BORN:

A

universe

III

Hans Gennow

In our first book we showed how the fundamental particles protons, electrons and neutrinos could be created out of vacuum through a fundamental quantum mechanical process. This leads to a universe where we specially noted that galaxies were formed with a massive core. The predicted mass range fits well with present observations of black holes.

In this book we will continue the simulation of the universe with the formation of the halo of the galaxies and the formation of stars and planets. Our result fits well with observations. Our candidate for dark matter, the neutrino, has become more likely since recent searches for exotic particles have failed. The neutrino is the dominating specie in the universe according to our findings.

In our second book we could show how the forces can be determined by the gravitational force through yet another fundamental quantum mechanical process. This means that we can determine the magnitude of their couplings. We note that the agreement is quite good. Combining the results of our earlier books we find that we can determine the mediators of the forces, specifically their masses.

We have in this book also investigated the role of the Planck constant by letting it vary. The result is that we can predict the value of the Planck constant although not overwhelmingly precise. The consequence of our findings is that this leads to the gravitational constant being the most fundamental one.

In all we have a consistent physical picture of how nature can create a universe with the known fundamental particles and their corresponding forces. This includes the various dark phenomena.

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Prologue

0. About this book.

In our first book (Born: A universe, available as a PDF on our site, www.gennowdata.se) we presented a method to produce the standard fundamental particles protons, electrons, and neutrinos out of vacuum without violating any laws of physics.

Based on this we showed how a universe could be built. It leads to a universe with galaxies having a massive core in the centre. The expected range of masses of the cores seem to fit well with present observations of black holes in the centre of the galaxies. Furthermore, we found that phenomena like dark matter and dark energy have quite natural explanations. We called are model “the Freezening” because it resembles the process where water freezes to ice.

We will in part II of this book continue that simulation now augmented with the formation of the halo of a galaxy. We will also build stars and planets. We compare our findings with observations that have come available since our first book. It turns out that the outcome is in good agreement with these observations.

We will also summarize our findings of the various dark phenomena. New observations call for this. Concerning black holes and dark matter we see a nice agreement. A more detailed analysis of the phenomenon of Dark energy or an accelerating universe leads to a bit astonishing result.

However, in our first book we could not explain why there should be exactly three forces except the gravitational force. We made the hypothetical suggestion that it is the gravitational force that is the creator. We argued that the gravitational force is the most fundamental one since it is needed to conserve energy. The problem is how such a feeble force can give rise to the tremendous span of the strengths of the forces.

Just think that a bubble creates a pair of electron-positrons that immediately annihilates into a pair of photons. What would prevent them to just disappear into infinity thereby breaking the conservation of energy? The gravitational force must be erected before anything else happens. The question then is what effect it might have on what follows thereafter.

In our second book we could show how this may come about. This means that we could predict the magnitude of the other forces starting off from the gravitational force. It turned out that we also could determine the gravitational constant through a very specific behaviour of the strong force when we let the gravitational constant vary. In this book we have continued this study by investigating the effect when we let the Planck constant vary in a similar way. We deal with this in part III.

The question we asked is what kind of mechanism can give rise to exactly three forces other than the gravitational one. There must be some mechanism because otherwise there could be millions of different types of forces. There may be various ways of achieving this but the way me just mentioned felt more natural.

In part III of this book we have also made a thorough investigation to try to understand the results of our second book better. By connecting the results of are earlier books we can now show how we can get a clue on the type of mediators of the forces.

We will begin with a short résumé of the relevant parts of our last books. It is needed for the understanding of what comes next. Please check out our earlier books for a more detailed description. In part I we will give you the fundamentals of how the different species of particles can be produced. In part II we will continue the build of the universe after a short review.

Part I

The creation of the fundamental particles.

0. Introduction.

In our first book we presented a method to produce the standard fundamental particles protons, electrons, and neutrinos out of vacuum without violating any laws of physics.

Based on this we showed how a universe could be built. It leads to a universe with galaxies having a massive core in the centre. The expected range of masses of the cores seem to fit well with present observations. Furthermore, we found that phenomena like dark matter and dark energy have quite natural explanations. We called are model "the Freezening" because it resembles the process where water freezes to ice. We will begin with a short résumé of the relevant parts of our last books.

Before we start, we would like to mention that we use the rationalized SI system for units. We also would like to note that all calculations are made on a 64-bit platform, but precision is limited to a 32-bit one by software. We will notify you when we get into problems.

1. Global energy conservation and the gravitational force.

We all knew that things might hide under the surface of a lake. We will now discuss what actually can hide under another surface, namely that of vacuum.

There are always things going on in a vacuum bubble. Lumps of energy can be created as long as they return to their original vacuum state in a reasonable time. How do we know there are bubbles at all? The answer is the speed of light. If there were no bubbles, the speed of light would in fact be infinite. What happens is that the bubbles can absorb and reemit the light, but with a delay. An example. It takes light about 3ns (nanoseconds) to move 1 meter. If each bubble delays the signal by 10^{-15} seconds, we expect about three million bubbles per meter.

Now suppose that something is created and flies away. What will make them return? If they do not, they will in fact violate energy conservation. We cannot prove that energy conservation must hold but it is plausible.

Axiom 1.

Global energy conservation.

The total energy of a system that is not under influence of external forces is constant. There can be no net flow of energy in any direction.

Note that we have extended the normal definition of energy conservation. We need some kind of a universal force, the gravitational, that assures that whatever is produced will eventually return back. The question is how such a force could look like. One could think of several possible ways, but nature will just do what is needed. Nothing more.

In fact, such a force could have a simple $1/R^{\alpha}$ dependence. Well, we already know this but there is no way to tell what it actually should look like. We can only make it plausible.

We could argue that this force, if having just that R dependence, should have $\alpha=2$, nothing else. If α is smaller the force will not be strong enough, if it is larger it would be over kill.

2. Local energy conservation.

In a world with only global energy conservation, strange things will happen. E.g. two cars in a straight head on collision could end up besides the row in the same ditch, while we intuitively would expect them to end up in different ones at least. Well, this is in fact the conservation of momentum we have in mind.

If they end up in the same ditch, it will mean that something else has to compensate the missing momentum. The earth itself, presumably. However, if there instead were two spaceships somewhere in empty space, what would then cause the compensation? We would in fact need a speed of interaction that is infinite. If not, we would break global energy conservation.

We therefore need local energy conservation as well.

Axiom 2.

Local energy conservation.

Axiom 1 holds at any point of interaction.
.

A direct consequence of Axiom2 is the Newton laws of mechanics.

3. The characteristics of matter.

A question we cannot answer is that of the existence of something we call the nature. This may lead to the discussion of something divined, which is not part of our profession. We must assume that something, whatever it is, can be created. This something we call energy or lumps of energy. In short energy lumps.

When lumps of energy are released in a vacuum bubble, there must be a local force that prevents them from just flying away. Local energy conservation must be fulfilled. To achieve this, we introduced the characteristics of the energy lumps.

Axiom.

The characteristics of energy lumps.

Every lump of energy has a property we call its characteristic Ç. Ç is always produced together with its anti-characteristic Ç* and fulfils the relation

$$Ç + Ç^* = 0.$$

This means that they eventually will annihilate completely. Furthermore, we associate with every Ç a quantum number of unity.

.

The reason for a number of unity is that a measurement of Ç should result in one unit of this property. The characteristic is a quantum mechanical property and when quantization takes place its z-component (the normal choice) can show up in three different states, +1, -1 and 0.

It is the characteristic that gives rise to the force that prevents the lumps from flying apart.

4. The mechanism.

What can be produced? Let us call it Q (Quo Vadis), whatever it is. Now, say a couple of Q's are produced. As we went through earlier, a force is erected between them and they will eventually come together and annihilate. Nothing left. No success.

Let's try again. A pair is again produced but just before they smash into each other upon return another pair is produced at the same spot. Off course we could expect that these guys might collide, and we assume it is done in such a way that one couple gets extra energy and flies away. The other pair loses energy and gets trapped into a bound state. We picture this process in Fig 4.1

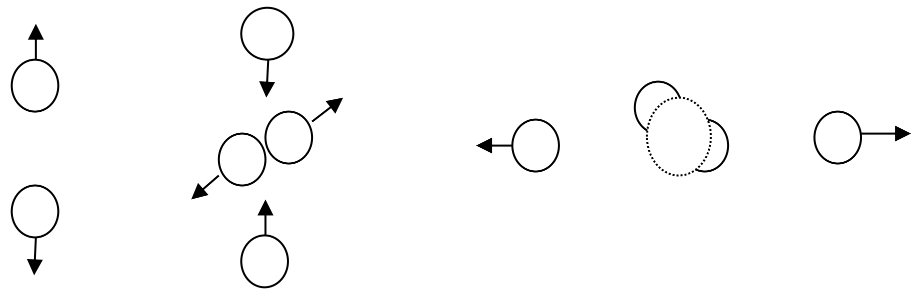

Fig. 4.1. The formation of a bound pair.

The bound pair cannot annihilate because if they did, we will be left with negative binding energy floating around and no force present. This is impossible.

The process must be a bit more complicated because the bound pair gives rise to an angular momentum that was not present from the beginning. We could compensate for this if the two objects acquire a spin upon the collision. If the spins are aligned, the rotational angular momentum could be compensated. The question is whether the spins can match the orbital momentum. In an atom they do not.

Another way would be to add another couple, created in parallel with the first one and which ends up in a bound state rotating the other way so that the net angular momentum will be zero. We now in fact have three couples, one of which escapes and two is left. What prevents the remaining couples from colliding and annihilating?

If the force that attracts a pair of Q's is a plain central force the two pairs that are left could be expected to start to attract each other with a catastrophic outcome. If the force on the other hand has a magnetic type of component that can be used to keep them apart. The nature of such a force is in fact just like the electromagnetic force.

Unfortunately, in the electromagnetic world the magnetic field can never exactly compensate for the electrical force. Only if the objects move with the velocity of light this can happen. However, if the objects have a spin, acquired through the collision, with an associated magnetic field that can be used to get full balance. An electron would thus do the job, and this will be our working hypothesis. We call this the balance act.

What says that we can have a pair in such a bound state? If the Q really is representing the electromagnetic force, we already know that an electron-positron pair cannot be in a stable state (positronium). Another problem is that the energy is far from enough in such a system to be useful. The objects must be very close to have enough energy, in fact they could even overlap.

To investigate whether they can form a bound state we used the Dirac equation since it is a relativistic wave equation also considering the spin of the electron. The problem with such equations is that they only hold for point like particles. In our case the particles produced are really close to each other and can in fact overlap. They will not look like points.

To get around this problem we calculated an effective potential due to the overlap and used that when solving the wave equation. Since the force is radial, we can always do this. We must account for all effects that are different from those of a point. We repeat the details of the calculations in the Appendix. We will, with a slight modification, also need them in part III.

In short, we find a correction to the Coulomb potential to mimic points. The correction is determined by calculating the resulting force starting from some assumed distribution of points. If the density of points goes as the inverse of the radial distance, the produced electrical field will be constant with R inside the object. We found that this was an adequate hypothesis. For the details we refer to our earlier book.

We show in Figs 4.2-3 the correctional factors to the coulomb force for the electric and magnetic parts separately. We plot them as functions of the radial distance R/ R_0, where R_0 is the radius of the objects. First, we note that if the objects were points, the factors would be identically 1 (R>2 R_0 always).

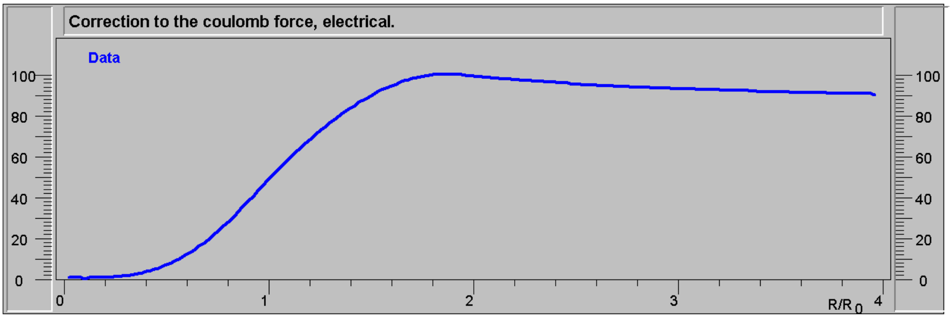

Fig 4.2. The behaviour of the correctional factor for the electrical part.

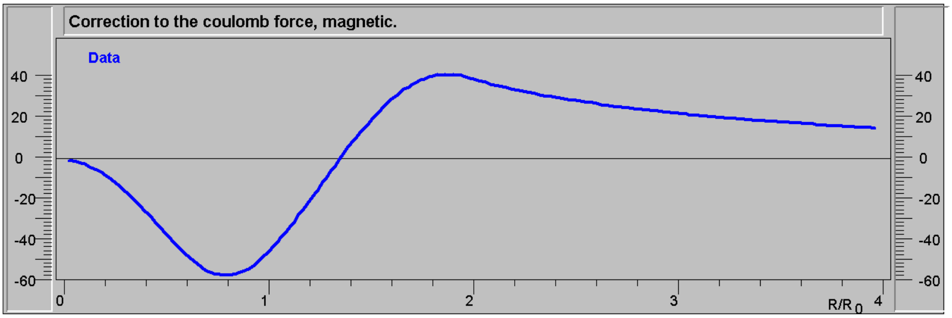

Fig 4.3. The behaviour of the correctional factor for the magnetic part.

We see that the electrical contribution in fact kills the force at small R, quite different from the coulomb force for points. The magnetic factor is a bit more spectacular. At smaller R it gives a force that is repulsive and for larger R attractive. To find the net effect we must add them together in the right proportions and apply them on the coulomb force, which we have done in Fig 4.4.

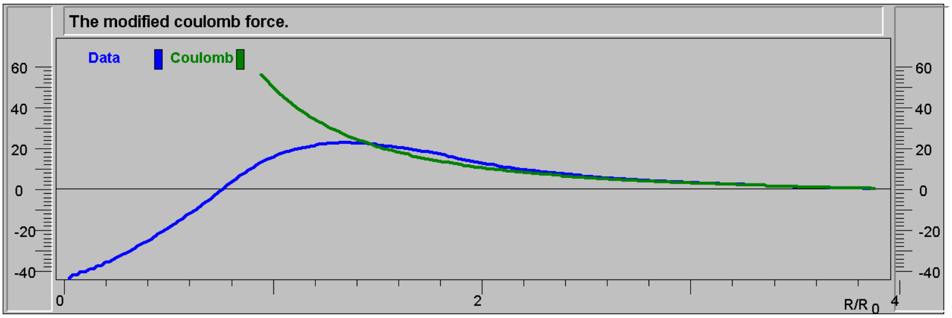

Fig 4.4. The effective force with the correction applied.

As we see the behaviour at small R is remarkable. The asymptotic behaviour of a point like coulomb force is gone. It could be interesting to see also how the net potential behaves. We obtain it by integrating the force (the electrical and magnetic factors separately). The result you find in Fig 4.5.

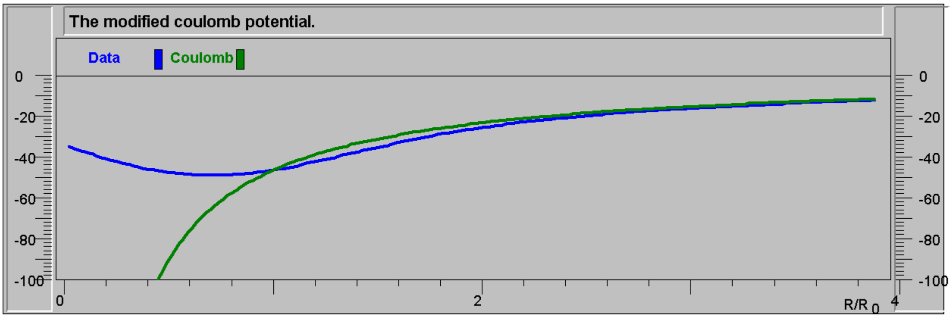

Fig 4.5. The effective potential with the correction applied.

