The Particulate Nature of Subatomic Matter

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Summary

This focuses on the particle side of the wave/particle duality, since Schrödinger has done a satisfactory job of covering the wave side. It treats the "fundamental" particles (leptons, photons, and quarks) as structures and examines their content. It includes an explanation of color and charge as special instances of angular momentum.

Matter

While much has been made of the wave nature of matter, the particulate nature is also important. Between them Planck and Einstein demonstrated the particulate nature of the photon. The particulate nature of atoms was never seriously questioned. The constituents of atoms also have particle properties: mass, velocity, momentum (both linear and angular), and a finite volume.

The simplest of the constituents of atoms are the electrons. These have rest mass of about 511 KeV over c^2. Their velocities vary from a tiny fraction of light to very near that of light, depending on local conditions. From Compton's work, they have an effective radius of about 386 femtometers. Both the rest mass-energy and the effective radius have been measured to many significant figures. As the other constituents of the atom (the nuclei) are tiny, the electrons occupy what little space in the atom is occupied. In the case of a hydrogen atom, the diameter of which is about $1.06 * 10^{-10}$ m, the atom occupies a volume of $6.2 * 10^{-31}$ m^3. The electron only occupies $3.2 * 10^{-37}$ m^3.

The electron also has 6 constituents, each with particulate properties: a charged proto-lepton, 3 proto-photons, and 2 gravitons. Each is moving briskly, with the proto-photons moving at the speed of light, the proto-lepton 12/13 of the speed of light, and the gravitons much faster than light. The proto-lepton has positive real rest mass, the proto-photons have zero rest mass, and the gravitons (which are low-energy tachyons) have imaginary negative rest mass. The proto-matter each has a radius of $4.66 * 10^{-36}$ meters ($L_p/\sqrt{12}$), while the radius of the graviton is small (circa 10^{-59}m). From our perspective, only the proto-lepton is apparent, since its charge is the most noticeable property of the electron as a whole.

Similarly, the photon has 6 constituents: 4 proto-photons and 2 gravitons. Again, the proto-photons are moving at the speed of light and the gravitons faster. The photon occupies a volume whose circumference is equal to their wavelengths. This implies a maximum intensity of light, since 2 photons of the same wavelength can't occupy the same space. Each of the constituents has a diameter as above.

It was possible to find the constituents of the photon and from there the other sub-atomic particles, by taking a force/energy balance on the constituents. For the photon, the proto-photons have no rest mass and the gravitons have imaginary rest mass, so all the effective mass is kinetic energy. A simple balance determined the gravitational attraction just balances the centripetal force outward for each proto-photon. In theory a photon-like structure can be built with any number of proto-photons, although only structures with 2 gravitons look viable. For constituents with a non-zero rest mass, a color or charge is necessary to bring a balance. Then the gravitational attraction is countered by the sum of the centripetal effect, a chroma-centripetal effect, and an electro-centripetal effect caused by accelerating the color or charge in an orbit.

Taking F_g as the force of gravity, F_c as the centripetal effect, F_q as the chromo-centripetal effect (zero for photons), and F_e as the electro-centripetal effect (zero for the proto-photons): $F_g=F_c+ F_q +F_e$. Again, with M_1 the effective mass of a graviton, M_2 as the effective mass of the proto-lepton, and L_0 as the separation distance calculated from the photon: $F_g=GM_1M_2/L_0^2$. Since the proto-lepton has rest mass M_0, $M_2=M_0+M_1$. With 2 total gravitons, total attraction is twice M_1's worth. More generally, for a proto-lepton in spherical orbit n, $M_2=M_0+M_1*n$. In this context it is more useful to speak of the energy E_0, E_1, and E_2, each of which is their respective M times c^2. E_1 is E_k, the kinetic energy of a graviton. The centripetal force on the proto-lepton in the electron is $4E_k/r$. More generally, for a proto-lepton in a charged lepton it is $2nE_k/r$. Since the constituents don't have identical effective mass, it is necessary to be more specific about the radius in question. The proto-lepton has more total "mass" in the electron than any other constituent, so it is closest to the center of mass, having the least effective radius. The effective radius is less than the actual radius r, the distance from the center of volume to the proto-lepton. In the electron there is no color so F_q is zero.

