Verifying Unmatter by Experiments, More Types of Unmatter, and a Quantum Chromodynamics Formula

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As shown, experiments registered unmatter: a new kind of matter whose atoms include both nucleons and anti-nucleons, while their life span was very short, no more than 10^{-20}sec. Stable states of unmatter can be built on quarks and anti-quarks: applying the unmatter principle here it is obtained a quantum chromodynamics formula that gives many combinations of unmatter built on quarks and anti-quarks.

In the last time, before the apparition of my articles defining "matter, antimatter, and unmatter" [1, 2], and Dr. S. Chubb's pertinent comment [3] on unmatter, new development has been made to the unmatter topic.

1 Definition of Unmatter

In short, unmatter is formed by matter and antimatter that bind together [1, 2]. The building blocks (most elementary particles known today) are 6 quarks and 6 leptons; their 12 antiparticles also exist. Then *unmatter* will be formed by at least a building block and at least an antibuilding block which can bind together.

2 Exotic atom

If in an atom we substitute one or more particles by other particles of the same charge (constituents) we obtain an exotic atom whose particles are held together due to the electric charge. For example, we can substitute in an ordinary atom one or more electrons by other negative particles (say π^-, anti-ρ-meson, D^-, D_s^-- muon, τ, Ω^-, Δ^-, etc., generally clusters of quarks and antiquarks whose total charge is negative), or the positively charged nucleus replaced by other positive particle (say clusters of quarks and antiquarks whose total charge is positive, etc).

3 Unmatter atom

It is possible to define the unmatter in a more general way, using the exotic atom. The classical unmatter atoms were formed by particles like:

(a) electrons, protons, and antineutrons, or

(b) antielectrons, antiprotons, and neutrons.

In a more general definition, an unmatter atom is a system of particles as above, or such that one or more particles are replaces by other particles of the same charge. Other categories would be:

(c) a matter atom with where one or more (but not all) of the electrons and/or protons are replaced by antimatter particles of the same corresponding charges, and

(d) an antimatter atom such that one or more (but not all) of the antielectrons and/or antiprotons are replaced by matter particles of the same corresponding charges.

In a more composed system we can substitute a particle by an unmatter particle and form an unmatter atom.

Of course, not all of these combinations are stable, semi-stable, or quasi-stable, especially when their time to bind together might be longer than their lifespan.

4 Examples of unmatter

During 1970-1975 numerous pure experimental verifications were obtained proving that "atom-like" systems built on nucleons (protons and neutrons) and anti-nucleons (anti-protons and anti-neutrons) are real. Such "atoms", where nucleon and anti-nucleon are moving at the opposite sides of the same orbit around the common centre of mass, are very unstable, their life span is no more than 10^{-20} sec. Then nucleon and anti-nucleon annihilate into gamma-quanta and more light particles (pions) which can not be connected with one another, see [6, 7, 8]. The experiments were done in mainly Brookhaven National Laboratory (USA) and, partially, CERN (Switzerland), where "proton — anti-proton" and "anti-proton — neutron" atoms were observed, called them $\bar{p}p$ and $\bar{p}n$ respectively, see Fig. 1 and Fig. 2.

After the experiments were done, the life span of such "atoms" was calculated in theoretical way in Chapiro's works [9, 10, 11]. His main idea was that nuclear forces, acting between nucleon and anti-nucleon, can keep them far way from each other, hindering their annihilation. For instance, a proton and anti-proton are located at the opposite sides in the same orbit and they are moved around the orbit centre. If the diameter of their orbit is much more than the diameter of "annihilation area", they can be kept out of annihilation (see Fig. 3). But because the orbit, according to Quantum Mechanics, is an actual cloud spreading far around the average radius, at any radius between the proton and the anti-proton there is a probability that they can meet one another at the annihilation distance. Therefore "nucleon — anti-nucleon" system annihilates in any case, this system