We note that the coulomb potential now has turned into a shallow potential well. In the appendix we give further details on how to apply these factors to the Dirac equation. With these tools we are set to start to investigate solutions to the wave equation.

Since we do not know what kind of states there might be, we do an energy scan. This means that we calculate the behaviour of the wave function as function of the radial distance R and investigate how it varies with energy. More precisely we investigate how the tail behaves by taken a sample of it at large R and plot that quantity. Instead of peaks we are looking for dips. The wave function should tend to zero with increasing R if there is a good solution.

To find a solution in the present case we must let the radius of the object also to vary. The result is presented in figures 6 and 7.

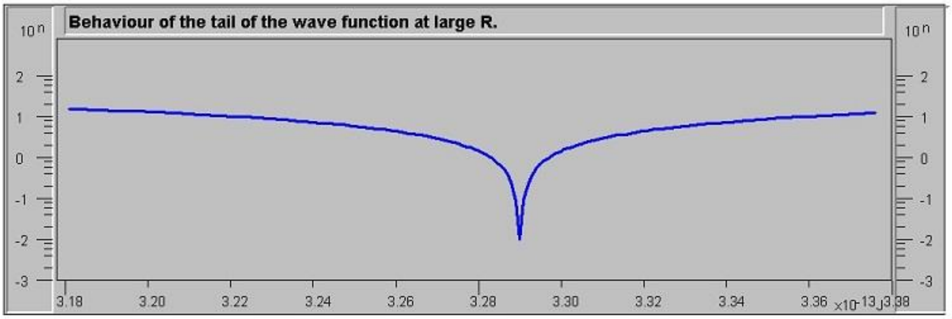

Fig 4.6. The behaviour as a function of the binding energy in units of joule.

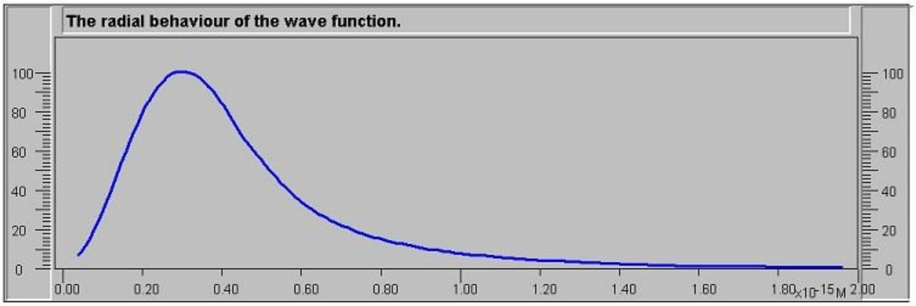

Fig 4.7. The radial probability density $R^2\Psi\,\Psi^*$.

The binding energy corresponds to four masses. This means that there is energy available to create one extra particle that leaves with a kinetic energy worth of one mass.

5. The three forces.

5.1 The electromagnetic force.

In the discussion above we used the electromagnetic force as an example. All forces must have the same construct, i.e. an electric like component as well as a magnetic like one. Otherwise they cannot be produced. This is the basis for our hypothesis of the gravitational force being the creator.

We have thus found a well-defined solution to the wave equation. We should perhaps clarify what we actually mean by the quantization:

Clarification.

> The quantization that takes place is a quantization of space. It is the size of the object that gets quantized. That results in a well-defined particle.

What about the particle mass? We made the following assumption:

Postulate.

> The electron is made up by a constant electric force field that is rotating. The spinning electrical field generates a magnetic field.

Exactly how the field lines are arranged we do not know. In the present case they will be radial. In another arrangement they might be perpendicular to the spin axis. You could perhaps think of it, as the field lines are standing waves fixed on the border. They might also form closed loops, which open up outside the electron. This is perhaps not in line with what you have been taught about the electrical fields, but who knows what rules hold inside of the object. Whatever we do it will not affect the Maxwell equations. What Maxwell concerns, the electron is a black box, just a charge of unknown origin.

The proof of our postulate is that if we calculate the energy content of the electron we find:

The properties of the electron.	Predicted	Measured
Radius [fm] Energy content [J]	.70±.03 .82±.04 10^{-13}	 .818 10^{-13}

We had a look into other arrangements of the field than a constant one. We see difficulties in getting consistent solutions. At some point they seem to fail.

The solution to the Dirac equation determines the radius of the particle being investigated. From this we got the following result concerning the electron:

Conclusion.

The mass of the electron and its charge are dual to each other. From the one we can calculate the other, e.g.:

$e = \sqrt{16\pi\varepsilon_0 mc^2 R_0}$.

5.2 The strong and weak forces.

The important point in the production of particles is that the balance between the pairs works. The strong force must have a similar construct as the electromagnetic force. This means that we have strong charge and strong magnetism. The same holds for the weak force, weak charge and weak magnetism.

Since these forces interact through a massive exchange, the correctional factors will have to be treated slightly differently. The treatment is else the same as in the electron case. The following tables display our findings.

The properties of the proton.	Predicted	Measured
Radius, strong [fm]	.92±.05	-
Radius, electrical [fm]	-“-	.875
Energy content [J]	$1.53\pm.08*10^{-10}$	$1.50*10^{-10}$

The properties of the neutrino.	
Radius [M]	$2.9\pm.2\ 10^{-16}$
Interaction length [M]	$3.2\pm.2\ 10^{-17}$
Mass [J] ([eV])	$2.1\pm.4\ 10^{-20}$ (.13±.03)

The descriptions of the forces are given in the Appendix.

6. The gravitational force revisited.

6.1 The relativistic gravitational force.

The gravitational force is completely different from the other ones just noting that it depends on the masses of the particles interacting. The electromagnetic force does depend on the charge, but that is a fixed value (we are not talking about composite objects) the same for all charged elementary particles.

To be more correct, we have learned that particles consist of bound fields. This means that we expect the gravitational force to act on the strength of the fields, or their energy content. Consequently, we should use the relativistic mass of an object in the Newton gravitational law.

To clarify, we first note that the energy density of the field is proportional to the field squared. Since a moving field scales with the Lorentz factor γ we get a factor γ^2 (see appendix). However, for an object with a given size, its volume will be reduced by a 1/ γ due to the Lorentz contraction, which means a net effect of γ, just as expected. That is, the relativistic mass goes like $m\gamma c^2$.

To find solutions to the Dirac equation we first assume that the gravitational force has an electric as well as magnetic component just as the other forces. We need it for the balance. The second problem is how to incorporate the gravitational force into the formalism of the Dirac equation. We give the details in the Appendix, chapter I.4. In short, we found the following expression for the force:

The general gravitational force.

$$F = G'E_1E_2 * (1 - \bar{v}_1 \cdot \bar{v}_2 / c^2) / R^2$$
$$E = Mc^2 \Big/ \sqrt{1 - v^2/c^2}\ , M > 0$$
$$E = h\nu, G' \rightarrow 2G' \quad , M = 0 \qquad (1)$$
$$G' = G/c^4\ ,$$
$$G \text{ the gravitational const.}$$

This means that the gravitational force acts indirectly on the other fields through their energy contents.

We note that we cannot prove that light can be included in the way given. It is just a plausible assumption. Photons have an energy content, and we must expect that they should behave with respect to the gravitational force in a similar way as other objects build by fields. Furthermore, the question is how the gravitational force acts upon fast oscillating fields.

The factor 2 in the case of light comes about for the following reason. The energy density of the field goes like γ^2 as we discussed earlier. For an object without definite size, i.e. no rest mass, we would be left with that factor.

Let us clarify. We first note that if we bring an object from infinity to a distance R from a gravitational source M, its kinetic energy will, according to (1), be

$$E_k = GMm\gamma / R \,. \qquad (2)$$

The total energy E of that object is

$$E = mc^2\gamma = mc^2 + E_k \,. \qquad (3)$$

If we divide (3) by mc^2 we get using (2)

$$\gamma_L - 1 = GM/Rc^2 * \gamma_L \,,$$

or

$$\gamma_L = 1/(1 - GM/Rc^2) \equiv \gamma_G \,. \qquad (4)$$

This defines the quantity γ_G, which depends only on the gravitational field from another object.

If we take the square of (4) we will get to first approximation

$$\gamma_G^2 \cong 1/(1 - 2GM/Rc^2) \,. \qquad (5)$$

This means that the energy density of the confined field in an object scales with a factor that depends only on the given gravitational field. For an object with a definite size the Lorentz contraction reduces this to the factor (4), i.e. the total energy of the object goes like $m\gamma_L c^2$ as expected. For a mass less object, the total energy instead depends on (5).

Comparing the two expressions we see that instead of G for normal objects we should replace it by 2G for mass less objects.

We have compared with two classical experiments. Firstly, we have the bending of light in a gravitational field. Secondly the perihelion shift. It turns out that our predictions agree very well with observations. In fact, we arrive at exactly the same equations as comes out of general relativity. This despite the fact that our approach is completely different.

We note an interesting consequence of our formulation of the gravitational force:

Conclusion.

Light bends light.

This means that two photons can interact through the gravitational force. This result is not contained within the formalism of general relativity.

6.2 Gravitational structures.

Can there be particles formed by the gravitational force? To differentiate it from elementary particles, we would like to call it:

Definition.

A gravitational structure,
or a “Grav” in short.

In our first book we discussed this subject but could not make any conclusion. However, in our second book when we investigated the possibility that it is the gravitational force that determines the other forces, we found a candidate of mass $1.9*10^{-8}$ kg and radius of $1.7*e^{-35}$ M. Quite a tiny guy but indeed massive. We also discussed how to detect such objects if they are produced. It turned out not to be quite easy.

We can show how the radial dependence comes out from the solution of the Dirac equation for a pair of Gravs, Fig 6.1. We assume they will have similar properties as the other elementary particle. This means a spin as well as electric and magnetic like components. As we have discussed we need a magnetic component to fulfil the balance act. We note that general relativity also give rise to a magnetic like component.

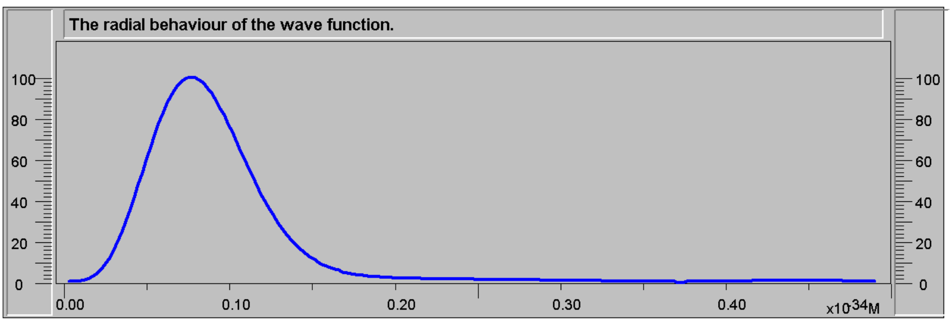

Fig 6.1. The probability density $R^2\ \Psi\ \Psi^*$.

This looks like the electron case, Fig 4.3. The major problem with such heavy objects is that the energy involved is extremely large making the signals broad and weak. The implementation of the gravitational force in the Dirac equation is given in the Appendix.

In part III we will come back to the gravitational force. After a short review of our second book, we will first explain in detail the mechanism behind the peculiar results we found. At that time, we could not quite understand those results. We will then continue with a look on how the results depend on the Planck constant.

7. Summary part I.

We have shown how the most fundamental particles can be produced out of vacuum, through a fundamental quantum mechanical process, while fulfilling the conservation laws. As a biproduct, the process leads to deeply bound pairs of particle-antiparticles. The binding prevents them from annihilating. Just like atoms, but now on a different scale.

A second consequence is that due to particles now being built by confined fields, the Newton gravitational law must be reformulated. In this new form various predictions come out quite right.

In our earlier book we showed how a universe can be build based on these processes. We especially noted that galaxies are formed with massive cores build from the bound pairs. The predicted masses of the cores fit well with present observations of black holes. In part II we will augment that study with the formation of the halos of the galaxies as well as the creations of stars and planets.

In part III we will discuss how the three forces can come about.

Part II

Building a Universe.

0. Preludes

We will come back to the simulation of the universe we did in our first book. We will fill in with some new aspects of it in the following chapters. Especially we simulate the formation of the galaxy halos and the stars and planets with quite a promising result.

We will also summarize our findings of the various dark phenomena. New observations call for this. Concerning black holes and dark matter we see a nice agreement. We will also come back to the supposed phenomenon of dark energy. In our first book we concluded that it just is an illusion. We will now have a more detailed view on this phenomenon. We will simply simulate an accelerating universe. The result is quite surprising.

1. Earlier results.

We will begin with a short review of our first book. Especially we describe the fundamental process so that you will have a better understanding of how it all comes about. In the appendix we describe shortly how our study was performed.

1.1 The dawn

From part 1 we have seen how particles can be created. A vacuum bubble can burst into a number of particles leaving bound pairs left.

The probability for this process must be exceedingly small because otherwise the consequences would be severe for our world. However, the possibility that more than one bubble creates objects at the same time is still conceivable. Strong fields with lot of energy are erected which may trigger other nearby bubbles to produce particles. It will look like a chain reaction in a nuclear plant.

Even if the probability is extremely small, we are in no hurry. Superverse, the container, has always existed and will continue to do so. The question is rather how many universes there are in Superverse. If the probability would be high, we would see new universes building up inside our present one. In fact, a high energy experiment could trigger it. Not very pleasant.

Once a process started, it will most likely continue. A core of bound particles (the ice) would be formed while energetic particles escape (the vapour). That is the reason for "the Freezening". Since this is a stochastic process it would be a bit erratic, perhaps a good comparison would be with the corona of our sun. We know that material can be thrown out all the way to earth.

We could imagine that small islands are formed that are sped up by absorbing free particles and leave the main core. These islands will develop by their own why we call them Miniverses.

When a bubble produces particles, specifically protons, electrons and neutrinos, it must be clear that it is easier to produce lighter particles than heavier ones. According to the Heisenberg uncertainty relation, the likelihood to produce an electron would be about 2000 times larger than that to produce a proton. We will thus have a certain given mixture of particles produced.

We note that due to the 1/M dependence each species will contribute with the same amount of total mass. It is the number of objects that differ. While time goes on this relation will change due to various interactions between the particles produced.

Charged particles will interact more frequently than neutral ones, especially than neutrinos. We would expect that the neutrinos can continue to the outer parts of the universe with, in the average, a larger speed. This means that the outmost part of the universe will be less visible. As we see the universe will be dominated by neutrinos. Perhaps as much as 90% as we estimated in our first book. Call it dark matter if you like.

1.2 Creation of miniverses.

When the core is building up, statistical fluctuations may cause a newly created bunch of bubbles to escape from the core by getting hit by an enough amount of debris. As we mentioned earlier, we could compare to the corona of the sun, which might throw out particles all the way to earth. These islands will develop on their own.

In the beginning fluctuations are too big for any islands to survive. There are not enough free particles to give them the necessary kick. When things stabilize a bit, it will be more likely. However, if it starts too late it turns out that the amount of debris from the mother will grow so large that the daughter simply will be drowned. Nice mother.

Thus, we have a window in which they are most likely produced. If early created, they tend to become larger. If they start later the central core produces relatively more material that will diminish the daughter. The captured debris can break the bonds of the bound pairs causing annihilations.

Fig 1.2.1 illustrates the process of the creation of miniverses. The numbers give the generation. Gx1 is hence produced by the central core, while Gx2 comes out of Gx1 and so on. Three generations are indicated. The bigger arrows give the direction of flight relative their mother, while the small ones indicate debris generated. All cores produce debris while they are active.