The combined form of the force balance comes to: $G*(E_0+nE_k)*2E_k/L_0^2c^4=2nE_k/r+K_1q/r$. The centripetal effect just balances the gravitational attraction on the kinetic energy with the electro-centripetal effect balancing the gravitational attraction on the rest energy. So $K_1q=2E_0$. Here E_0 is about 48.207445 KeV making K_1about 6.01774 $*10^{23}$ eV/C. This represents an ideal case. Since we are dealing with waves and uncertainty, the real solution vibrates around this ideal. At small distances from the ideal, the force balance approximates Hook's law, with a tiny deviation producing a small corrective force.

Since the energy and force equations are continuous, we need to look to the angular momentum to find a quantization. The photon has zero angular momentum (with 2 wavicles each in the 1s, 2s, and 3s sub-shells), but the neutrino does have angular momentum. Assuming the simplest case, the Electron-Neutrino has 3 wavicles: 2 gravitons in the 2s orbitals and a neutral proto-lepton in a 1s orbital. From the Planck equations, with a 6 piece photon, as above, the 1s pieces have $1/12^{th}$ the energy each. This gives an angular momentum of 1 standard unit for the Electron-Neutrino of 16.443914 MeVfm/c ($\hbar/12c$). This Angular Momentum is only the structural portion, the proto-lepton has angular momentum as well (from its constituents elliptic orbits), but it is a constant for all the negatively charged leptons. The sum of the two is typically given as 6 small units, so the proto-lepton contributes either 5 (if its angular momentum adds to the structural amount), or 7 if they are aligned oppositely (which seems likelier).

In order to generate the required angular momentum, the charged proto-lepton would have a rest energy of 48.207445 KeV (in a 2s orbit balanced by a proto-photon). There are many possible neutrino states that could match the Muon and Tauon: 1 unit (aligned opposite that of the electron – so the muon anti-neutrino is the electron neutrino), and 2 units for the Tauon seem likely. See also the Neutrino for an analysis of the possible states that wavicle can enter. In all 3 cases of charged leptons, there are also a pair of proto-photons in the other available s orbital which have 0 net angular momentum. From the published sizes of the Muon and Tauon, the 5 other constituents total 10 units of energy. This can be accomplished with either 1,1,2,3,3 or 1,1,2,2,4 as the 5 orbitals (all s). A 4s orbital along with the first gives 2 units of angular momentum, while it gives no angular momentum with the second. A 2s with the first again gives no angular momentum, while a 3s with the second gives 1 unit (which is the likely match to the Muon). Additional charged leptons are possible, some with 3 or more units of structural angular momentum.

The content of the nucleus (described in detail elsewhere) includes monoquarks and diquarks. Each independent monoquark consists of a proto-quark and 2 gravitons, plus 1 or 2 proto-photons (depending on charge), and probably a neutral proto-pion (since the quark has net color). Each independent diquark is a structure of 2 proto-quarks and 2 gravitons, plus a proto-photon, and probably 2 proto-pions. When 2 or more quarks and/or diquarks are congealed into a nucleus, the proto-photons may be promoted to surround the whole structure. If the structure had net color, the proto-pions would also be promoted. So the nucleus as a whole also has 1 or more photon-like structures consisting of proto-photons and gravitons. The outermost photon-like structure has 3z proto-photons and at least 2 gravitons, where z is the overall charge on the nucleus. The other proto-photons beyond 3z remain with their quarks and diquarks. See also the sub-shells article for an analysis of proto-photon energy content. Again each of the proto-photons, proto-quarks, and the gravitons have effective mass, velocity, momentum, and occupy a small volume. In the case of a proton, with a diameter of about 1.6 femtometers, the total volume of which is $2.14 * 10^{-45}$ m^3, the constituents occupy a total volume of $2.39 * 10^{-105}$ m^3. Like the atom, the proton is mostly empty space. Unlike the atom – which has a dense nucleus – the proton resembles 2 soap bubbles clinging to each other embedded in a larger soap bubble.

