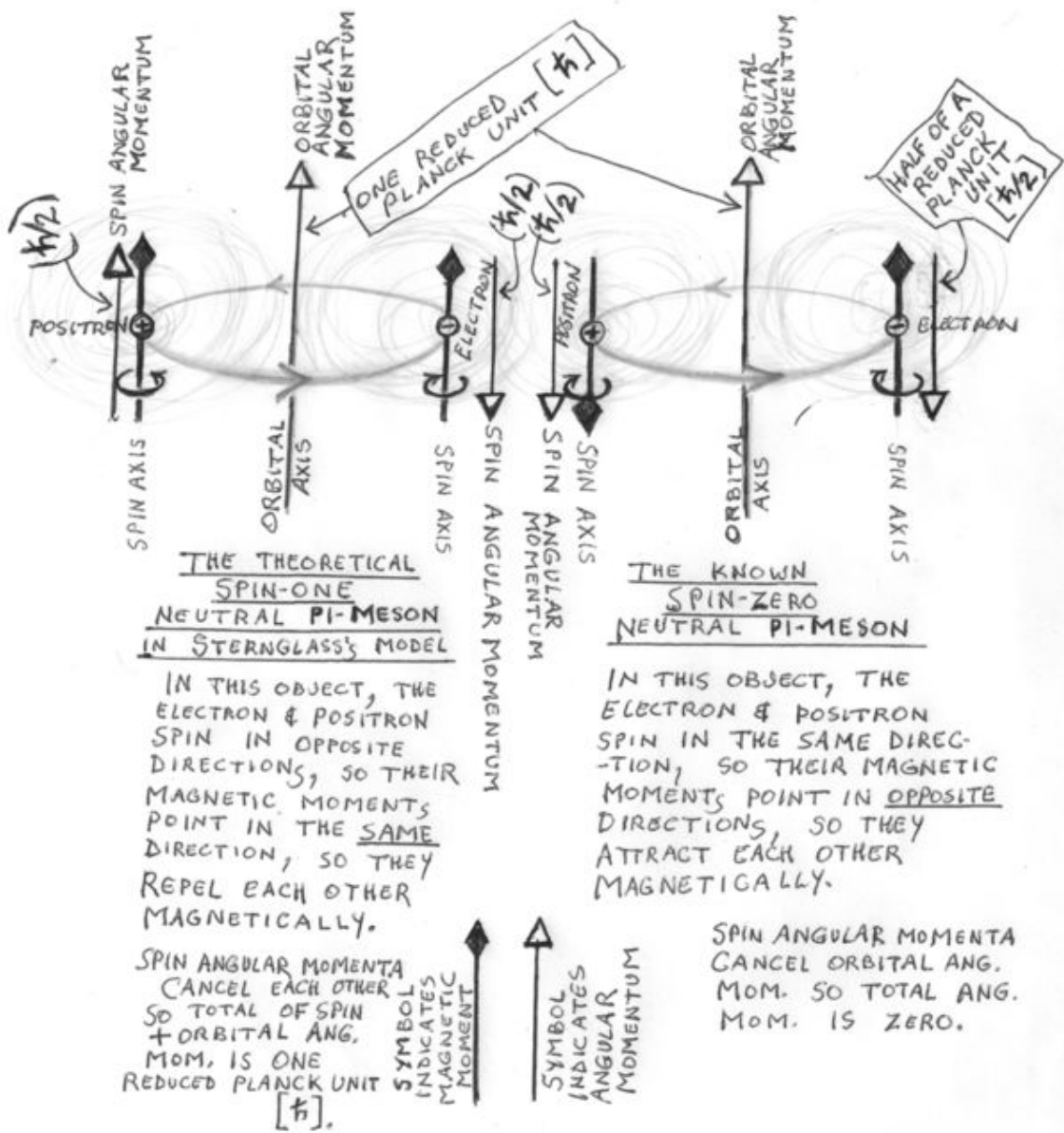
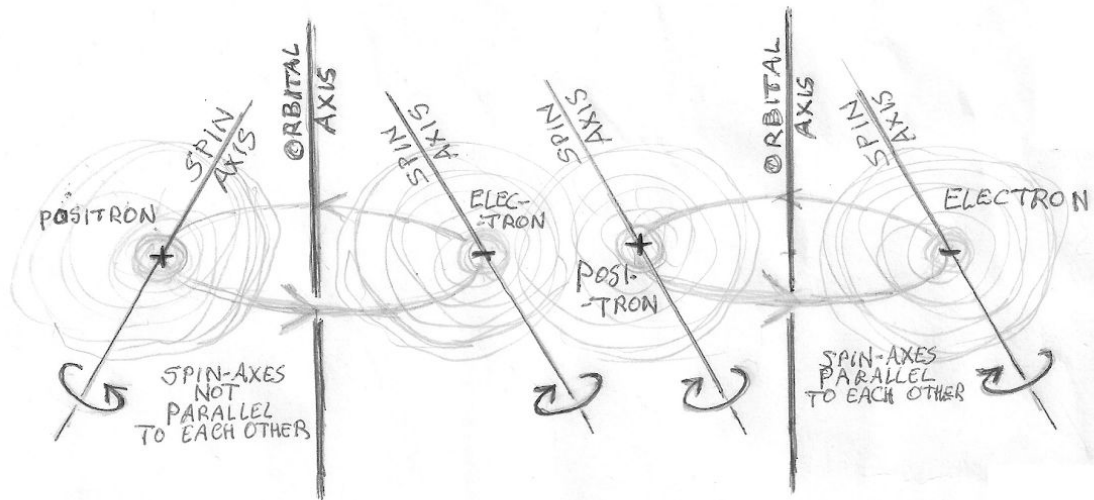


FIGURE 1
STERNGLOSS'S PI-MESON MODEL
 (THE NEUTRAL PI-MESON)



THE SPIN-ONE
(THEORETICAL)
NEUTRAL PI-MESON

THE SPIN-ZERO
(KNOWN)
NEUTRAL PI-MESON

PERHAPS THE SPIN-AXES ARE NOT PARALLEL TO THE ORBITAL AXIS??

FIGURE 2

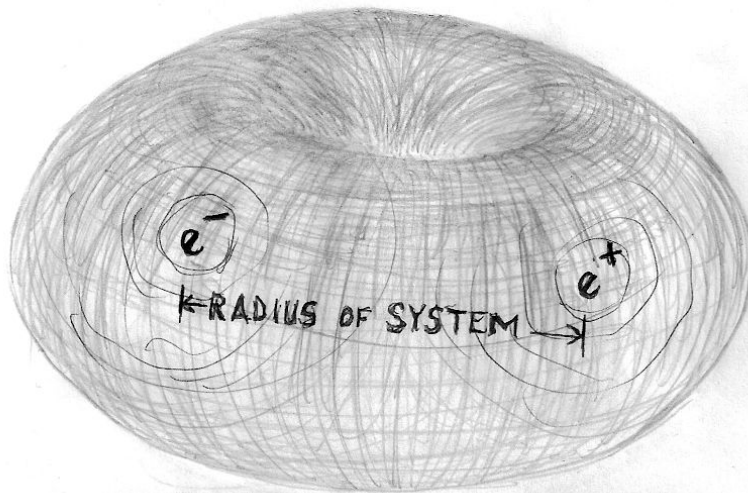


FIGURE 3

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THE ORBITING ELECTRON-POSITRON PAIR
IN A STERNGLOSS COSMOLOGICAL SYSTEM
CREATE A TORUS-[DONUT]-SHAPED OBJECT