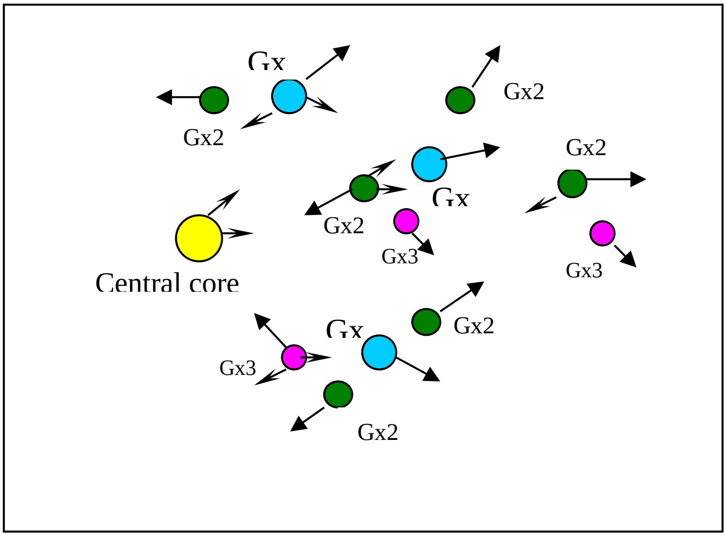

Fig 1.2.1 Production of miniverses (galaxies).

The growing central core will constantly feed the miniverses with material (indicated by small arrows). Part of this material will be absorbed by the cores leading to annihilations. The kinetic energy of the miniverses will increase and so the speed.

Another part of the material will be absorbed into the halo of the miniverses. In the beginning the particles from the central core will be too fast to be absorbed by the halo but later on the difference in speed will become small enough.

The reason for this is that we have assumed that a miniverse will have a smaller initial velocity than the debris. There will off cause be statistical fluctuations in this number. If we start off with a higher speed the material that catches up will give a smaller energy transfer, which means that the speed of the miniverse will not increase as much. In the long run the difference should not be large. The only effect we see is that a faster guy could get a larger mass. This due to the fact, that the absorbed material, now being less, decreases the core less.

We show in Fig 1.2.2 how a core first accelerates and then gently slows down. It shows the first few hours of the evolution.

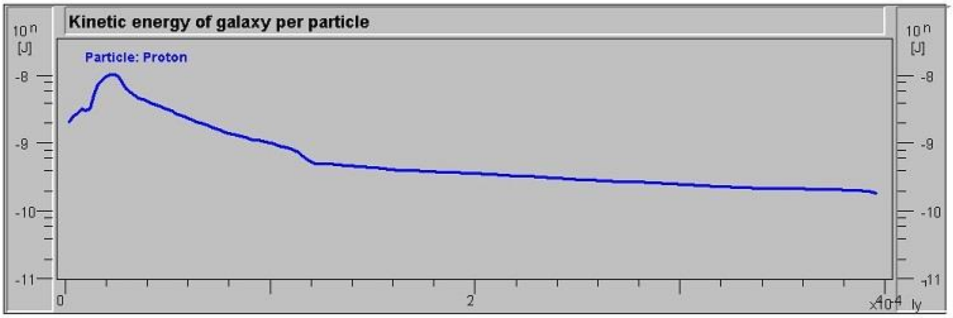

Fig 1.2.2 The kinetic energy of a constituent particle as function of the radial distance.

The halo will off course be spread out. When material is absorbed charged particles will interact more than neutral ones, especially neutrinos. However, as time runs along things should smear out but perhaps with an overweight of neutral stuff at the outskirt.

The miniverse will also absorb material from neighbouring galaxies. This time it will mainly end up in the core since these galaxies move approximately in parallel. This means the particles are too fast to be caught in the halo. However, when time elapses, we will have material flying around in all kind of directions and with varying speeds. We have now (below) simulated the process of catching debris into the halo.

Another sizeable source of debris are the cores that collide. Earlier we just made a simple estimate of the effect and counted it up. However, we estimated that at most 5-6 generations could be created before the amount of debris was so large that the evolution of new cores was stopped. In fact, we see that the last generations come out much smaller than the others. In chapter 2 we will make a proper simulation of the formation of the galaxy halo.

Eventually the process will stop, and we have a galaxy with a massive core. We get a typical core of the order of 10^{37} kg with the size of the sun. However, we see large variations.

1.3 Superverse.

The process we have been describing is in its nature stochastic. We could expect that it has happened not only once but many times.

This means that we need a container to hold them, namely Superverse. Superverse has always existed and its size is infinite. Thus, we could expect that it contains an infinite number of universes.

To explain the existence of superverse we may need something divined. For the moment we have no better idea. However, some day, someone may grasp the ingenuity of nature. That would just be in line with the evolution theory of Darwin.

2 Collecting debris.

2.1 The formation of a Galaxy halo.

In our first book we discussed the effect of debris but did not perform a simulation, merely estimated the impact. We found that the halo of the galaxies could grew to a couple of thousand times the mass of the core. The larger the core is the larger the galaxy. This agrees with what recently was reported by NASA.

For a simulation we first need to know the frequency of collisions. We must realize that it will be quite crowded in the beginning of the development. Chaotic we would say. A major fraction will collide making things quite messy. Cores may collide later but rarely. We concluded in our first book that if 5-6 generations of galaxies are created that is done in only 15 minutes. During that period the amount of debris will become so large that it will choke further evolution of cores.

Secondly, we need to know the energy of the debris. As we explained earlier, cores are built from bound pairs of particle-antiparticle. When the bonds are released, they will have their maximum energy, corresponding to a mass worth of energy. However, they will collide whereby some will lose energy while others will gain. We have assumed a distribution with overweight of rapid ones. The exact form of this distribution will not affect the result notably. We select from this distribution by drawing a random number. In all what do we work with average aspects.

For every step we take we add up a chunk of debris depending on the solid angle as seen from the source. We calculate relative speeds and apply an energy loss on that chunk when added. At the beginning we assumed it to be 20% but along with the halo is growing it is reduced.

It turns out that the halo mass varies around a couple of 1000 times the mass of the core. The result is in good agreement with the estimate we made in our first book. This gives galaxies of the order of $5*10^{40}$ kg but with variations of a factor ten up or down. The cores themself can also vary quite a bit depending on how and when they are produced as we explained in our first book. A later, fast generation e.g. comes out a bit smaller due to time dilation. It grows in a slower pace. Its halo will also become smaller.

The halo has acquired 95% of its mass after a day or so. This could be compared to the cores themselves that build in a few minutes. However, it will take some time to collect the debris. We show in fig 2.1.1 how this evolves. After a rapid rise it seems to level off, but it will continue to grow a bit more. The plot shows the first few hours.

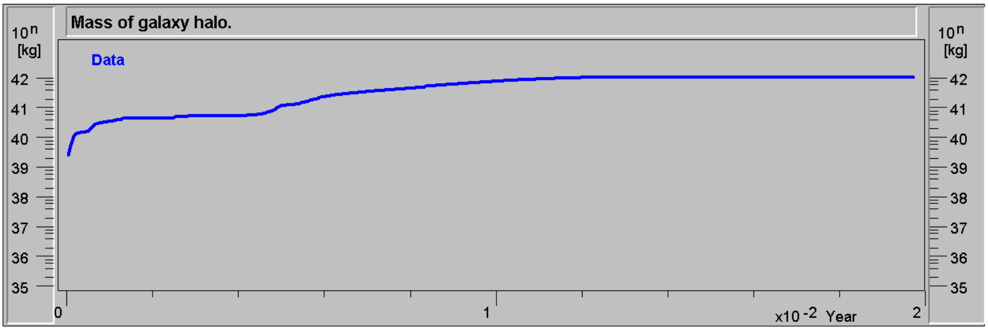

Fig 2.1.1. The evolution of the halo of a galaxy.

The size of the halo will grow in a slower pace. We had a look at the density of the halo and applied a reduction of the halo energy depending on that. When it is crowded in the beginning, we assume that the particles can lose 20% of their kinetic energy on the average. When it is less crowded the energy loss will be smaller, again on the average. The exact amount of energy loss is not important, it is just a question of how long time it will take until stable.

This leads to galaxies with radius of the order of a few 10^{21} M, i.e. a few 100 000 light years. At the beginning the radius is relatively smaller due to the debris being in the average relative fast. Due to energy loss the halo will broaden by time, but that takes a considerable time. We must remember that the debris collected by the core originally come from all kind of directions. By time, a preferred rotational direction will crystalize. We show in fig 2.1.2 the evolution of the size of the halo. It shows the first 5 million years.

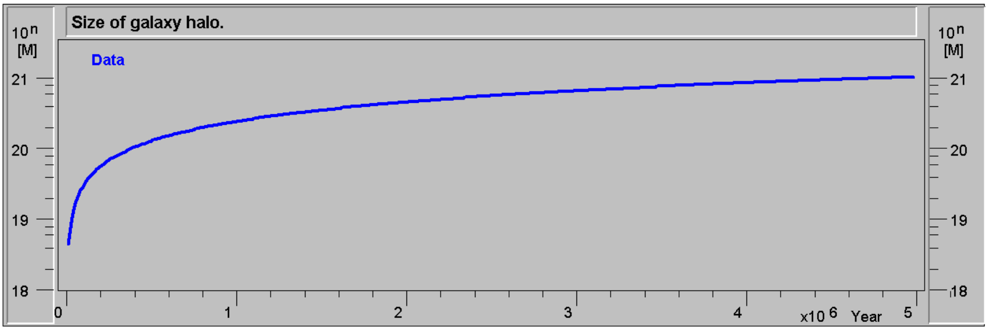

Fig 2.1.2. The evolution of the halo of a galaxy.

The halo will grow during some million years about. During that time, the average density of the halo has dropped to about 10^{-25} kg/m^3. In a recent measurement [1] of the interstellar density outside the solar system the density was found to be about $3e^{-22}$ kg/m^3 of hydrogen. This was achieved by the NASA probe New Horizons. 2015 the probe past Pluto and got some nice pictures. However, the average halo is about a factor 10 larger than the distance of the sun to the centre of the galaxy. This means that if we scale our density we would be in the neighbourhood of that measured value.

We note that the radius of the galaxies may vary by a factor 10 up or down as with the mass. In the former case the radius is in fact what a resent measurement, of the outer radius of the Andromeda galaxy indicates, project AMIGA [2]. They found an external gaseous halo around it. The inner halo is about 500 000 light-years in size. This was achieved by help of the Hubble space telescope.

When the first disruptive period of the halo evolution is over, we could think that atoms start to form. Exactly how long time this will take is not quite easy to estimate. We could use the density of the halo to find something out, but it is not clear cut. During this period material will clump together and stars will start to form. If it takes some million years to build a halo, stars may be formed during that time and the answer will be given in the next chapter. Anyhow, our findings are quite different from what is pictured in the Big Bang story. That story does not explain how the elementary particles are created, so how can one make any predictions whatsoever on the evolution? They assume that some kind of potential existed at the beginning but who created that?

In 2019, astronomers reported on a tidal disruption event detected by the TESS facility and denoted ASASSN-19bt [3]. A star that came close to a supermassive black hole was simply torn apart. The supermassive black hole that generated ASASSN-19bt weighs around 10^{37} kg, just like the one in SgrA* in the center of our galaxy. It sits at the center of a galaxy called 2MASXJ07001137-6602251 located around 375 million light-years away in the constellation Volans. The mass of the galaxy is estimated to 10^{40} kg. In their analysis they have set the radius of the core to that of the sun. Whether this is an estimate or not is not quite clear. From what we can judge it does not look unreasonable. This is in line with our prediction of the radius of such an object but perhaps a bit biased conjecture you may say.

It is quite amusing to see that all these numbers mentioned above fit rather well with our results.

[1] P.Swaczyna et al, APJ, Vol 903, no 1, 2020
[2] N. Lehner et al, APJ 900:9, 2020.
[3] T. Holien et al, APJ, 883, no2, 2019.

2.2 The formation of a stars and planets.

After the formation of the galaxy halo we can have a look on how atoms may form and gather up to stars and planets. In our first book we never came so far. We have seen in the last chapter that a typical galaxy comes out to $5*10^{40}$ kg and with a radius of some 10^5 light-years.

As we noted the density of the halo is quite large at the beginning of the halo formation. The distance between particles is in fact much smaller than the size of the hydrogen atom. We will expect a lot of collisions taking place. Protons colliding can give rise to neutrons and a lot of pions. Neutrons can combine with protons to start to build heavier atomic cores. However, they will have to move with about the same speed for this to happen. Things will have to settle down before it can happen, and it will take some time. The pions will decay into muons predominantly due to the Q-value. Muons will decay to electrons. In these steps of decays neutrinos will be created. Their energy will not be so large due to the multiplicity (many particles that like to share the available energy). They may end up in the outer parts of the halo.

Furthermore, it will be quite chaotic. We will hardly expect atoms to be formed. However, when the halo grows the density drops and the distance between particles get large enough to form atoms, mainly hydrogen. We have assumed a mixture with 15% helium. This happens approximately when the halo has grown to a size of 10^{15} M. We are talking about after some years of the evolution. When time passes on heavier compounds will form but we stay with the given mixture. The result will not change notably.

Under these conditions we can start to accrete atoms into lumps. In doing so we calculate the time it takes to collect particles. When the mass of the star grows the speed of the particles that get collected increase and the amount added likewise increase. This process is quite slow at the beginning but accelerates fast. When the halo grows the chunk added will gradually become smaller due to the smaller density of the galaxy halo and the process slows down and ends in a natural way. By this procedure we can achieve a reasonable estimate of the time needed to build a star.

At the end we find stars of the order of 10^{30} kg. Their sizes are about that of our sun. Their distance to the centre of the galaxy comes out to the order of 50 000 light-years. When we build the stars, we also form a halo around them. We see that the size of the halo encompasses the planets of our sun.

We note that the density of the galaxy halo has dropped down by the time the star is build. A star has reach 2% of its final mass around some 100 million years. The time to build a star is close to 10^{10} years (98.5%). Just as with the creation of the central cores, the masses of the galaxies as well as the masses of the stars we see variations of a factor 10 up or down. The numbers we give are averages (medians). You may take it as an uncertainty in our calculations. However, we must expect to see a variation of values. We are in fact looking at a sample of cores that evolve to galaxies. They have been produced under different conditions and we must expect to see variations. We show in fig 2.2.1 the evolution of a star. It shows the first $5*10^9$ years.

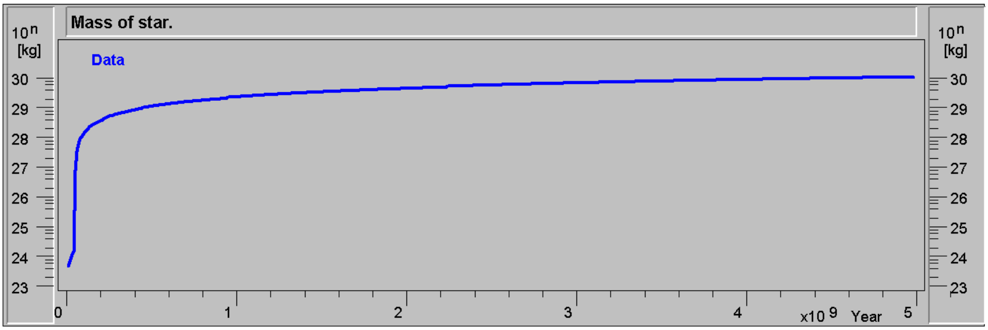

Fig 2.2.1. The evolution of the mass of a star.

As mentioned, we have tried to build planets as well. The situation is now a bit more complicated. The relative distance to a star is much smaller than that of a star to the core of the galaxy. Debris being collected by a planet may instead turn towards the star. In principle we would need to calculate the forces from the star and the planet on the debris on every occasion. This is an impossible task, so what we can do is to construct a simple algorithm which we can apply in an average sense.

We must also wait for heavier elements to form. The particles that fly around must not be too differentiated in speed (energy). If they are, the result would just be some elastic or inelastic collision. The difference in energy should not be more than about the binding energy. We judge this from the average distance between particles which just corresponds to a certain density of the halo.

We can imagine that when planets start to build there will still be hydrogen floating around so that at first, we will have a portion of hydrogen collected. Heavier elements will fill up by time thereby compressing the core. Nuclear reactions may start so that there will be a hot interior of the planets. If this process started earlier, before enough heavier elements have formed, we would just get a new star.