The only distinctions remaining among the 7 non-tachyons proto-wavicles are the charge, color, and the corresponding property of rest-energy. Since the electro-centripetal effect shows a balance between rest-energy and charge, it would follow that the rest energy of the proto-matter wavicles attributable to charge is proportionate to the absolute value of the charge they contain. So if the charge on the proto-lepton corresponds to 48.2 KeV of rest energy, each charge bit would correspond to 16.1 KeV of rest energy. We can treat this "rest" energy as the result of 1 to 3 charge bits, weakly attached, able to attach to some other wavicle if they get bumped hard (that is, if they weakly interact).

Similarly, the chroma bits (with values of plus or minus red, plus or minus blue, plus or minus green, and the neutral state of white: with no chroma bit) cause a chroma-centripetal effect that has to be balanced by a chromatic rest mass. Due to the stronger forces involved, this is probably on the order of a few MeV rest mass, rather than the dozens of KeV implied by charge. From the traditional force ratio of 137:1, the color bit adds 2.2 MeV of "rest" energy. While the charge bit has 3.5 small units of angular momentum, the color bit has about 480. It appears that only a few color/charge combinations are allowed (no charge of 3 bits with a color). The base wavicle may have something resembling valence that determines how many bits it can accept. These add-on bits may be tachyons, like the graviton, trapped within the proto-matter. From the state count (6) color and charge look like p orbitals, possibly conflicting.

Going down another level, the proto-photon has 2 types of constituents: a very low energy luxon (moving at the speed of light), and a very low energy tachyon (moving much faster than light). If the scale of proto-matter to infra-matter (this new level) repeats the scale from the electron to the proto-lepton, the new bits are around 10^{-59} m in diameter. That would give the tachyon a speed of 10^{24} c. This level has just 1 non-tachyon, already described, plus at least 4 tachyons: the graviton, the base tachyon just described (let's call it a base bit), a charge tachyon (a charge bit), and a tachyon producing color (a color bit). The base bit is assumed to be in 1s orbits (2 for each proto-photon), and the luxons (infra-photons) are in 2s orbits. The charge bits and color bits can occupy 2p orbits. This produces significant angular momentum, the effects of which we interpret as charge and color.

While it is easy to envision a three-dimensional arrangement of angular momenta generating the 2 types of charge, this does not work well with color. In order to have red, blue, and green add to white, while anti-red, anti-blue, and anti-green also add to white, a two-dimensional arrangement is called for. Then each of the colors represents a vector 120º ($2\pi/3$ radians) from the other two. The anti-color is 180 º (π radians) away from its color. With the color bits and the charge bits each in p orbitals, both would be 3D or both would be 2D, so the charge would also end up 2D. This implies the up quark has 2 charge bits aligned opposite the color bit, and down quark with 2 charge bits around the color bit, and the diquark with a color bit opposite the charge bits (note – the anti-colors are shown as ghosts of the opposing colors).

This solution raises some new concerns. While there are 3 charge bits, the vector sum of the outer pair is equal to the central vector. That is, the charge on the up and the diquark is each ½ that on a positron, while the charge on the down quark is ½ that on an electron. Further, since the orientation matters, charge and color assignment are not independent. Some particular color is positive or negative (shown here as blue being negative), while the other 2 colors add up to the other charge direction. Additionally, color would (like charge) cause a dipole when there is a separation between the center of the blue wavicle and the center of the red-green, as for instance in a proton. A dipole would require a color transmitting wavicle (like the photon does for electromagnetic dipoles). This may be a pion or pion-like structure with no net color (shown here as the proto-pion). Structures with net color (such as wild quarks) would have this embedded in the overall structure, just as a photon-like shell surrounds the charged structure of the electrons and protons.