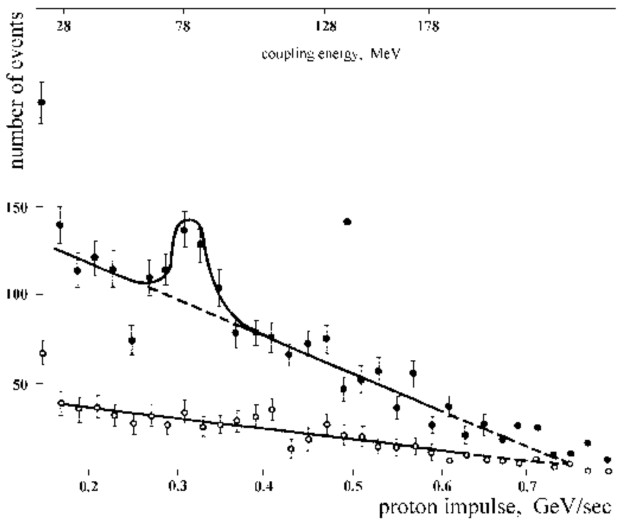

Fig. 1: Spectra of proton impulses in the reaction $\bar{\mathrm{p}}+\mathrm{d} \rightarrow (\bar{\mathrm{p}}\mathrm{n})+\mathrm{p}$. The upper arc — annihilation of $\bar{\mathrm{p}}\mathrm{n}$ into even number of pions, the lower arc — its annihilation into odd number of pions. The observed maximum points out that there is a connected system$\bar{\mathrm{p}}\mathrm{n}$. Abscissa axis represents the proton impulse in GeV/sec (and the connection energy of the system $\bar{\mathrm{p}}\mathrm{n}$). Ordinate axis — the number of events. Cited from [6].

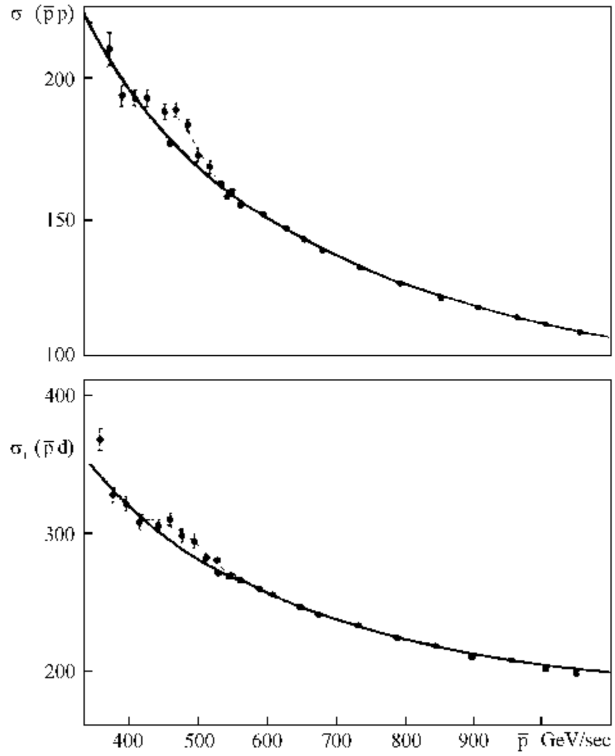

Fig. 2: Probability σ of interaction between $\bar{\mathrm{p}}$, p and deutrons d (cited from [7]). The presence of maximum stands out the existence of the resonance state of "nucleon — anti-nucleon".

is unstable by definition having life span no more than 10^{-20} sec.

Unfortunately, the researchers limited the research to the consideration of $\bar{\mathrm{p}}\mathrm{p}$ and $\bar{\mathrm{p}}\mathrm{n}$ "atoms" only. The reason was that they, in the absence of a theory, considered $\bar{\mathrm{p}}\mathrm{p}$ and $\bar{\mathrm{p}}\mathrm{n}$ "atoms" as only a rare exception, which gives no classes of matter.

Despite Benn Tannenbaum's and Randall J. Scalise's rejections of unmatter and Scalise's personal attack on me in a true Ancient Inquisitionist style under MadSci moderator John Link's tolerance (MadSci web site, June-July 2005), the unmatter does exists, for example some messons and antimessons, through for a trifling of a second lifetime, so the pions are unmatter*, the kaon K^+ (usˆ), K^- (uˆs), Phi (ssˆ), D^+ (cdˆ), D^0 (cuˆ), D_s^+ (csˆ), J/Psi (ccˆ), B^- (buˆ), B^0 (dbˆ), B_s^0 (sbˆ), Upsilon (bbˆ), etc. are unmatter too†.

Also, the pentaquark theta-plus Θ^+, of charge $+1$, uuddsˆ (i. e. two quarks up, two quarks down, and one anti-strange quark), at a mass of 1.54 GeV and a narrow width of 22 MeV, is unmatter, observed in 2003 at the Jefferson Lab in Newport News, Virginia, in the experiments that involved multi-GeV photons impacting a deuterium target. Similar pentaquark evidence was obtained by Takashi Nakano of Osaka University in 2002, by researchers at the ELSA accelerator in Bonn in 1997-1998, and by researchers at ITEP in Moscow in 1986. Besides theta-plus, evidence has been found in one experiment [4] for other pentaquarks, Ξ_s^- (ddssuˆ) and Ξ_s^+ (uussdˆ).