We find a typical planet of the size and mass of Jupiter, fig 2.2.2. It is positioned somewhere around Neptune. As we pointed out before there are large variations. The time scale has increased to 10^{10} years about (98.5% of their final masses). We are approaching the age of the earth. It is interesting to note that the spread of the masses and the distances of the planets to the star looks like a representation of our own solar system. Off course not in detail. We are investigating various galaxies, and this is the variation we see. One representative planet per galaxy.

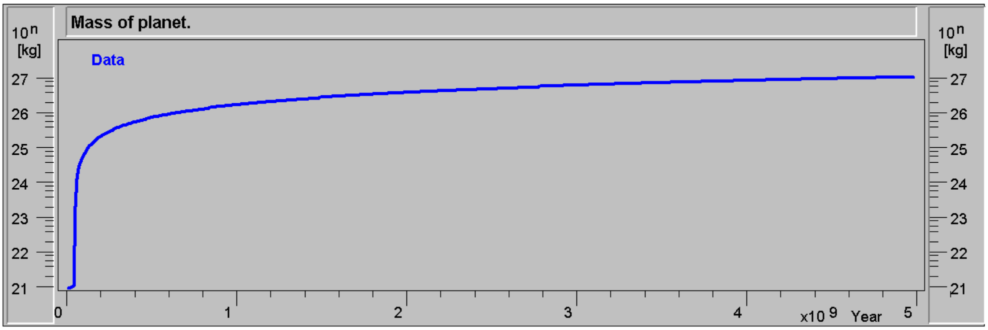

Fig 2.2.2. The evolution of the mass of a planet.

It looks like the evolution of stars and planets follow each other. However, the first seed of a star happens after about a month in contrast to a year for planets. This is just what we stated above when we said the evolution is quite slow at the beginning. Furthermore, we observe that the density of the galaxy halo is close to its final value when the stars and the planets are getting a bit fatter. That is the reason for a similar evolution.

2.3 Gravitational waves.

It may be illuminating to see how earth may be affected if we experienced a collision between two massive cores of say 10^{37} kg. Let us assume this happens a million light years from us. We assumed above that half each core would burst into debris while the rest joined into a new one. If we set the radius of earth to $.7*10^{7}$ M, the solid angle is $.5*10^{-30}$ as seen from the colliding cores. If the debris are spread out isotropic, we could expect a burst of $.5*10^{7}$ kg hitting us.

However, the speed of the debris varies as we assumed above. When the bond between a pair of particles is released, they will leave with a speed of .94c. However, there will clearly be collisions, which will give part of them some extra speed while others will slow done. Let us assume that 10% of them will be ejected with more or less the speed of light, which means that $.5*10^{6}$ kg will hit us at one instant. The rest of the stuff will be spread out in time. Would we detect this as a gravitational wave?

If the most energetic particles have a speed differing from the speed of light by 1 part to 10^{16} (our precision) they will arrive .003 seconds after the light have reached us. We mention this to give you a feeling of how it may look like.

3. Dark stuff.

We would like to summarize our findings on the dark story. This means black holes, dark matter, and dark energy. A lot of attempts to explain these phenomena have been presented in the literature so far. All of them are in practice just hypothetical mathematical inventions, i.e. not physics.

So, we will start off by black holes and then continue with dark matter and last dark energy (revisited).

3.1 Black holes.

From part 1 we have seen how particles can be created. A vacuum bubble can burst into a number of particles leaving bound pairs left. This process will thus conserve energy. Strong fields with lot of energy are erected which may trigger other nearby bubbles to produce particles. It will look like a chain reaction in a nuclear plant.

Once a process started, it will most likely continue. A core of bound particles would be formed while energetic particles escape. Thus, we get a core consisting of pairs of bound particle-antiparticle. The binding energy prevents them to annihilate. The density of such an object is enormous, the distances between the pairs are about 2 fm ($2*10^{-15}$ M). Compare to solid hydrogen, around 10^{-10} M.

It is interesting to note that a typical object comes out to 10^{37} Kg and with a radius of about the sun. As we mentioned in chapter 2.1 recent observations confirm our result. It is said in the literature that nothing can escape. Such a statement must be modified. As we have discussed when an energetic particle impinges on such an object it might break the bonds of a bound pair. The remnants will have enough energy to escape some distance. A normal light ray will on the other hand not come far, not even a standard gamma ray.

3.2 Dark matter.

As we see the universe will be dominated by neutrinos. Perhaps as much as 90% as we estimated in our first book. Call it dark matter if you like.

Searches for various kind of exotic particles that could explain dark matter have been made. Axion and axionlike particles [1] as well as sterile neutrinos [2,3] both report negative results. Likewise, a search for WIMPs report a negative result [4].

A recent report [5] from the XENON collaborations claims to see an effect of solar axions. However, looking at their data we do not find it extremely significant and to our mind far from what would be required for such a conclusion. There is also a background caused by tritium that must be accounted for correctly.

As we explained above, we expect each species will contribute with the same amount of total mass due to the Heisenberg relation in the creation of the universe. It is the number of objects that differ. While time goes on this relation will change due to various interactions between the particles produced.

Charged particles will interact more frequently than neutral ones, especially than neutrinos. We would expect that the neutrinos will be the dominating species. Perhaps as much as 90% as we estimated in our first book.

In a report [6] it is claimed that gravitational lensing may be an effect of dark matter. As we explained we could expect neutrinos to gather up and give such an effect.

[1] Manuel Meyer et al, arXiv 2006.06722v2[astro-ph.HE]4 Aug 2020
[2] M.G. Aartsen et al, Physical review D102,052009 (2020)
[3] J.H. Choi et al, Physical review Letters 125,191801 (2020)
[4] A.Aguilar-Arevo et al., Physical review Letters 125,24803 (2020)
[5] E.April et al., Physical review D102,0720004 (2020)
[6] M. Menighetti et al., Mon. Not. R. Astron. Soc. 472,3177(2017)

3.3 Dark energy.

We delt with this subject already in our first book and concluded that it was an illusion. After that new data on super novae have become available [1]. These new data do not support an accelerating universe in variance with [2]. Before we found this out, we had already made a more thorough study of [2] and therefore we will present it below.

First, we would like to make a note on vacuum polarisation. It has been suggested that it could explain the phenomenon of Dark energy, the accelerating behaviour of the universe.

If vacuum is isotropic and homogenous it would have no effect on what is inside. This is lucky because otherwise the universe would have been ripped to pieces. This since the vacuum would be infinite and therefore would generate an infinite force.

However, the vacuum inside would counteract, i.e. it could make the universe shrink, not expand. Obviously, vacuum polarisation is not the answer. In our first book we in fact made the conclusion that dark energy most likely is an illusion.

In fig 3.1 we plot the speed of two examples of galaxies vs the distance as it would be seen from earth. We have assumed that all galaxies move with about the same speed as explained earlier. Two cases are shown including a straight line with slope 72. The calculation details are given in the appendix.

As we explained earlier, we do not see how distant galaxies moved just after the creation, but rather after a long time when they already have slowed down. As we see the galaxies that enter the Hubble plot did not drop more than about 1% in speed over the whole range.

They do not follow a straight line and the size of the deviation from the straight line depends on the speed. In both cases we note that even if they are moving with a constant speed the result will not be a straight line. It is a geometrical effect modified by relativistic effects. This is what was observed by [2].

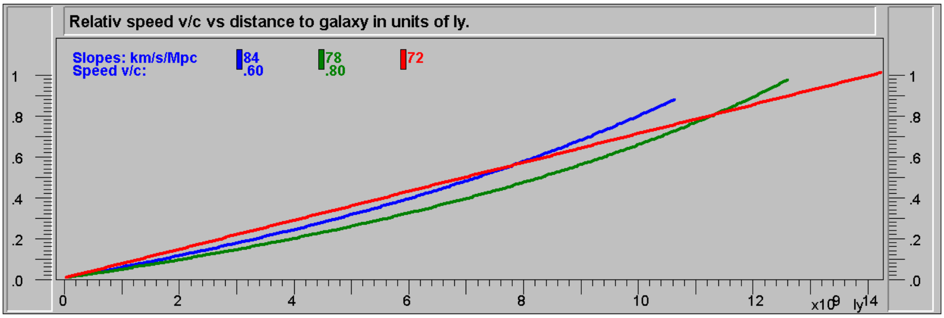

Fig 3.1. Two scenarios (blue and green) of the evolution of galaxies.

The red curve is just a line with slope 72 km/s/Mpc. The slope is taken between the end points. We will use an average speed of .7c in the following. We have investigated the effect of an accelerating universe by a simple simulation. We let the universe accelerate by 5%. The result is shown in Fig 3.2.

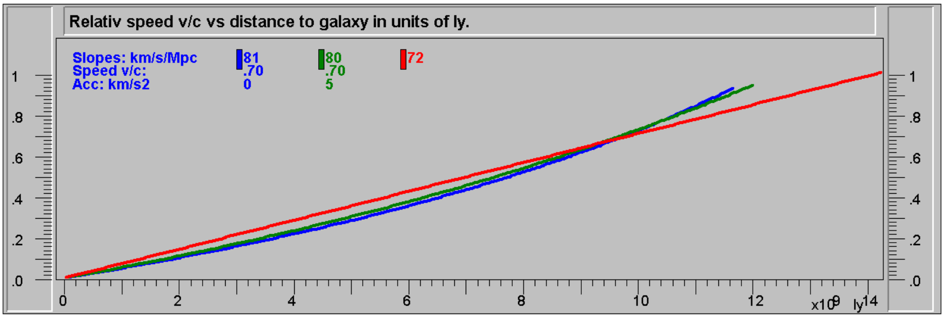

Fig 3.2. Two scenarios (blue and green) of the evolution of galaxies.

We have two curves, the blue one corresponds to galaxies moving outwards with a constant speed of .7c. This is the behaviour we found from our simulation. The green curve is the case when we also let them accelerate by 5%. We start off from .7c.

In the green case we see that the 5% acceleration did not change the curve much. To determine which case the observation follows would need an enormous accuracy which is not the case for [2].

What happens if we let the galaxies accelerate even more? We increased the acceleration to 15% and the result you find in Fig 3.3.

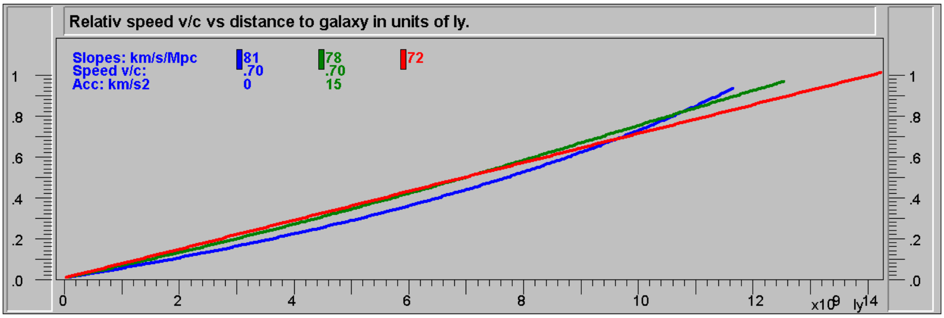

Fig 3.3. Two scenarios (blue and green) of the evolution of galaxies.

The green curve is approaching the red line. We as observer our now moving with a speed of .95c. The relative speed between us and the light emitting sender cannot be smaller than that irrespective of how fast the sender is moving. The conclusion then is that we should see no deviation from a straight line if the acceleration is large.

We show in Fig 3.4 the actual data [2] but turned into proper distances. We use their distance modules and formula.

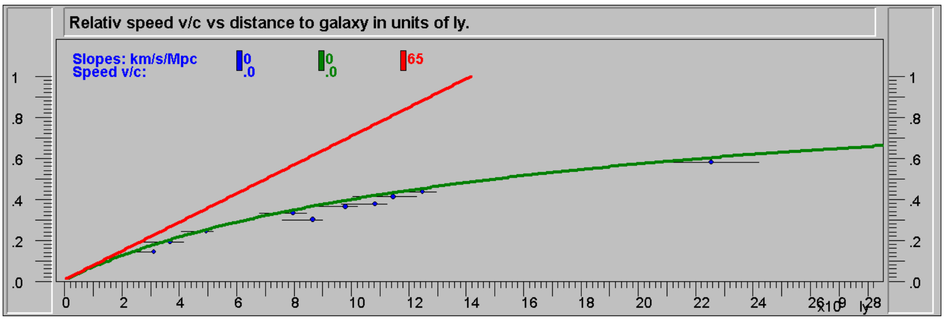

Fig 3.4. The evolution as found by [2]. The red curve is a line with slope 65.

The curve is a fit to a cosmological model which looks quite good. However, check out the distances. Everything to the right of the red line is impossible. How can a distance to a star be larger than the corresponding age of the universe? Obviously, they have not been able to estimate the effect of interstellar dust in a correct way. This is discussed by ref [1] where they in fact conclude that the new data, they present does not support an accelerating universe.

The other problem with ref [2] is that they compared to a questionable model. The curves we have presented are independent of any model. If we compare to our calculations it might look like Fig 3.5

Fig 3.5. The evolution as found by [2]. The red curve is a line with slope 65.

The curve does not quite fit, but the points at larger distances might have to be corrected for interstellar dust shifting them to the left. The nova at 23 Gly clearly indicates that. Let us shift the red line to a slope of 35, Fig 3.6.

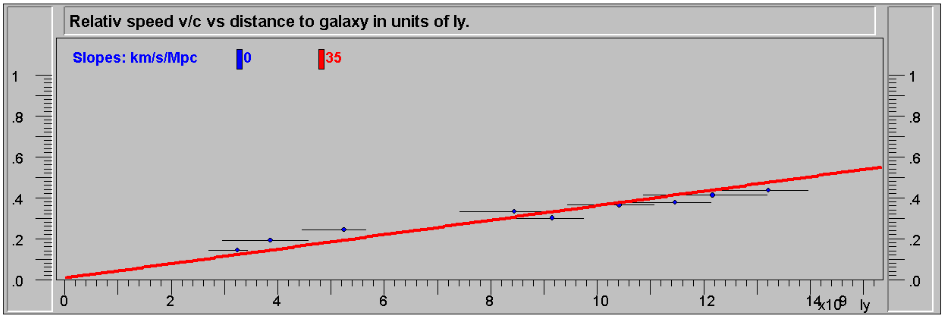

Fig 3.6. The evolution as found by [2]. The red curve is a line with slope 35.

That line seems to fit rather well to the data. The problem is that the slope corresponds to a universe of an age of 28 GYear. If a slope of 35 would be used in their fit, it would go completely wrong. We therefore can repeat our earlier finding.

Conclusion.

Dark energy is an illusion.

It may look like galaxies are more distant (slower) than expected, but they are in fact not.

In other words, we cannot make any conclusion of an accelerating expansion of the universe today. It did this in the past.

What would happen if the universe was decelerating instead? We first let it decelerate by 5%, Fig 3.7.

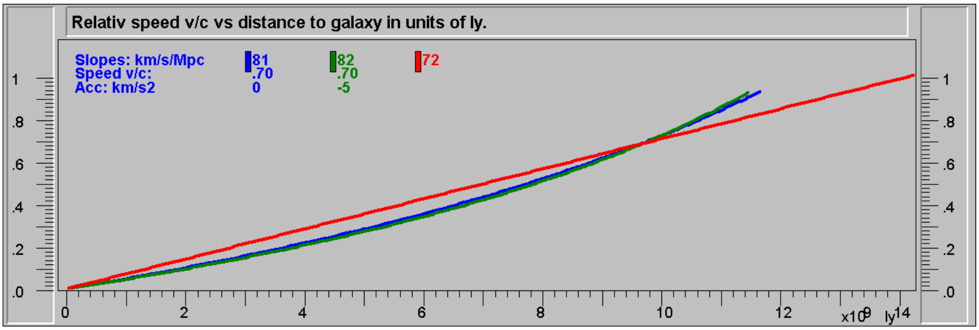

Fig 3.7. Two scenarios (blue and green) of the evolution of galaxies.