Even more troubling, the infra-matter must have some energy to be bound together to form proto-matter. That means that neither the proto-photons nor the photons themselves are luxons: they have rest energy, making them tardyons. They are very quick moving tardyons, but still travel somewhat less than the speed of light. Measuring the speed of extremely low energy photons would give a ceiling on the rest energy of the proto-photon. Alternately, measuring the exact moment a glitch occurs in the rhythm of Pulsars in widely different frequencies could be used. From the existing data on photons, the rest energy should be less than 10^{-20} eV.

An alternate structure would replace the proto-photons by a proto-matter wavicle with 2 opposing charge bits (the proto-dielectric). The balance point to produce 1 unit of angular momentum under those conditions yields a 1206 fm gross radius electron (1070 fm effective radius) with a charge bit of 38.6 KeV kinetic energy. Both of these look a tad large.

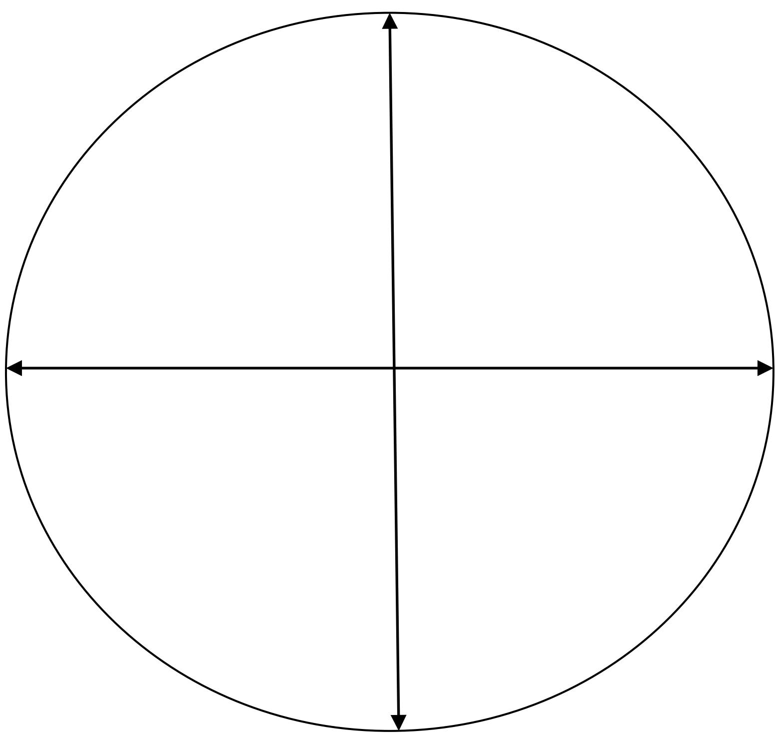
The solution does explain why only a small subset of the possible combinations of charge bits occur. In order for angular momentum to be conserved among elliptical orbits, there must be 2 or more wavicles where the vector sum remains invariant. With a single charge bit the angular momentum varies between 55.6 and 59.5 MeVfm/c of angular momentum (assuming the proto-lepton has 7 small units of angular momentum). With 3 bits, 2 of which are 60° away from the central vector, the outer pair can be at their far points when the central bit is near the mid point (where angular momentum is minimal), thus maintaining a steady 115.1 MeVfm/c. Similarly 2 charge bits would cancel to zero if directly opposite in direction, and passing through their maxima simultaneously (like the proto-dielectric below). This resembles the actual case with color (where the 3 bits have angular momentum that cancels out), since no structures with net color are known. Structures with net color would need to have 2 units (as in the double-anti-blue tri-quark below).

It was possible to generalize a formula to calculate the velocity needed to produce m units of extra angular momentum for a proto-lepton in a ns orbit where $V=(a/b)c$ and $b=a+m$ of $a+b=(2n+m)^2/m$. This often has a and b as rationals, rather than integers.

