Retrodicting the Electron and Neutron Masses [March 2011]

1. Introduction

We have seen in the July 2010 addition ("Understanding the Particle Mass Spectrum …") to the New Developments section of this website that the masses of the proton and other major baryons can be retrodicted with reasonable accuracy using a Kerr metric black hole approximation.

We used a basic equation from General Relativity for a rotating black hole:

$$J = \mathbf{a} G_{\Psi} M^2/c \quad , \qquad (1)$$

where J is the angular momentum and **a** is a dimensionless rotation parameter. Using $G_{-1} = 2.18 \times 10^{31}$ $cm^3/g\ sec^2$, which is the gravitational coupling constant predicted by Discrete Scale Relativity for the *interiors* of *bound* Atomic Scale systems, and the conventional total $J_p = (j\{j+1\})^{1/2}\ \hbar$, we found:

$$m_p = (j\{j+1\}/\mathbf{a}^2)^{1/4}\ (\hbar c/G_{-1})^{1/2} \quad . \qquad (2)$$

Then we noted that:

$$(\hbar c/G_{-1})^{1/2} \equiv \text{Revised Planck Mass} \equiv \mathfrak{M}_P = 1.20 \times 10^{-24}\ g = 675.5\ MeV \quad . \qquad (3)$$

Using the conventionally assigned $j_p = ½$, and approximating **a** = 4/9, we got $m_p = 942.935$ MeV, which agrees with the observed m_p of 938.3 MeV at the 99.5% level. We achieved an average agreement level of <99.6%> for 11 of the major (most stable) baryons.

2. A Heuristic Retrodiction of the Electron Mass

Given that $m_p = (j\{j+1\}/\mathbf{a}^2)^{1/4}\ \mathfrak{M}_P$, we consider the possibility that a similar Kerr metric approach might give us a reasonable approximation of the electron mass. A first step is to find a fundamental mass that corresponds to $\mathfrak{M}_P$, but applies in the case of the much lighter electron. Given the fundamental Atomic Scale constants G_{-1}, c, e and ħ, there are two general ways to derive a fundamental Atomic Scale mass from these constants:

$$(\hbar c/G_{-1})^{1/2} = \mathfrak{M}_P = 1.20 \times 10^{-24} \text{ g} = 675.5 \text{ MeV} \qquad (4)$$

$$(e^2/G_{-1})^{1/2} = 1.03 \times 10^{-25} \text{ g} = 57.711 \text{ MeV} \quad . \qquad (5)$$

Proceeding in a heuristic manner we consider modifying Eq. (5) by normalizing with the dimensionless fine structure constant α, which we have found to represent the relative strengths of the electromagnetic and gravitational interactions within bound Atomic Scale systems (New Developments – July 2007 – "The Meaning of the Fine Structure Constant").

We generate a promising counterpart to $\mathfrak{M}_P$ for the case of the electron:

$$(\alpha^2 e^2/G_{-1})^{1/2} = 7.507 \times 10^{-28} \text{ g} = 0.42113 \text{ MeV} \quad . \qquad (6)$$

We will define $(\alpha^2 e^2/G_{-1})^{1/2}$ as the **Einstein Mass** and designate this new fundamental mass parameter by the symbol $\mathfrak{M}_E$. Using $\mathfrak{M}_E$ as the leptonic counterpart to the fundamental baryonic mass $\mathfrak{M}_P$, we propose that:

$$m_e = (j\{j+1\}/\mathbf{a}^2)^{1/4} \mathfrak{M}_E \quad . \qquad (7)$$

Here we are proceeding in analogy to our method used to retrodict the proton and major baryon masses, which was to identify a fundamental "base mass" and then to include a correction factor for the spin and rotational energy of the particle. Using the conventionally assigned $j_e = ½$ for the electron and choosing **a** = 7/12, which is also ≈ ½, we find:

$$m_e = 9.1469 \times 10^{-28} \text{ g} = 0.5131 \text{ MeV} \ , \qquad (8)$$

which agrees with the observed $m_e = 0.511$ MeV at the 99.6% level. Given the heuristic and approximate nature of our analysis, it can only be claimed that Discrete Scale Relativity has identified a promising path toward more accurate retrodictions of the electron mass using more sophisticated Kerr-Newman analyses based on the Einstein-Maxwell field equations. However, it can also be noted that previous theoretical models proposed by the physics community have been unable to even *attempt* a retrodiction of the electron mass. Until now the mass of the electron has been an enigmatic and unexplained empirical fact. Henceforth we have the beginnings of a physical explanation.

3. A Heuristic Retrodiction of the Neutron Mass

The neutron mass of 939.566 MeV is slightly larger than the proton mass of 938.272 MeV, *but not by an integral multiple of the electron mass*. This m_n-m_p mass difference has always been something of an enigmatic mystery to physicists.

Given the arguments and results discussed above, it is natural to ask whether the m_n-m_p mass difference *might involve an integral multiple of the **Einstein Mass***. In fact we find:

$$m_n = m_p + 3\,\mathfrak{M}_E \quad . \qquad (9)$$

Using Eq. (9), we retrodict :

$$m_n = 939.5354 \text{ MeV} \quad , \qquad (10)$$

which agrees with the observed neutron mass at the 99.9967% level.

One might ask: Why **3** $\mathfrak{M}_E$? This is a good question that awaits a good answer.

4. Conclusions

The retrodictions of m_e and m_n presented above are admittedly quite heuristic. In a full Kerr-Newman analysis the mass of a typical particle would be expected to have components associated with the gravitational energy of the particle, with the electromagnetic energy of its EM fields, and with the rotational energy of the particle.

One clue to future progress in understanding the electron mass might be that the constants and form of the **Einstein Mass**, $(\alpha^2 e^2/G_{-1})^{1/2}$, strongly suggest that its mass/energy content may be primarily due to the electron's electromagnetic energy, rather than its gravitational energy. Quite possibly the fact that the electron appears to be a virtually horizon-free singularity (see Technical Notes, August 2008, sections III and V) plays a major role in the difference between the fundamental leptonic and baryonic masses, $\mathfrak{M}_E$ and $\mathfrak{M}_P$.

Omnia exeunt in mysterium.