It almost looks like fig 3.2, with 5% acceleration. If we increase the deceleration to 15 %, we see a small difference between the curves.

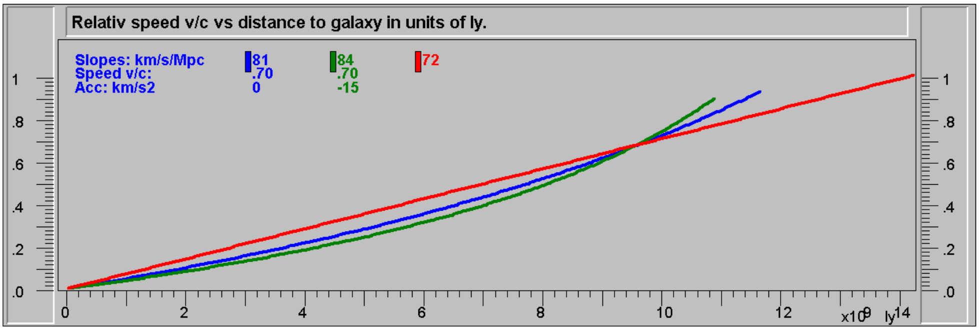

Fig 3.8. Two scenarios (blue and green) of the evolution of galaxies.

It would be hard to disentangle the curves. Also, if we choose another speed the curves will change. However, we might get a clue on how fast we are actually moving which would be a very exiting achievement. At present we know nothing.

In all cases, we would have to investigate the region of redshifts of 3 or more.

[1] J.T. Nielsen et al, arXiv:1506.01354v3 [astro-ph.CO] 17 Oct 2016
[2] Riess, A.G. et al., Astron. J 116, 1009(1998)

4. Summary part II.

We have shown how the most fundamental particles can be produced out of vacuum, through a fundamental quantum mechanical process, while fulfilling the conservation laws. As a biproduct, the process leads to deeply bound pairs of particle-antiparticles. The binding prevents them from annihilating. Just like atoms, but now on a different scale.

In our earlier book we showed how a universe can be build based on these processes. We especially noted that galaxies are formed with massive cores build from the bound pairs. The predicted masses of the cores fit well with present observations of black holes.

In this book we have augment that study with the formation of the halos of the galaxies as well as the creations of stars and planets. We note that the result is in good agreement with observations.

We have also discussed dark matter which we can explain as due to neutrinos which we found to dominate the universe. Lumps of neutrinos can give rise to lensing as has been observed.

This is the basis of what we call “the Freezening”, a new model of the creation process of our universe. It is important to note that this a physical description. It starts off from the production of real particles from which we build our universe.

In part III we will discuss how the three forces can come about.

Part III

The creation of the fundamental forces.

0. Preludes

In this part we will come back to our second book and explain the peculiar result we achieved. To do so we will first give a short review on the subject.

We have in part I given you the background of the creation of the fundamental particles. As you have seen we have assumed that they have a similar structure, namely that they are composed of electric and magnetic like components. We need this to create the fundamental particles through a quantum mechanical process (the balance act made this possible, chapter I.4).

If the forces have a similar structure the idea that they were generated by a fourth force came along. That one is the gravitational force. The gravitational force is needed to sustain global energy conservation and thus the most fundamental force.

Just imaging that a pair of electron-positrons are produced that annihilate right away. What would prevent the photons from just escaping thereby violating energy conservation? We need the gravitational force. It must always be erected when objects are created out of vacuum and we will next discuss what the consequences can be.

1. The mechanism.

In part I we presented a scenario of the creation of objects out of vacuum. We called them lumps of energy or energy lumps in short.

This led to the creation of e.g. electrons (/positrons) whose sizes we could determine by using the Dirac equation (the masses were then given by a simple picture of the particles in form of confined fields). Bound pairs of electrons and positrons were formed while another couple acquired enough energy to escape.

This time we are looking into the process that precedes the one where the particles are created. This means that we are investigating the mechanism that could determine which species of particles can be produced, i.e. protons, electrons, and neutrinos. Due to the assumption of an associated quantum number of unity (chapter I.3) we expect three forces. More specifically, we would like to calculate the strength of these forces. The elementary particles are created in the step that follows this initial process.

As we discussed in our earlier book the gravitational force must be erected when lumps of energy begin to form. This to fulfil global energy conservation. Thus, we will investigate the gravitational force by making the picture of two virtual gravitational structures (Gravs) that blow apart and investigate the quantum mechanical behaviour of such a system. A Grav is a gravitational object just like an electron is the fundamental object of electromagnetism. We investigated the possibility of gravitational structures in our first book but could not make any conclusions of their existence. We were lacking a needed constraint. In our second book we found such a candidate. A typical radius of such an object is $1.7\ 10^{-35}$ m and a mass of $1.9\ 10^{-8}$ kg.

The picture is that a gravitational field is erected and leads to three quantized states. In this field particles are formed accordingly and along the description we gave in our earlier book. The states we find we associate with the different forces. It is not the question of any bound states as in part I.

In part I, Fig 4.1 we showed how particles may be produced. A bubble explodes and a pair of particle-antiparticle flies away. However, the gravitational force will make sure that they return to fulfil global energy conservation. Upon return they might collide by another couple just opening in such a way that one pair acquire energy to escape the scene while the other pair gets trapped into a bound state like an atom.

We are thus investigating a linear problem and the procedure is that in this case we will use the Klein-Gordon equation implemented on a Coulomb like potential. The treatment is quite like the case in part I, namely we consider the size of the virtual objects. This led to correctional terms that modify the force. The procedure transforms the force into a nice function, i.e. no singularity at R=0. The details are described in the appendix.

The question is what masses these virtual Gravs must have or more correctly, what strength the gravitational force must have to be able to create the other forces. To cover all known forces the strength of the force must be at least as that of the strong force when the formation starts. This is our first assumption. We will mention below the consequences if we change that criteria.

2. The procedure.

As we did in our earlier investigation, we considered the size of objects. This leads to the calculation of correctional terms to be applied on a coulomb like force. The wave equation is simply modified with these terms so that it is applicable on sizeable objects and not just points. We use the same technic now with the difference that the objects just move longitudinal and not in a circular orbit. We give the details in the appendix. There will be one factor for the force and one for the potential. We have assumed that gravitational structures, Gravs, will have an "electrical" and "magnetic" component like the electron and a spin. Thus, there are four factors in all, but the electrical and magnetic components can be added up in their right proportions.

In fact, in our earlier book we assumed that the strong, the electromagnetic and the weak forces have a similar structure. We need this to have the gravitational force to give rise to the other forces.

We have two unknown parameters, namely the radius of the virtual object and its mass. From the solutions to the Dirac equation of a bound pair of the fundamental particles we found that the binding energy were a factor four times the mass. Due to the Lorentz factor this might change but the exact value is not important in the following. From expression 6.1.1 in part I the potential energy for two alike objects with one fix and the other circulating around is

$$U = GM^2 \Big/ [R * \sqrt{1 - v^2/c^2}]$$

This means that, using the binding energy $E_b=4Mc^2$, we have

$$M^2 / R \propto M \ ,$$

or:

$$M \propto R. \qquad (1)$$

We want to investigate the behaviour of the effective coupling. As seen, we expect it to be proportional to R^2 for a given binding energy. We therefore investigate the density $R^2\ \Psi\ \Psi^*$ as function of R. The Lorentz factor is implicitly included through the correctional factors as described in the appendix.

In the case of the strong coupling we would expect an object with mass and radius of order 10^{-8} Kg and 10^{-35} m, respectively. More specifically, we require that the construct

$$GM^2 \Big/ \sqrt{1 - v^2/c^2}$$

be equal to the strong coupling at R=0 (one object is at rest). We evaluate it from the calculation of the correctional factors, see Appendix. The parameters must be chosen so that they fit with the strong force. The correctional terms are then calculated according to that prescript and implemented into the wave equation.

To explain the procedure in more detail, we make an analogy with the hydrogen atom. We have a look at the third orbital state and plot the radial density in fig 2.1.

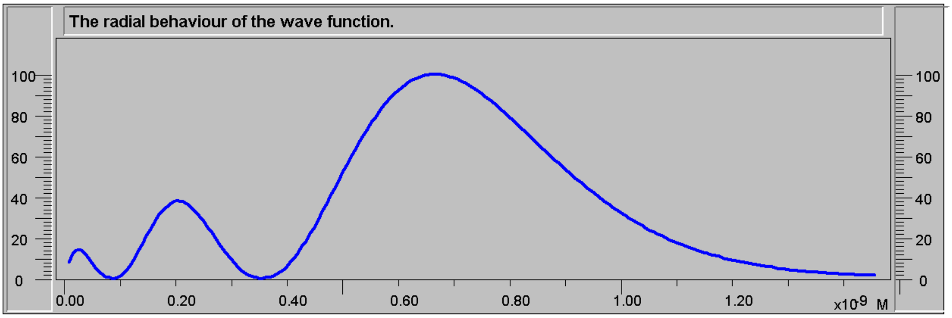

Fig 2.1. The probability density $R^2\ \Psi\ \Psi^*$ for the third orbital state of hydrogen.

As seen, there are three signals and not just one. What happens is that the electron in the third level has a probability to be found in the other levels. An electron could emit a photon spontaneously and drop down to a lower level. The probability for these transitions we find by first integrating the peaks and then take the square of these numbers. See any textbook on the subject, e.g. [1].

We show in fig 2.2a and 2.2b the radial distribution for the present case, again the third state. We see that we have three peaks corresponding to the three states. We divided them into two regions in R due to the enormous span of magnitudes of the peaks.

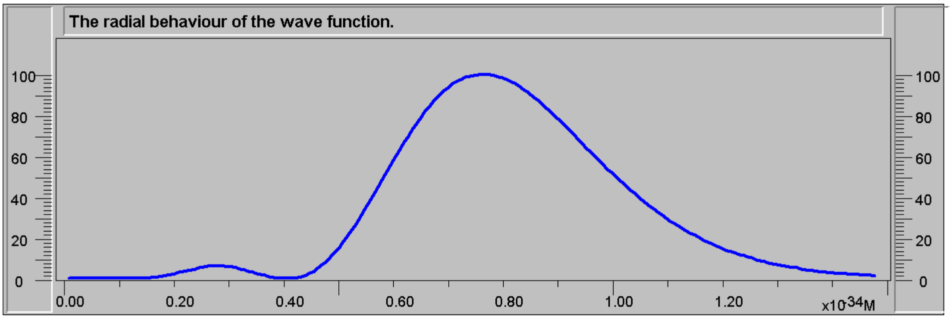

Fig 2.2a. The probability density $R^2\ \Psi\ \Psi^*$.

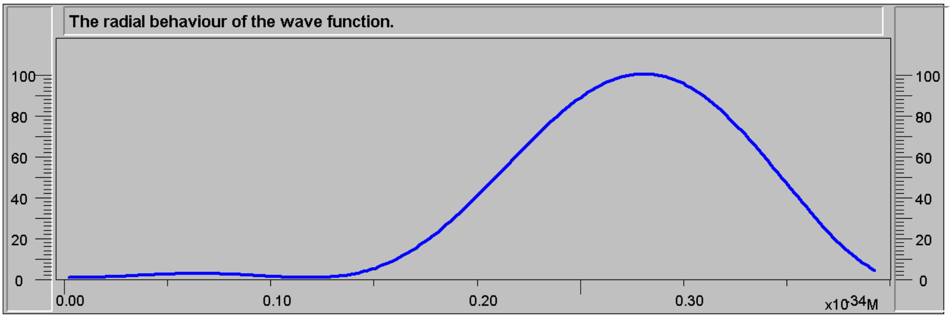

Fig 2.2b. The probability density $R^2\ \Psi\ \Psi^*$, but for lower R.

As you see it looks quite like the hydrogen case, except for the magnitude of the peaks. Their relative sizes differ quite substantially.

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However, we cannot directly compare the hydrogen case with the present case since we are not dealing with bound objects circulating around each other. We are instead investigating the behaviour when we drag apart two virtual objects. What we can do is to read off the probability to find the virtual objects in the various states just as in the atomic case.

In doing so we note that the peak at the largest R corresponds to a larger energy and therefore to a stronger force which we take to represent the strong force. We need more energy and a stronger force to drag them further apart. This means that we can investigate transitions to the other states with other energies. The middle one would then correspond to the electromagnetic force while the one at the smallest R represents the weak force. This is our hypothesis, and the outcome of the calculations will show whether this is reasonable.

If you are still in the atomic world one would expect a larger R to correspond to less energy. However, in our case you should rather think of a spring or rubber band that is being stretched, the more the more energy needed.

We integrate the peaks and take the square of these numbers which gives us the probability. We compare them by dividing the two larger peaks and the two smaller ones. The result are two fractions which we compare to the ratio of the strong over the electromagnetic couplings respectively the electromagnetic over the weak. It turns out that the fractions come close to the expected ratios.

However, the parameters are not completely fixed by this procedure why we need another constraint. We have investigated this in two ways. If the virtual objects become real, we can require that we achieve a good solution to the Dirac equation. This means that the presumed gravitational structures, Gravs, should give a reasonable solution just as is the case for the standard elementary particles. It turns out that our precision is not good enough to make any definite conclusions. The reason for this is that the energy is exceptionally large which means we are close to the classical limit with weak, broad signals. In any case we noted in our earlier book that the wave equation is not very selective in this case.

Another way would be to simply require that the electromagnetic to weak ratio comes out as expected. We only need a smaller adjustment to achieve this. We would like to find some way to relax this criterion. It turns out this can be achieved but in a very unexpected way.

The spin of the virtual Grav is determined in the same way as we did for the other elementary particles, namely a point on the boarder is set to the velocity as given from a trapped, bound couple. In the case of the other forces the velocity of the boarder corresponds to a Lorentz factor of 3. We now see that we might expect a somewhat larger value as indicated by the solutions to the Dirac equation. But, as noted, we cannot give a definite answer, so have investigated two cases (3 and 4) to be able to see if there is any difference in the result. We discussed this in our earlier book, and we will here just note that we find no difference. Spinless objects were however excluded.

The procedure is to choose a combination of R and M that gives rise to a certain value of the strong coupling G_Y (defined in Appendix I.2) and a certain value of the strong to electromagnetic ratio. We choose R and M such that the second ratio, the electromagnetic to weak, comes out as well as possible.

[1] Eugen Merzbacher, quantum mechanics, John Wiley & sons, Inc, 1961

3.Results.

We solve the Klein-Gordon equation for the case of dragging apart two sizeable virtual objects to investigate the effective coupling. We thereby account for the correctional factors as explained in the appendix. As we did in our first book, we do an energy scan to find signals. This means that we calculate the behaviour of the wave function as function of the radial distance R and investigate how it varies with energy. More precisely we investigate how the tail behaves by taking a sample of it at large R and plot that quantity. Instead of peaks we are looking for dips. The wave function should tend to zero with increasing R if there is a good solution. We show in fig 3.1 how it can look like. As expected, the outcome will be a series of signals. The requirement of a quantum number of one will limit it to the three highest ones.

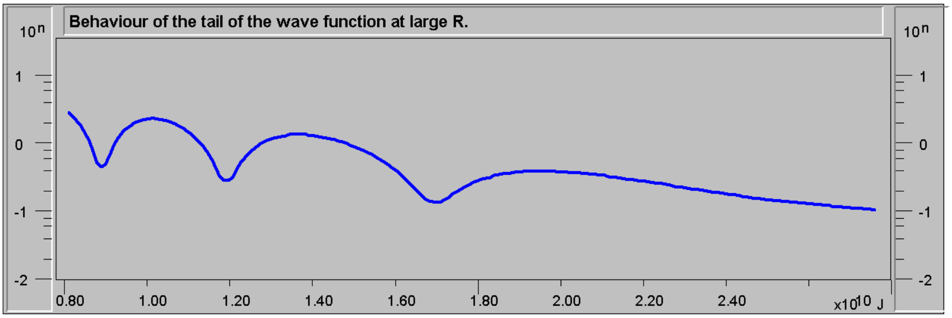

Fig 3.1. The behaviour as a function of the binding energy in units of joule.