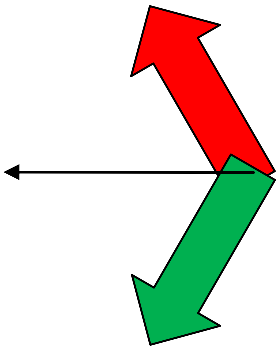
A solution assuming the muon differs from the electron solely by the orbits the proto-matter occupies implies a half life typical of strong interactions, < 10^{-15} s. The actual half life (~10^{-6} s) indicates a weak decay mode, involving changes in the proto-matter itself. A balance point for each lepton needs to be calculated. From the force equation, $F_E=2E_0/r$, where the E_0 is the “rest” energy of the proto-matter. The obvious balance point for the muon has the proto-lepton in a 3s orbit moving 24/25c (so 8.71 MeV “rest” energy, giving a fourth unit of angular momentum). Similarly the tauon could have its proto-lepton in a 4s orbit moving 40/41c (hence 132 MeV “rest” energy) for a fifth unit of angular momentum (for which a matching 4s proto-photon gives 6 units net of angular momentum). Alternately and more likely, the muon could have its proto-lepton travelling 15/17c (with 18 MeV “rest” energy), giving 2 extra units of angular momentum (making 6 units total for the muon). Each of these would have highly excited infra-matter within the proto-lepton. Overall, only wavicles where the forces balance and angular momentum is conserved would be observed.

Main Page of Website

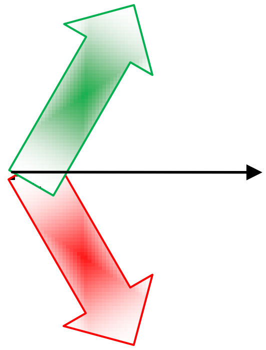
Illustrations



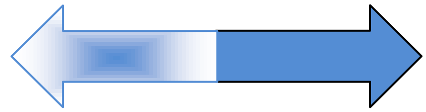
This ellipse is 4.0000 units wide by 3.7417 units high: the shape of a 2p orbit. The foci are .7071 units right and left of the center. In a Hydrogen atom, the proton is near 1 focus, so the distance to the electron varies from 1.2929 to 2.7071 units, where a unit is the radius of a 1s orbit. Note that the center of mass of the atom is at the focus, not the proton. Within proto-matter the sides are tangent to the spherical orbits.



