Investigation of the rhombic triacontahedron as a semi-classical particle model

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Summary

After the author determined that the mass of a proton and electron are equal to the vacuum energy excluded by a shell the size of their charge radii, it became important to find a particle model that forms a shell, since there is no commonly accepted shell-like model. A survey of all common geometric solids was undertaken and only the rhombic tricontahedron was identified as a likely candidate that would allow for a stable quasi-spherical form made of an unequal number of point charges, 12 outer and 20 inner. The electrostatic forces were then computed and it was found that the inward and outward forces cancelled to a large extent. The remaining inward directed force necessary for stability would have to be due to magnetic interactions, which should be possible given a modest amount of rotation. Consequently the rhombic triacontahedron is thought to be a promising semi-classical model for the electron and proton.

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Background

The Casimir effect was discovered by Casimir and Polder and first introduced in Nature in 1946 and later in more detail in Physical Review in 1948. Both papers were titled "*The Influence of Retardation on the London-van der Waals Forces.*"[1,2] The theory is based on the idea that vacuum fluctuations can be considered to behave as induced dipoles, producing a London-van der Waals force, and can be excluded from a cavity such as between two plates or a spherical shell. In the author's paper "*Proton and electron mass derived as the vacuum energy displaced by a Casimir cavity*" it was shown that the mass-energy of the proton is equivalent to the vacuum energy excluded by a spherical Casimir cavity with an average radius equal to the charge radius of a proton.[3] Likewise the electron mass is shown to be equal to the vacuum energy excluded by a spherical shell with an average diameter equal to or approximating the Compton wavelength of the electron. It was also shown that the shell thickness has width, which is approximately the length of a wavelength of vacuum energy of the particle's total mass energy. This fundamental derivation of mass implies that the proton and electron must exist in a shell-like form.

The author has additionally shown in his paper *"The Nuclear Force Computed as the Casimir Effect Between Spheres"* that spherical proton sized shells are attracted to each other enough to overcome Coulomb repulsion and account for the strong nuclear force.[4] However, if the shell structure were infinitely smooth the Casimir force would become infinitely great as the two spheres approached. The simplest way to overcome this difficulty is if it is not infinitely smooth but rather has openings in the structure which are transparent to smaller vacuum fluctuations. The shell structure must then be open on the scale of 0.5 to 0.7 femtometers (fm) in order for the nuclear force to decline at that distance as observed.

The question one must ask then is; if the particle is in the form of a spherical shell, what sort of form must it take? Casimir proposed a semi classical model for the electron based on the idea that if an electron were a spherical shell composed of an evenly distributed charge, then the Casimir force on the shell may be able to oppose the coulomb repulsion.[5] That theory was shown incorrect by Boyer as the Casimir force on a conducting infinitely thin spherical shell is directed outward.[6] Presently there is no particle model that we can use to explain the mass to particle shell relationship, and certainly none would explain an open structure that would match the observed Casimir force to nuclear force relationship.

Investigation

The first important thing to recognize is that if a particle consists of a quasi-spherical shell of a certain width with some type of open structure, then it most likely is composed of smaller sub-particles with an equivalent effective width. It also must be able to account for basic particle properties such as electric charge, matter or antimatter charge, and magnetic field.

It is thought that each sub-particle must have a discreet positive or negative electric charge, or whatever property leads to charge, and that there must be an unequal number of charges so that there is a net electric charge for the structure as a whole. Likewise it is thought that each sub-particle should be either matter or antimatter in the same proportion. In order for a structure composed of two separate charges to be stable, the charges have to be arranged such that opposite charges are closest and like charges farther away. The distances would also have to be symmetric, identical or otherwise balanced in some way.

At that point a survey of all common geometric solids was undertaken to identify the ones that could have one of two unlike charges at each vertex without having like charges adjacent and that the distance between charges would be uniform and/or symmetric. Most importantly the solid had to have an unequal number of inner versus outer vertices where those sub-particles could be positioned. The only candidate found to meet those criteria was the rhombic triacontahedron as shown in figure 1.