Compare this to fig 4.6, part I, where we plotted the binding energy for the case of the electron and please note the difference in the scale of the energy. The signals are now much wider and the background level larger. If we just zoom in on them, the distribution in R looks quite reasonable but still not as nice as in fig 2.2. That one was taken at lower energy where background is smaller. The largest peak is affected by the background which leads to a subtraction method which we describe in the appendix.

For every chosen combination of R and M we get a value for the Yukawa coupling G_Y. We plot the square root of the calculated ratio of the strong to electromagnetic couplings normalized to the expected ratio of the couplings. In doing so we have chosen the parameters so that the electromagnetic to weak ratio comes out correctly, but we are dealing with small adjustments (< 5%). The reason for taking the root is just historical. It gives numbers of the order

50-100 for the values of the ratios which are a bit easier to handle. The visualization also is improved as seen from fig 2 where the result is presented. The region below the line in fig 2 is easier to disentangle.

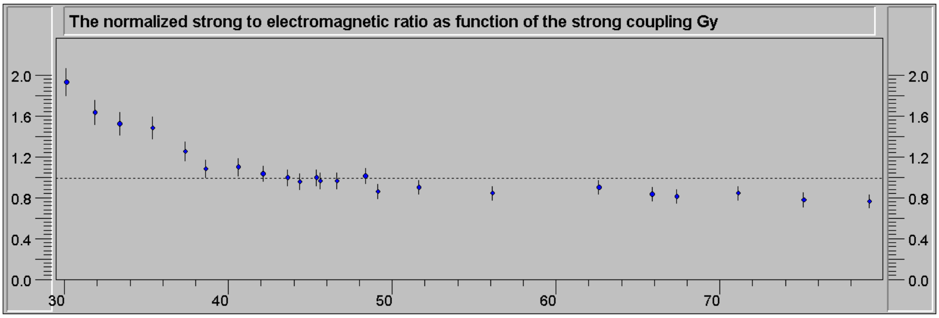

Fig 3.2. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio.

The ratio shown in fig 2 is expected to be one. This is shown by the dotted line. As seen, we have a distribution that first drops off rather quickly but more gently after the cross over. For values of the Yukawa coupling G_Y less than about 30 the curve blows up above 2.

We see that when the strong coupling is about 44 the calculated value agrees with the expected one, Table 3.1 (by eye, we have not tried any fit since we do not know what the behaviour should be). In the cross over region the electromagnetic to weak ratio comes out to the expected value.

We discuss in the appendix the procedure to extract the values shown. It involves corrections due to background. Such corrections are larger for smaller values of G_Y but drops to essentially zero at the largest values. The electromagnetic to weak ratio cannot be kept quite at its expected value for larger values of G_Y which leads to corrections that works the other way around (< 5%). We give the details in the Appendix, but we show in fig 3.3 how the electromagnetic to weak ratio comes out.

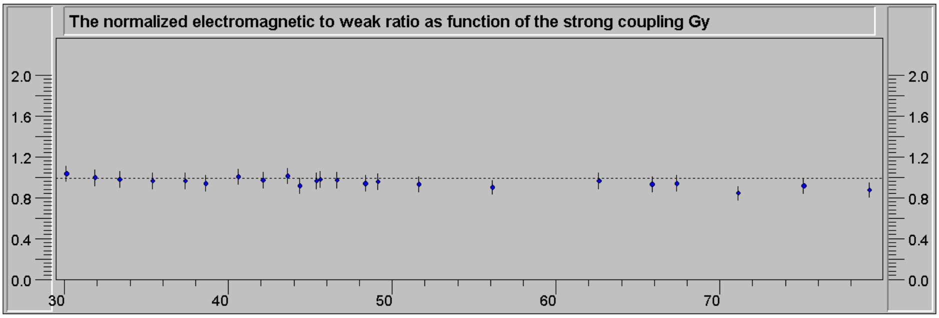

Fig 3.3. The root of the ratio of the electromagnetic to weak coupling divided by the expected ratio.

At the cross over the gravitational object comes out to approximately a mass of $1.9*10^{-8}$ kg and a radius of $1.7*10^{-35}$ m. This is remarkably close to the Planck scale. We see that the signals are becoming quite wide when we come up in energy as expected. We are approaching the regime of classical physics. We could mention that if we use the radius and mass of a Planck object, the Yukawa coupling G_Y would come out to 90.

To confirm are model an experimental finding of such kind of objects would be welcome. In our earlier book we discussed a possible experimental setup.

It is interesting to note that since we have one unique solution for the value of G_Y we can in principle determine the electromagnetic coupling and hence the weak coupling absolutely. However, the result depends on the ratio of the electromagnetic and weak coupling constants although not much. If that ratio is different the curve will shift a bit to the right or the left. Perhaps a unit or two. We need another piece of information which we will discuss below.

We summarize the result in the following table where we compare to the expected ratios of the known values. The expected value of G_Y we have estimated from [1] at the threshold for nucleon production. The energy dependence is quite strong in this region which makes the expected value a bit difficult to determine.

Table 3.1

Relative probabilities	calculated	expected
Yukawa coupling G_Y	44±3	38-43
Ratio of strong to electromagnetic	$5.6\pm.3*10^3$	$5.48*10^3$
Ratio of electromagnetic to weak	$1.09\pm.04*10^4$	$1.117*10^4$

This result is a bit surprising. The values fit quite well with expectations. Nothing says that this should be possible at all. We should clarify that we have two parameters, R and M which we could let vary to adjust the electromagnetic to weak ratio to come out approximately right. We note that the effect of that adjustment is at most 5%, essentially at larger G_Y.

The question is whether this is just a coincidence or not. We have three numbers, quite different, that fit. What is the likelihood for that? It raises a lot of questions. If we use the distribution in R in the case of the hydrogen atom, the ratios come out about a factor 100 times smaller. If we instead start off from the strong force directly the result comes out about a factor two wrong. If we on the other hand would use the Newton formulation of the gravitational force, we again find the result goes wrong by a similar amount.

[1] The H1 and ZEUS Collaboration, V. Radescu, HERA Precision Measurements and Impact for LHC Predictions, arXiv:1107.4193 [hep-ex].

4. The dependence of the value of gravitational constant.

What would happen if we changed the value of the gravitational constant? If we lower it, we must compensate by larger masses to come back to the original situation (the requirement on the coupling at R=0). If we increase it we must go the opposite way, lower the mass. If we make it four times stronger, we need to decrease M by a factor of 2 but also to increase R by the same factor (due to the Lorentz factor). If we instead look at G/4, then M is increased by a factor 2 while the radius is decreased by the same factor.

We tried out various scaling factors but will here just show how it looks for a selected value, namely a factor two. In doing so we have to make minor modifications of R and M to make the electromagnetic to weak ratio come out correctly just as before. The requirement that the force at R=0 should be equal to the strong force is always required to be fulfilled. We show in fig 1 and 2 the results for two cases, G*2 respectively G/2.

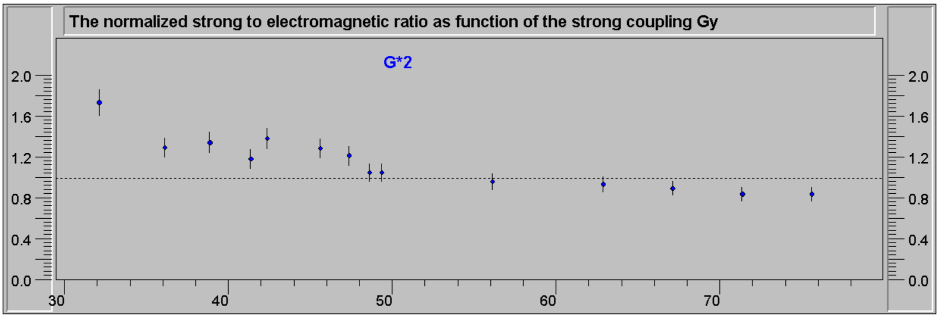

Fig 4.1. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio with twice the gravitational constant.

This looks much the same as in fig 3.2 with the nominal value of the gravitational constant. However, the cross over point clearly shifts upwards. Exactly how this comes about we will explain in the next chapter. However, we noted earlier that we need a somewhat larger mass at smaller values of the Yukawa coupling G_Y than at larger values. This to avoid a too large value of the electromagnetic over weak ratio in the lower region. Since the mass now is smaller by a factor √2 this might be the cause. All points would in fact move up a bit, especially at lower G_Y, but perhaps not as much as in fig. 4.1.

If we on the other hand, make the gravitational constant smaller we need a larger mass. By the same argument we would expect the curve to shift down, fig 4.2.

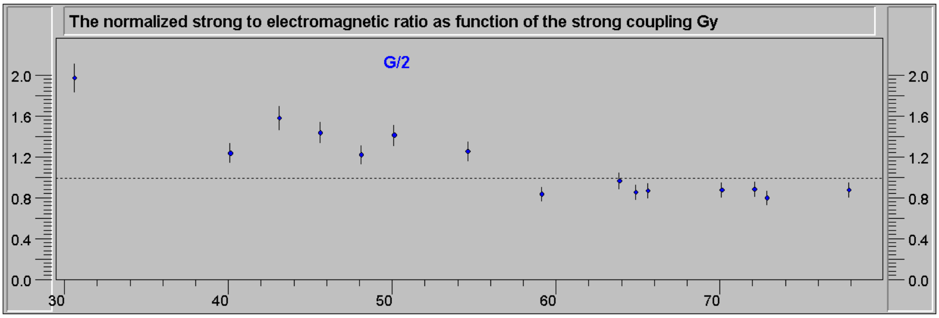

Fig 4.2. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio with half the gravitational constant.

Instead, it again shifts upwards. This means that the explanation we just tried is not the answer. The mass now is larger by a factor √2. We got a bit puzzled when we saw the result. Furthermore, we note that the shift is in fact about the same.

We repeated the calculations scaling the gravitational constant with different factors. The results are summarized in the following plot where we show the Yukawa coupling G_Y at the cross over point for the various values of the gravitational constant G.

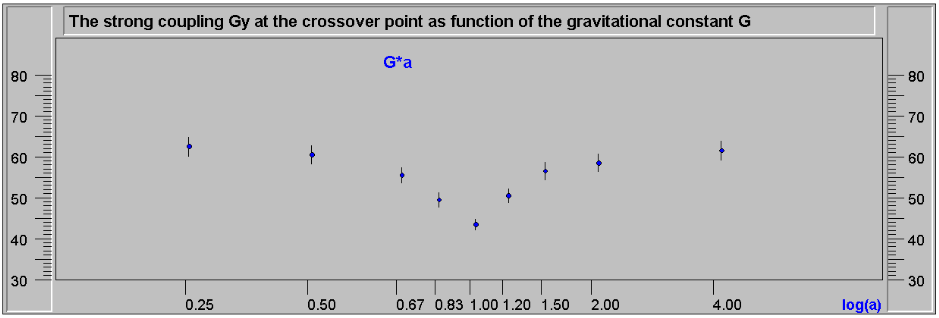

Fig 4.3. Yukawa coupling G_Y at the cross over point for various values of the gravitational constant. The abscissa is the log of the scaling factor.

It looks like we have a minimum at the nominal value of the gravitational constant. The shape of the curve does not look like a normal minimum with a rounded off dip. It rather looks like the behaviour of the solutions to the wave equation with the dips in the energy distributions. The question we asked ourselves if the behaviour in fig 4.3 represents the solution to the wave equation but for a potential representing the combined effect of correlated gravitational and strong forces.

The points entering the plot represent the summary of a lot of solutions to the wave equation as function of G_Y as well as function of the gravitational constant G. This means that we are dealing with a two-dimensional potential. Exactly how to interpret the potential and how to understand the mechanism behind it, is not easily deduced.

Conclusion.

Our result indicates that the strong force exhibits a minimum at the present value of the gravitational constant.

This is quite a remarkable result. We have checked our procedure very carefully, but we find no obvious reason for this behaviour. Before we found this out, we thought that we just would get a curve with some slope as function of G. In our earlier book we could give no good explanation for the observed behaviour. However, we can now explain it in the next chapter.

It is not easy to understand why the outcome is much the same on both sides. We can see what happens due to changes of R and M, but to see how it affects the distribution in R is much more difficult. We also have the Lorentz factor that changes at the same time making things more difficult.

We could turn the arguments around. If the minimum is the right answer, we can determine not only the gravitational constant but also the others.

Conclusion.

If the minimum is the right answer, we can determine the couplings of all the four forces absolutely.

Indeed, a remarkable finding.

5. Understanding the dependence of the value of gravitational constant.

5.1 Starting off from another value of gravitational constant.

We earlier found a very symmetric behaviour when we scaled the gravitational constant by some factor a, fig 4.3. G*a and G/a comes out the same. For a given factor a, we must scale M down with a sqrt(a) in the first case but scale it up for the second case. The radius R_0 is likewise scaled but in the opposite way. The first thing we noted is that the kinematics comes out the same for both sides which leads to the same values for the correctional terms. When we compare the distributions, we find them to be identical.

We did not notice this before because the calculations of the correctional terms were not made at the cross over points but spread out.

When we solve the wave equation, we in fact do it for two different sets of R_0/M. Despite that the crossover comes out the same. When we look at the distributions of R, they are quite different, but the ratios still come out the same.

We will now have a look on this but from another starting point. We assume another value of the gravitational constant and then follow the same procedure as before. More precisely we define $G'=1.00*10^{-10}$ and use that in the following. This is just G*1.5, one of the values we checked out earlier.

If we plot G' as function of G_Y we would naturally expect it to come out the same as G*1.5. This is also the case. The correctional terms will be the same and we can use the same values of M an R_0. If we take G'/1.5 we would expect it to be the same as G*1, fig 3.2. If we continue with other factors, we will arrive at new distributions as function of G_Y.

If we summarize, we get the following distribution as function of the parameter a.

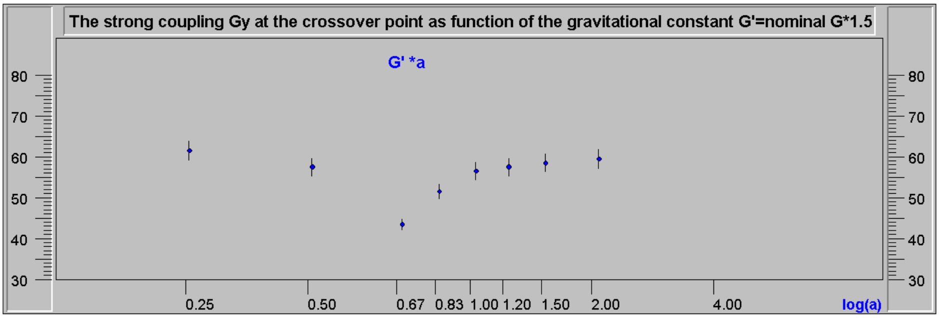

Fig 5.1. Yukawa coupling G_Y at the cross over point for various values of the gravitational constant G'= nominal G*1.5. The abscissa is the log of the scaling factor.

As seen, it looks about the same as before but with the major difference that the minimum is not any longer at the nominal value of G' (a=1). G_Y is instead about 57 at a=1, clearly larger than the expected value in Table 3.1.

If we instead start off from G'=G/1.5 we again get a similar distribution but now shifted the other way around, i.e. reflected through the line a=1. In doing so we just used the values in Fig 4.3 (they are tabulated in our earlier book) and made interpolation between the various values of a. Off course we checked out a few points to be sure we did not miss something.