In order for the paper to be self-contained let's recall that the *pionium* is formed by a π^+ and π^- mesons, the *positronium* is formed by an antielectron (positron) and an electron in a semi-stable arrangement, the *protonium* is formed by a proton and an antiproton also semi-stable, the *antiprotonic helium* is formed by an antiproton and electron together with the helium nucleus (semi-stable), and *muonium* is formed by a positive muon and an electron. Also, the *mesonic atom* is an ordinary atom with one or more of its electrons replaced by negative mesons. The *strange matter* is a ultra-dense matter formed by a big number of strange quarks bounded together with an electron atmosphere (this strange matter is hypothetical).

From the exotic atom, the pionium, positronium, protonium, antiprotonic helium, and muonium are unmatter. The mesonic atom is unmatter if the electron(s) are replaced by negatively-charged antimessons. Also we can define a mesonic antiatom as an ordinary antiatomic nucleous with one or more of its antielectrons replaced by positively-charged mesons. Hence, this mesonic antiatom is unmatter if the antielectron(s) are replaced by positively-charged messons. The strange matter can be unmatter if these exists at least an antiquark together with so many quarks in the nucleous. Also, we can define the strange antimatter as formed by

*Which have the composition uˆd and udˆ, where by uˆ we mean anti-up quark, d = down quark, and analogously u = up quark and dˆ = anti-down quark, while by ˆ we mean "anti".

†Here c = charm quark, s = strange quark, b = bottom quark.

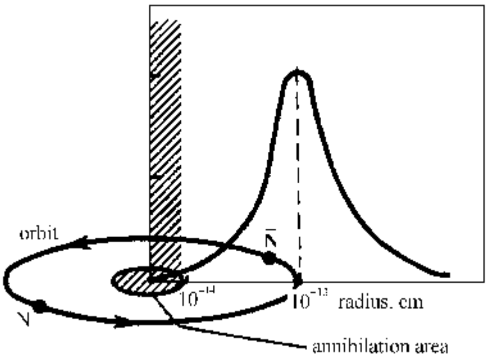

Fig. 3: Annihilation area and the probability arc in "nucleon — anti-nucleon" system (cited from [11]).

a large number of antiquarks bound together with an anti-electron around them. Similarly, the strange antimatter can be unmatter if there exists at least one quark together with so many antiquarks in its nucleous.

The bosons and antibosons help in the decay of unmatter. There are 13 + 1 (Higgs boson) known bosons and 14 anti-bosons in present.

5 Quantum Chromodynamics formula

In order to save the colorless combinations prevailed in the Theory of Quantum Chromodynamics (QCD) of quarks and antiquarks in their combinations when binding, we devise the following formula:

$$\mathrm{Q} - \mathrm{A} \in \pm \mathrm{M3}\,, \qquad (1)$$

where M3 means multiple of three, i. e. $\pm\mathrm{M3} = \{3k \mid k \in Z\} = \{\ldots, -12, -9, -6, -3, 0, 3, 6, 9, 12, \ldots\}$, and Q = number of quarks, A = number of antiquarks. But (1) is equivalent to

$$\mathrm{Q} \equiv \mathrm{A} \pmod 3 \qquad (2)$$

(Q is congruent to A modulo 3).

To justify this formula we mention that 3 quarks form a colorless combination, and any multiple of three (M3) combination of quarks too, i. e. 6, 9, 12, etc. quarks. In a similar way, 3 antiquarks form a colorless combination, and any multiple of three (M3) combination of antiquarks too, i. e. 6, 9, 12, etc. antiquarks. Hence, when we have hybrid combinations of quarks and antiquarks, a quark and an antiquark will annihilate their colors and, therefore, what's left should be a multiple of three number of quarks (in the case when the number of quarks is bigger, and the difference in the formula is positive), or a multiple of three number of antiquarks (in the case when the number of antiquarks is bigger, and the difference in the formula is negative).

6 Quark-antiquark combinations

Let's note by q = quark ∈ {Up, Down, Top, Bottom, Strange, Charm}, and by a = antiquark ∈ {Upˆ, Downˆ, Topˆ, Bottomˆ, Strangeˆ, Charmˆ}. Hence, for combinations of n quarks and antiquarks, $n \geqslant 2$, prevailing the colorless, we have the following possibilities:

- if n = 2, we have: qa (biquark — for example the mesons and antimessons);
- if n = 3, we have qqq, aaa (triquark — for example the baryons and antibaryons);
- if n = 4, we have qqaa (tetraquark);
- if n = 5, we have qqqqa, aaaaq (pentaquark);
- if n = 6, we have qqqaaa, qqqqqq, aaaaaa (hexaquark);
- if n = 7, we have qqqqqaa, qqaaaaa (septiquark);
- if n = 8, we have qqqqaaaa, qqqqqqaa, qqaaaaaa (octoquark);
- if n = 9, we have qqqqqqqqq, qqqqqqaaa, qqqaaaaaa, aaaaaaaaa (nonaquark);
- if n = 10, we have qqqqqaaaaa, qqqqqqqqaa, qqaaaaaaaa (decaquark); etc.