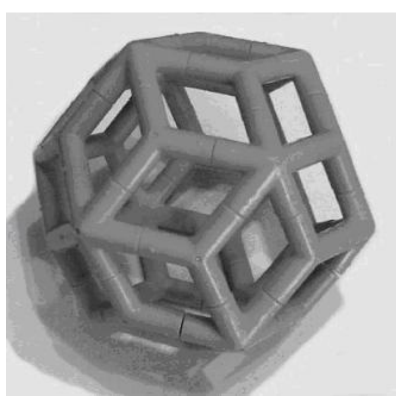

Figure 1 A toy rhombic triacontahedron. [Pictured with permission, Roger von Oech's Star-Ball® www.CreativeWhack.com]

We can then consider a rhombic triacontahedron shell with the average of the inner and outer radii equal to the charge radius of a proton, which from CODATA 2010 is 0.8775(51) fm. In that case the radius is approximately 1.4 times the edge length, and the openings in the structure are approximately 0.94 fm along the long diagonal and 0.66 along the short. If we then take into account the average width of the sub-particles, 0.338 fm,[3] the opening is on the order of 0.6 fm by 0.32 fm. These dimensions correlate well with the necessary reduction in the strong Casimir force between protons over the range of 0.7 to 0.5 fm.

The rhombic triacontahedron is also a self-dual such that it can have 12 positive outer charges and 20 inner negative charges or 12 negative outer charges and 20 positive inner charges. In this manner two complementary stable particles could be formed such as an electron and positron. If the electric charge to matter orientation is reversed within the sub-particles then two additional particles could be formed such as the proton and antiproton. These complementary self-duel forms could also annihilate each other if they occupied the same space as required by basic particle theory. Additionally the rhombic triacontahedron has been identified as having a zero electric field gradient at its internal point of origin.[7] This is another necessary condition for a stable solid form.

Computation

A simplified computation can then be made to compare the force on the outer charges toward the origin with the force on the inner charges away from the origin. Simplifications included use of a unit charge, unit coefficients and a unit length defined as the edge length. Then if one calculates the force toward the origin on the outer charges it is proportional to 34.7. Similarly the force on the inner charges away from the point of origin is proportional to 35.1. Due to the greater distance from the origin we can then note that the attractive force on the outer charges is actually greater than the repulsive force on the inner charges. However, since there are 20 inner charges to 12 outer charges there is a net electrostatic outward force on the structure as a whole. An inward force opposes only about 72% of the outward force.

Discussion

Based on the above computation electrostatic effects alone are not adequate to produce a stable particle with a rhombic tricontahedron structure. This is expected or otherwise there would be numerous stable solutions rather than only one unique solution per particle type. Also we must note that the electron and proton have a magnetic field, so there must also be magnetic interactions that will place magnetic forces on the sub-particles. Additionally, for an electrodynamically stable solution to exist the entire particle will have to rotate in some manner. The motion of the sub-particles through the particle's overall electrostatic field will produce an additional inward force. Given the small additional force required to achieve stability it is assured that there is a solution to produce an electrodynamically stable rhombic triacontahedron particle from this model. It is expected that one or more of the parameters is fixed in such a way that a unique solution is required that is consistent with observation.

Conclusion

The derivation of the origin of the proton and electron mass as the amount of vacuum fluctuation energy displaced by a spherical shell the size of their charge radii requires that we find and adopt a spherical shell model of the proton and electron. Known nuclear force range of action additionally limits the fineness of the shell structure. If we attempt a semi-classical spherical model composed of an unequal number of discreet sub-particles with opposite charges, the best candidate from among the geometric solids based on charge distribution is the rhombic triacontahedron.

Based on a simplified computation of the electrostatic forces, the inward forces on the outer charges account for the majority of the force necessary to produce a stable particle. Additional forces due to motion of the sub-particles in the particle's overall electrostatic field along with other magnetic force contributions are necessary to achieve a stable model. The magnitude of these additional forces lies well within the realm of possibility but a more sophisticated mathematical development will be necessary to prove the rhombic triacontahedron particle model.

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