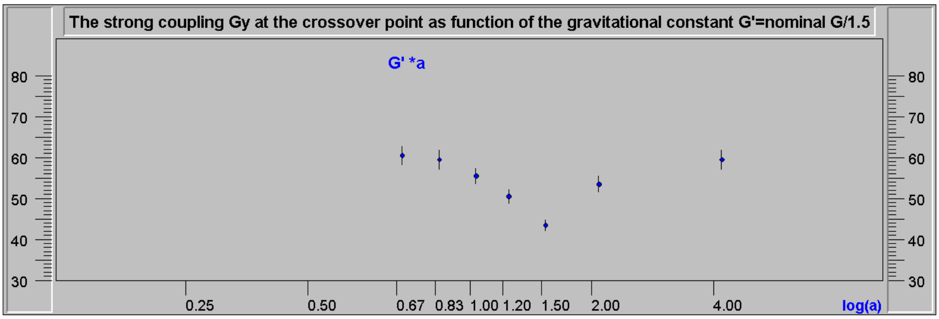

Fig 5.2. Yukawa coupling G_Y at the cross over point for various values of the gravitational constant G'= nominal G/1.5. The abscissa is the log of the scaling factor.

At nominal G', i.e. a=1, we find G_Y=56 this time, again clearly larger than the expected value of 44, Table 3.1.

The conclusion of all this is that the present value of the gravitational constant is special. Only when we start off from the present value of the constant, we find a minimum at the value we started from. And a result for G_Y that fits with expectations.

Conclusion.

The value of the gravitational constant is determined by the quantization of the gravitational force.

For comparison we could mention that in our first book we could determine the value of the elementary charge of the electron through another quantum mechanical process. That process allowed the calculation of the size of the fundamental elementary particles and hence of their masses. In the next section we present an explanation of the symmetric behaviour we just have seen.

5.2 Explaining the behaviour of a varying gravitational constant.

As we have seen when vary the value of the gravitational constant a nice behaviour turns up, Fig 4.3. We see a quite symmetric behaviour with the strong coupling having a minimum right at the present value of the gravitational constant.

When we wrote our last book, we just could not understand how this came about. We have now had a closer look and starts to understand the mechanism behind it. First, we checked out the symmetric behaviour by looking at a given scale factor and investigate the correctional terms.

When we look at e.g. a scale factor of 2 we note that the kinematics come out the same for the two cases (G*2 and G/2) at the cross over point for the respective case. Originally, we just took random values of the Yakawa coupling along the curves. Since the values of R_0 and M vary along the curve we just missed the cross over.

The potential energy for two alike objects is given by

$$U = GM^2 \Big/ [R * \sqrt{1 - v^2/c^2}\,].$$

If we replace G, M and R by G*4, M/2 and R*2 to compensate for the changed Lorentz factor the potential energy comes out the same. This leads to the same correctional term. If we parametrize the correctional term for G*2 and compare to the one for G/2 they are in practise the same. This only partly explains the symmetry.

However, solving the wave equation with two different sets of values of R and M but with the same correctional factors and still getting the same answer is not quite easy to figure out. The solution follows from the observation that the larger peak in both distributions come out at $R=R_0$. If we instead present the R-dependence as function of R/R_0 we arrive at two more or less identical distributions. These means that the two ratios will be the same.

5.3 The exchange mechanism of the forces.

We have so far not discussed how we can get a clue on the mediators of the forces. We found that when calculating the spin G factor for the elementary particles the neutrino deviated from 2. The others came out just as expected.

From what we could understand it was the noticeably short Compton length that gave rise to this effect in some way. We investigated what would happen if the exchange is due to weak photon instead of a heavy W/Z. As explained in appendix the weight factor leads to an overall normalisation of $(1+R_0/L)\ e^{-R0/L}$ =.00012341 (R_0/L=9 from what we found) of the effective coupling. R_0 is the radius and L the Compton wavelength of the mediator. We will need that to keep the mass unchanged. A factor $10/M_z^2$ =.00012346 (M_z =90GeV) would be just right. If R_0=0, i.e. a point like particle, there will be no such effect.

Thus, changing the mass of the mediator results in a change of the coupling. Since we have determined the magnitude of the couplings in chapter 4 everything is now fixed. In our first book we arrived at the correct masses of the elementary particles assuming the known mediators. This means that we know what kind of objects (as given by their masses) are mediating the various forces. Why the forces behave like they do is a question we see no answer to. We can only conclude that we have a consistent picture.

6. The dependence of the value of the Planck constant.

The question we asked ourselves is whether a variation of the Planck constant would behave similar as with the variation of the gravitational constant. We have seen how things behave when we let the gravitational constant vary. We asked the question what would happen if we instead let the value of the Planck constant change. The procedure is the same as before, we investigate various values of the strong coupling constant and plot the strong to electromagnetic couplings.

In chapter 4 we showed what happens when G is dived or multiplied by a factor 2. If we perform the same operation with the Planck constant h will we see a similar behaviour? Dividing h by 2 gives the result in Fig 6.1.

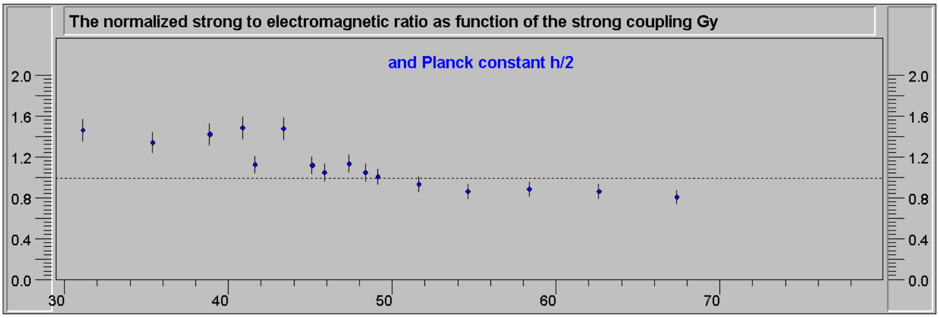

Fig 6.1. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio with the Planck constant divided by 2.

We do get similar curves as before, but they are not identical. Compare to fig 4.2 with G/2. As seen, we have a crossover around G_Y=51 i.e. shifted down a bit as for the G/2 case. The cross over comes out higher as compared to the nominal case of G, Fig 3.2.

A major problem is however that the electromagnetic to weak ratio comes out much too low over the whole region, Fig 6.2. At lower values of G_Y (< 30) it comes up a bit but still too low. The other ratio is instead a factor 2 too large in this range. The conclusion is then that if the Planck constant would have been different, our prediction would go wrong.

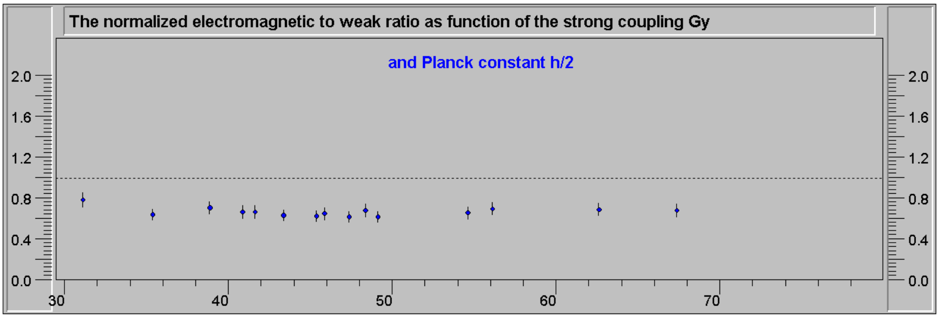

Fig 6.2. The root of the ratio of the electromagnetic to weak coupling divided by the expected ratio.

If we instead make the Planck coupling a factor two stronger, we get the result shown in Fig 6.3.

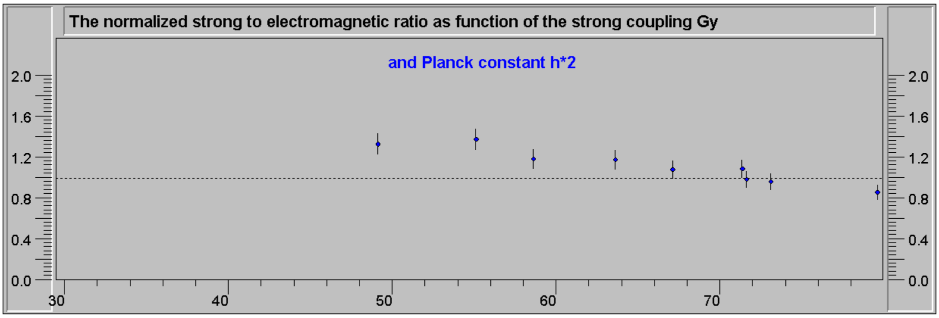

Fig 6.3. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio with the Planck constant multiplied by 2.

In this case we have difficulties getting any result at all out of the wave equation for smaller values of G_Y. The cross over comes out higher than the corresponding case of G*2, fig 4.1. However, the electromagnetic to weak ratio comes out better, but perhaps slightly high in the cross over region, Fig6. 4. Whatever we do, we cannot get it to come out quite right in neither case.

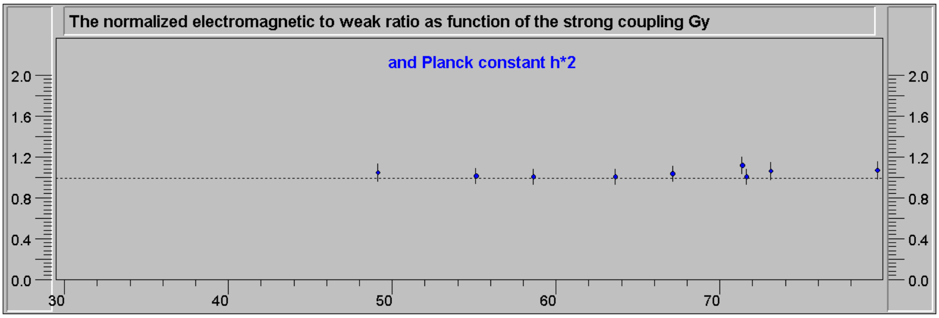

Fig 6.4. The root of the ratio of the electromagnetic to weak coupling divided by the expected ratio.

If we compare to the cases where we multiplied respectively divided the gravitational constant by a factor, we see a major difference. In that case the curves were both shifted upwards in about equal amounts.

If we use a smaller scaling factor the shift of the crossover point will be reduced and the electromagnetic to weak ratio comes out better just as we would expect. We summarize the results of various factors and arrive at a plot like Fig. 4.3, Fig 6.9.

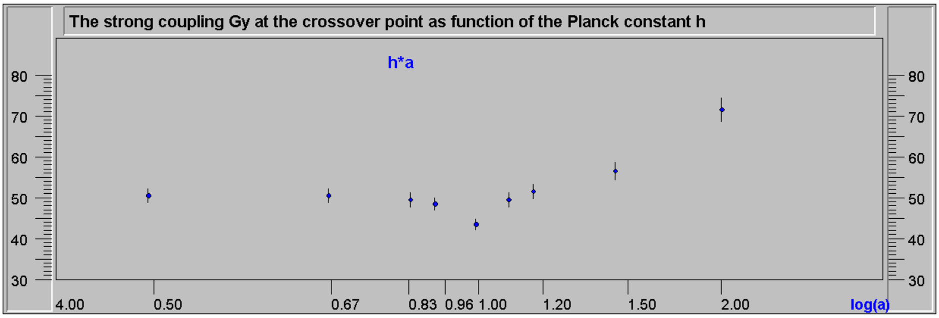

Fig 6.9. Yukawa coupling G_Y at the cross over point for various values of the Planck constant h. The abscissa is the log of the scaling factor.

We get a minimum right at the nominal value of the Planck constant just like we got a minimum right at the nominal value of the gravitational constant when we let that vary. As we have seen, scaling the Planck constant by some factor is not quite the same as with the gravitational constant. The difference is that it is not as symmetric this time. We also note that the electromagnetic to weak ratio will be offset from the expected value for scaling factors different from 1. We plot the values in the following table as well.

Table 4.1

h*a	Yukawa coupling G_Y at crossover
1/2	51
1/1.5	53
1/1.2	50
1/1.1	49
*1	44
*1.1	51
*1.2	52
*1.5	58
*2	70

To remind you, the crossover point is the point where the calculated value of the strong to electromagnetic ratio fits with the expected value. What we can conclude is that with a different value of the Planck constant, the predictions of the couplings would go wrong.

Conclusion.

Our result indicates that the strong force exhibits a minimum at the present value of the Planck constant.

We could now very well turn the argumentation the other way around. If our hypothesis that the gravitational force can give rise to the other forces is correct, then we could conclude that we not only can determine the couplings of the forces, but also the value of the Planck constant. Off course, the value of the latter is not overwhelmingly well determined.

Conclusion.

If the minimum is the right answer, we can determine the Planck constant.

There is another way to look on this. What would happen if we e.g. divide the Planck constant with say 1.5 and instead let the gravitational constant vary. The result you see in the next figure.

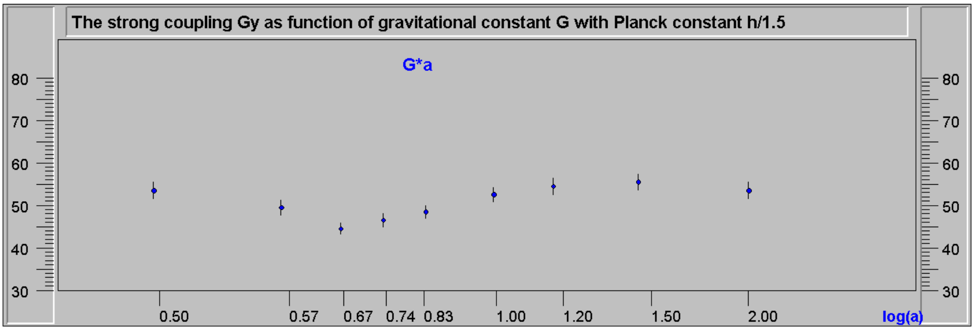

Fig 6.10. Yukawa coupling G_Y at the cross over point for various values of the gravitational constant G given the Planck constant divided by 1.5. The abscissa is the log of the scaling factor.

Compared to fig 4.3 we see that the minimum now has shifted down to G/1.5 about. It in fact looks like fig 5.1 when we started off from a new nominal value of G of G/1.5. We note that the distribution of points flattens out, so it is a bit different. However, it is obvious that a shift in the Planck constant h leads to a corresponding shift of the gravitational constant G.

Obviously, we observe a clear correlation between the two constants. That will also mean that the Planck constant is correlated with the magnitude of the couplings of all the four forces. This follows since we have demonstrated the correlation between the gravitational force and the other forces in our earlier book.

The photoelectric effect once demonstrated that the Planck constant is the result of the quantisation of the atoms. As we concluded in chapter 5.3 the gravitational constant is the outcome of another quantisation process, namely that of the gravitational force. We have now found that they are intimately correlated.

One may now ask the question what will happen to the energy levels of the atoms. Let us have a look at the hydrogen atom. For states with the orbital quantum number being zero we have

$$E = m_e \left[\frac{e^2}{4\pi\varepsilon_0}\right]^2 \frac{1}{\hbar^2 n^2} \quad (1)$$

Obviously, the energy levels will change if h is changed. However, we have just seen that the gravitational constant changes if we change the Planck constant. The change of the former might affect the strong to electromagnetic ratio. To investigate this we plot the dependence of the ratio as a function of the strong coupling G_y , Fig 6.11.

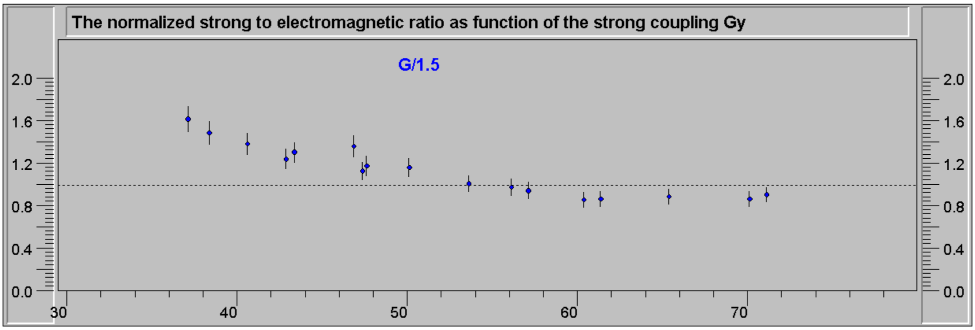

Fig 6.11. The root of the ratio of the strong to electromagnetic coupling divided by the expected ratio with the gravitational constant divided by 1.5.