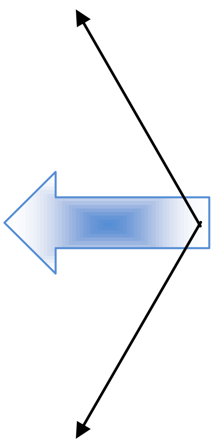
Positive Proto Di-quark



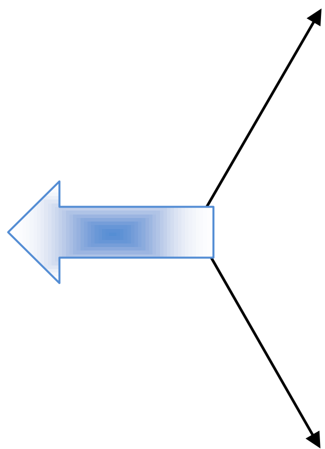
Negative Proto Anti-Di-quark



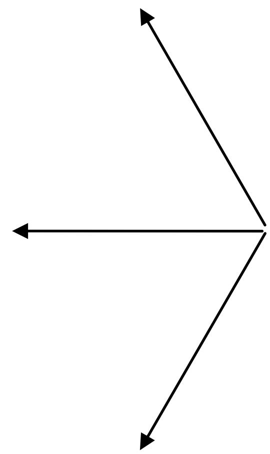
Proto-Pion: 1 of 3 arrangements



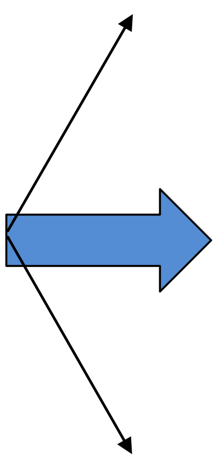
Proto Anti-Down quark



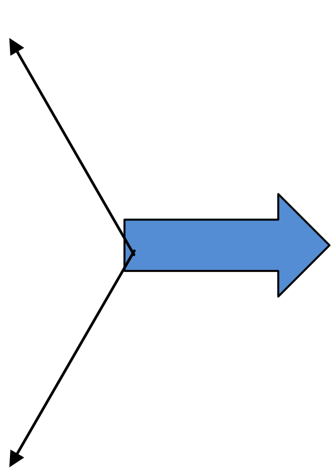
Proto Anti-Up quark



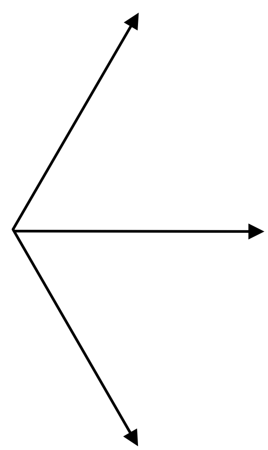
Proto Anti-Lepton



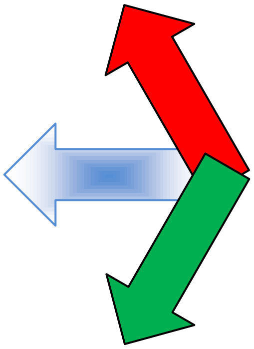
Proto Down quark



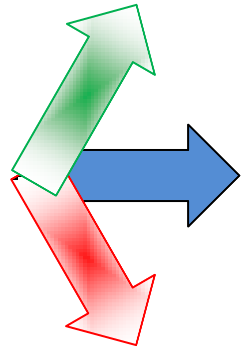
Proto Up quark



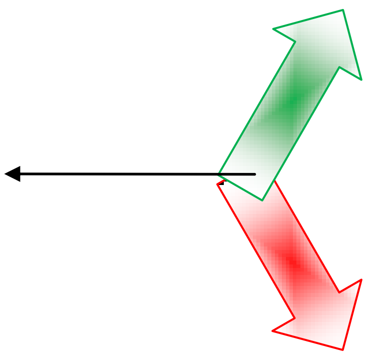
Proto Lepton



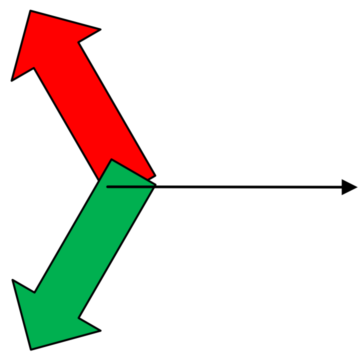
Proto double anti-blue tri-quark.



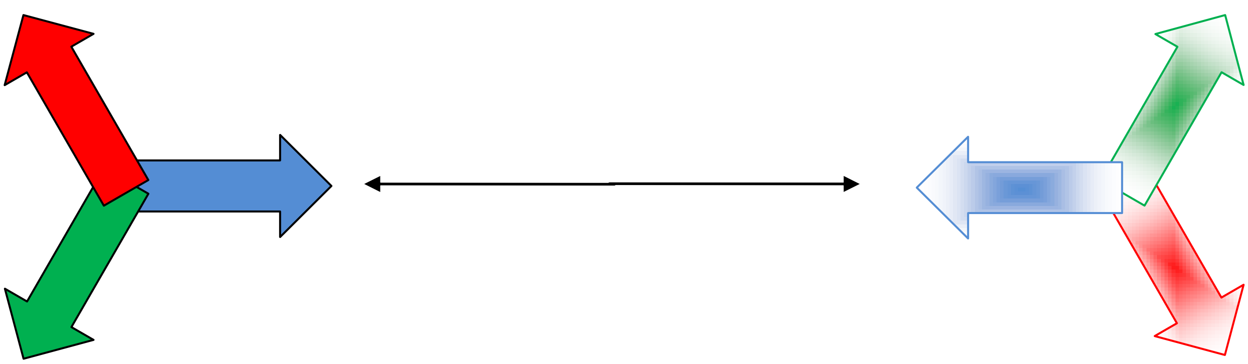
Proto double blue tri-quark.



Positive Proto Anti-Di-quark



Negative Proto Di-quark



Proto Tri-quark

Proto-dielectric: 1 of 3 arrangements

Proto Anti-tri-quark