7 Unmatter combinations

From the above general case we extract the unmatter combinations:

- For combinations of 2 we have: qa (unmatter biquark), mesons and antimesons; the number of all possible unmatter combinations will be $6 \times 6 = 36$, but not all of them will bind together.

It is possible to combine an entity with its mirror opposite and still bound them, such as: uuˆ, ddˆ, ssˆ, ccˆ, bbˆ which form mesons. It is possible to combine, unmatter + unmatter = unmatter, as in udˆ + usˆ = uudˆsˆ (of course if they bind together).

- For combinations of 3 (unmatter triquark) we can not form unmatter since the colorless can not hold.
- For combinations of 4 we have: qqaa (unmatter tetraquark); the number of all possible unmatter combinations will be $6^2 \times 6^2 = 1{,}296$, but not all of them will bind together.
- For combinations of 5 we have: qqqqa, or aaaaq (unmatter pentaquarks); the number of all possible unmatter combinations will be $6^4 \times 6 + 6^4 \times 6 = 15{,}552$, but not all of them will bind together.
- For combinations of 6 we have: qqqaaa (unmatter hexaquarks); the number of all possible unmatter combinations will be $6^3 \times 6^3 = 46{,}656$, but not all of them will bind together.
- For combinations of 7 we have: qqqqqaa, qqaaaaa (unmatter septiquarks); the number of all possible unmatter combinations will be $6^5 \times 6^2 + 6^2 \times 6^5 = 559{,}872$, but not all of them will bind together.

- For combinations of 8 we have: qqqqaaaa, qqqqqqqa, qaaaaaaa (unmatter octoquarks); the number of all the unmatter combinations will be $6^4 \times 6^4 + 6^7 \times 6^1 + 6^1 \times 6^7 = 5{,}038{,}848$, but not all of them will bind together.
- For combinations of 9 we have types: qqqqqqaaa, qqqaaaaaa (unmatter nonaquarks); the number of all the unmatter combinations will be $6^6 \times 6^3 + 6^3 \times 6^6 = 2 \times 6^9 = 20{,}155{,}392$, but not all of them will bind together.
- For combinations of 10 we have types: qqqqqqqqaa, qqqqqaaaaa, qqaaaaaaaa (unmatter decaquarks); the number of all the unmatter combinations will be $3 \times 6^{10} = 181{,}398{,}528$, but not all of them will bind together. Etc.

I wonder if it is possible to make infinitely many combinations of quarks/antiquarks and leptons/antileptons... Unmatter can combine with matter and/or antimatter and the result may be any of these three. Some unmatter could be in the strong force, hence part of hadrons.

8 Unmatter charge

The charge of unmatter may be positive as in the pentaquark theta-plus, 0 (as in positronium), or negative as in anti-ρ-meson (uˆd) (M. Jordan).

9 Containment

I think for the containment of antimatter and unmatter it would be possible to use electromagnetic fields (a container whose walls are electromagnetic fields). But its duration is unknown.

10 Further research

Let's start from neutrosophy [13], which is a generalization of dialectics, i. e. not only the opposites are combined but also the neutralities. Why? Because when an idea is launched, a category of people will accept it, others will reject it, and a third one will ignore it (don't care). But the dynamics between these three categories changes, so somebody accepting it might later reject or ignore it, or an ignorant will accept it or reject it, and so on. Similarly the dynamicity of <A>, <antiA>, <neutA>, where <neutA> means neither <A> nor <antiA>, but in between (neutral). Neutrosophy considers a kind not of di-alectics but tri-alectics (based on three components: <A>, <antiA>, <neutA>). Hence unmatter is a kind of neutrality (not referring to the charge) between matter and antimatter, i. e. neither one, nor the other.

Upon the model of unmatter we may look at ungravity, unforce, unenergy, etc.

Ungravity would be a mixture between gravity and antigravity (for example attracting and rejecting simultaneously or alternatively; or a magnet which changes the + and − poles frequently).

Unforce. We may consider positive force (in the direction we want), and negative force (repulsive, opposed to the previous). There could be a combination of both positive and negative forces in the same time, or alternating positive and negative, etc.

Unenergy would similarly be a combination between positive and negative energies (as the alternating current, a. c., which periodically reverses its direction in a circuit and whose frequency, f, is independent of the circuit's constants). Would it be possible to construct an alternating-energy generator?

To conclusion: According to the Universal Dialectic the unity is manifested in duality and the duality in unity. "Thus, Unmatter (unity) is experienced as duality (matter vs antimatter). Ungravity (unity) as duality (gravity vs antigravity). Unenergy (unity) as duality (positive energy vs negative energy) and thus also ... between duality of being (existence) vs nothingness (antiexistence) must be 'unexistence' (or pure unity)" (R. Davic).

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