If we read off the strong to electromagnetic ratio at G_y =44, the value at the minimum, we find it to be about 1.28±.03 and not 1. This means that the electromagnetic coupling will be reduced. One could think that the mass of the electron will change as well. In chapter 1, part I we determined it by solving the Dirac equation for a bound electron/positron pair. We found (Appendix 1.7, part I)

$$m = \frac{e^2}{4\pi\varepsilon_0 4R_0 c^2} \quad (2)$$

, where R_0 is the radius of the electron. The radius does not change with the Planck constant since it in principle is determined by the correctional factors (leading to a well-defined minimum in the potential). If we insert (2) in (1) we get

$$E = \left[\frac{e^2}{4\pi\varepsilon_0}\right]^3 \frac{1}{4c^2 R_0\, \hbar^2 n^2} \quad (3)$$

Dividing e^2 by 1.28 squared and h by 1.5 we find that E turns into

E'=E*(.52±.03).

The energy drops by a factor 2 about instead of increasing by 2.25 (1.5^2) as we would expect. A bit surprising perhaps. It is interesting to note that it is the behaviour of the gravitational constant that causes this effect.

What would happen if we instead turn to the corresponding case with h*1.5? It turns out to be completely different. There is only a small indication of a minimum around G*1.5. Having noted earlier that changing h is not as symmetric as changing G this is perhaps no surprise. However, looking at the behaviour of G*1.5 at the minimum, we now see that the strong to electromagnetic ratio drops down below 1. Reading it off and repeating the exercise above it now instead leads to a shift downwards in energy of roughly a factor 1.2 instead of a decrease by 2.25.

As we noted earlier, we have a clear correlation between the two constants, but at the same time the relation is obviously quite complicated. In our last book we discussed the effect of a different value of the gravitational constant. The question how it might change the evolution of the universe remains to be studied. After a first glance we realised that it is perhaps even more complicated, so we decided to postpone it to the future.

7. Determining our universe.

We must emphasis the profound meaning of our findings. We have seen how the gravitational force can give rise to the other forces. This means that we determine the magnitude of their couplings. We have demonstrated the correlation between the Planck constant and the gravitational one. This leads to the following

Conclusion.

The gravitational constant is the most fundamental one of them all. That constant is the outcome of a quantum mechanical process. It determines all we need to know to create our world and the universe.

8. Summary I-III.

We have in our earlier book shown how the elementary particles can be created out of vacuum without breaking the standard conservation laws. The consequence of that process is that two pairs of deeply bound particle-antiparticles are created to match the released energy while energetic particles escape. A second consequence is that due to particles now being built by confined fields, the Newton gravitational law must be reformulated. In this new form various predictions come out quite right.

This is the basis of what we call “the Freezening”, a new model of the creation process of our universe. It leads to galaxies having a massive core in its centre. We note that the predicted masses of cores fit well with present observations of black holes in the centre of the galaxies. The halo of the galaxies also come out in agreement with observations both concerning size and mass. The same holds for the stars and planets that we simulate.

In recent years reports on searches for various kinds of exotic particles have come forward. All of them with negative results. Our own candidate, the neutrino, now boils up as the most likely candidate. As we have found it should be the dominating species in the universe. We can expect that lumps of them may be formed giving rise to lensing. This is exactly what has recently been reported.

We made the hypothesis that the gravitational force was the generator of the three species of fundamental particles. It is the most fundamental force of them all and must always be erected. We have now shown how this can come about. This means that we can predict the magnitude of the couplings of the other forces.

If we let the value of the gravitational constant vary, we find that the strong force exhibits a minimum right at the present value of the gravitational constant. This is a quite remarkable finding. This means that we can deduce the couplings of all the four forces. Likewise, the gravitational constant also determines the Planck constant. This means that the gravitational constant is the most important one of them all. It is the only one we need to construct our universe.

In all we have a consistent physical picture of how nature can create a universe with the known fundamental particles and their corresponding forces.

9. Short history.

We just would like to mention something about the history behind this work and our earlier.

The original idea came about 45 years ago at the time the author was working for his theses in particle physics. It all started with the question why quarks, the really hot stuff then, were not seen. Later some clever guy stated that they were only asymptotically free. Nice fix.

However, it led to the question whether quantum mechanics could explain it in some way. Consequently, that led to the question how particles can be created and how a universe could be formed. At that time, we were too busy with the daily stuff so that it was forgotten. Until about 15 years ago when it popped up again.

Lastly, we just like to note that the author has a long experience of working with and constructing simulations of e.g. large detector systems (NA4, ARGUS and a proposal for a detector at HERA).

Appendix part I.

1.The electromagnetic force.

1.1 Preparing the wave equation.

Wave equations only holds for point like objects. To set up a wave equation for composite bodies is most likely an endless story. We could divide a body into a million pieces and construct a million equations coupled in some complicated way. However, how to solve them? We will take another approach.

What we do is to find a correction to the Coulomb potential to mimic points. I.e. with a modified potential we can use the Dirac equation to solve the problem for two big balls. The correction is determined by calculating the resulting force starting from some assumed distribution of points. Since we do not know that distribution, we have investigated various scenarios. If the density of points goes as the inverse of the radial distance, the produced electrical field will be constant with R inside the object. This is the hypothesis we will begin with.

The normal procedure to solve equations like this is to let one object be at rest and the other circulating around with its reduced mass. This means that the actual calculation we perform starts off by looking at the field produced by the one at the centre. Shortly, we can treat it as build up by current tubes that produce an electric field as well as a magnetic one. We separate these contributions in order get a better understanding of how things work. This also gives us a better chance to check out the procedure.

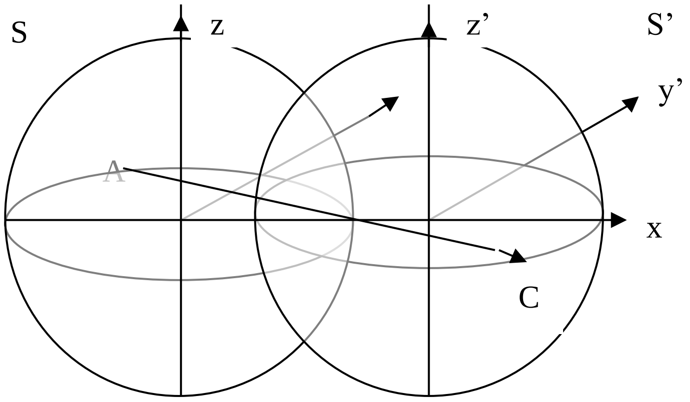

Fig. 1.1 Two objects in close encounter. S' is rotating around S.

To get the effective force we must integrate over two spheres, for every point C in one sphere S' we calculate the field generated from all points A in S and sum up the resulting force. In doing so we take care of the relativistic effects as described below. We do the integration numerically for varying distances R between the objects and then we just fit a simple expression to parameterise the result. By integration of the resulting distribution we find the potential. Both are needed. We express the result as a correction factor to a point like coulomb interaction.

In these calculations we separate the *original* electrical and magnetic fields. The treatment is a bit different, but we also would like to see the importance of the two components. The magnetic field gives rise to two contributions, namely the force between two magnetic moments and the effect of the magnetic moment of the particle at rest on the moving charge. In solving the wave equation, we work as usual in a system fixed at one of them.

There is in fact a third effect, namely the force on the particle at rest due to the electric field generated by the moving dipole. However, this is automatically included by the relativistic treatment. This treatment is made in two steps. First, every point is transformed from the precessing system S' attached to the moving particle to the system S at rest. Then we apply the field from the object at rest.

The treatment of the precession ω_T (see under kinematics), known as the Thomas effect in atomic physics, gets more complicated in our case. If you try to use it straight off, you will find that the surface of the particle might be moving faster than light! Off course, a point does not care about that. Now we must care for the internal rotational energy that leads to a modified result. In fact, for a given available kinetic energy a point will move faster than a spinning ball in an orbital motion. Part of the linear energy goes into rotational energy.

We all know that a sizable object will look compressed when moving fast. A ball will look like a cigar from the side. If you now let the ball rotate, the cigar will get even more deformed and look like nothing else.

In doing all this it is clear we must have a model for the particle. The result will differ depending on how we look upon it. You may now start to realize that this is getting complicated. It's almost like a never-ending story.

In the model we now used we assume that we have a constant electric field that is rotating. To achieve this, we use a point distribution that goes like 1/r, where r is the radial distance inside an object.

1.2 The electrical field contribution.

There are different ways to treat this field. The first way is to start off from the object at rest and calculate the field at every point in the moving object. We then apply the Lorentz force in usual manor and get the component of the force along the common axis.

The other way is to divide the moving ball into small cells that we treat as moving charged points. In doing so we can use the retarded potentials or better the Effimenko fields directly. However, the retarded point is not so easy to find since the points move in complicated orbits. In the first way we could divide the rotating ball at the centre into static current tubes with a given linear continuous charge density.
Since the charges are rotating, they will be describing an accelerated motion. In principle they would radiate. However, the situation is the same as in the atomic world. We are only interested in the case when the two objects are in a quantized state where no radiation takes place. We have simply switched it off.

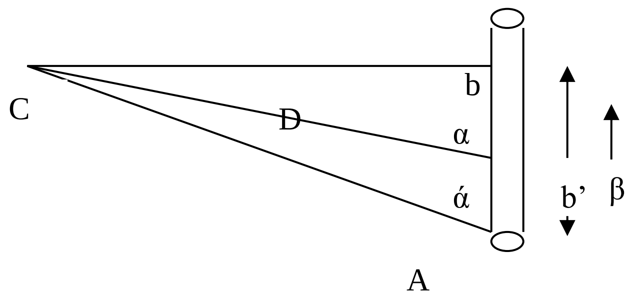

Fig. 1.2. A current element of charges moving with relative speed β.

Since the electrical field E’ is perpendicular to the current element the component in C is γE’sinά. However, the observed angle is α. Using $b' = \gamma b$, $\gamma = 1/\sqrt{1-\beta^2}$,
we have

$$tg\alpha' = tg\alpha / \gamma.$$

This gives

$$\sin\alpha' = tg\alpha' / \sqrt{1+tg^2\alpha'} = tg\alpha / \gamma\sqrt{1+(1-\beta^2)tg^2\alpha}$$
$$= \sin\alpha / \gamma\sqrt{1-\beta^2\sin^2\alpha}.$$

Likewise, we find

$$\cos\alpha' = \cos\alpha / \sqrt{1-\beta^2\sin^2\alpha}.$$

The distance becomes

$$D' = b'/\cos\alpha' = \gamma b/\cos\alpha' = \gamma D\cos\alpha/\cos\alpha' = \gamma D\sqrt{1-\beta^2\sin^2\alpha}$$

The gives us the field

$$E = \gamma E'\sin\alpha' = \gamma\frac{\delta q}{4\pi\varepsilon_0}\frac{\sin\alpha'}{D'^2} = \frac{\delta q}{4\pi\varepsilon_0}\frac{\sin\alpha}{\gamma^2 D^2(1-\beta^2\sin^2\alpha)^{3/2}}, \quad (1)$$

where $\delta q = \gamma\rho ds$ due to the Lorentz contraction, ρ is the charge density, ds the line segment.

The force between the two objects caused by a charge δq in A and an element δq in B then is

$$\delta F = \delta F_x = \delta q E_x = \delta q E * \frac{D_x}{D},$$

where E is given by (1). D is the distance vector from A to C. The net force is obtained by integrating over both spheres.

As a check-up we calculate all components of F to make sure that there is no net force in the perpendicular directions.

1.3 The magnetic field contribution.

We are not going to deal with the vector potential. We have to deal with forces and we note that the magnetic fields from two dipoles gives rice to a force that only depends on R. We can therefore calculate a scalar potential, just as in the electrical case. Since we have a static situation we can use the standard Biot-Savare formulation if we just remember to scale the charge density according to its velocity.

The magnetic field in C from a current element A is

$$\overline{B} = \frac{\mu_0}{4\pi} \delta q \, \overline{v}_A x \overline{D} / D^3 .$$

The angle between $\overline{v}_A$ and $\overline{D}$ is just the same as for the electrical field case, i.e. we can use the derivation from above.

The force on a charge δq in C is

$$\overline{F} = \delta q \, \overline{v}_C x \overline{B}$$

Again, we integrate over the two spheres and take the component of F along the x-axis.

1.4 Correctional factors.

The calculation of the force between the two objects is repeated for various distances between them. The result is normalized to the coulomb force between two points in both cases. The correctional factor to the force is given through

$$F = \frac{k}{r^2} V_p .$$

The correction V_c to the potential is defined in a similar way.

We fit an expression to resulting distribution that is used in the Dirac equation. This expression must be very smooth because otherwise we will get problems with the wave equation. We will explain this below. A smooth expression could be a short polynomial (2-3 terms normally) divided by a longer one. In this way we can get the right asymptotic behaviour.

In the case of the B field, we have dressed up a sinus function with polynomials.

The whole procedure must be repeated a few times in order to make it converge. We note that the region of small R is not very well determined due to precision problems.

1.5 Kinematics.

When solving the wave equation, the procedure is to transform to a system where one is at rest and the other is turning around but now replaced by its reduced mass.

For a given R the potential energy and the force depends on the correctional factors. On Vc and Vp respectively. From the kinetic energy we get the speed and can calculate the acceleration from the force:

$$F = \frac{dp}{dt} = \frac{ma}{\sqrt{1 - v^2 / c^2}}$$

This holds in the case of a circular orbit where the object moves with constant velocity. On the left side we have:

$$F = \frac{e^2 V_p}{4\pi\varepsilon_0 R^2} . \quad (3)$$

From this we get the Thomas frequency (see any textbook on the subject)

$$\omega_T = a * (1 - \sqrt{1 - v^2 / c^2}) / v .$$

If we assume the object moves in a circular orbit, we have the following relation between the speed and the acceleration:

$$v^2 = R * a . \quad (4)$$

This is the classical expression, but it holds also in the relativistic case. Now, it turns out that when R is in the region around $2R_0$, the velocity of the boarder becomes larger than the speed of light! R_0 is the radius of the object. If we on the other hand use (4) in (2) we can solve for a or v from the force. This time the velocity is reasonable but quite larger than the velocity as given by the kinetic energy.

Something definitely looks wrong. One would first come to the conclusion that the object is not in an orbital state but has a vertical speed component. That will just make it even worse.

The problem goes back to the behaviour of the correctional factors. The kinetic part will in fact never go to zero with decreasing R, while this is the case for the force. In fact, the force becomes negative when R goes below R_0 approximately.

The real problem is how to understand this. One could say that when R is not equal to that of the bound state, we will get such kind of result. Then we are thinking in classical terms, which is hardly applicable here. At the end the wave function will tell us that we are in a less likely situation, but not completely forbidden.

We have investigated the effects of using the different methods to determine the Thomas angular velocity. There are effects, but in short, we are talking about a few percent at most in the energy of the solutions and less in the radius. We also used an average of the two methods. The nice thing with this is that the angular velocity comes out to approximately ½ of the spin for R in the region between R_0 and $2R_0$. This is in fact what happens in case of the hydrogen atom. The meaning of this is not clear to us. When R is outside ω_T will drop.

1.6 The Dirac equation.

We use the Dirac equation since we are at relativistic energies. This equation can be written

$$(\frac{\delta}{\delta x_\mu} - \frac{ie}{hc}A_\mu)\gamma_\mu \psi + \frac{mc}{h}\psi = 0$$

for a potential A_μ. This equation can also be written as two coupled first order equations expressed in the two components f and g of the wave function (see any textbook on the subject):

$$\hbar c(\frac{dF}{dr} - \frac{\kappa}{r}F) = -(E - V - mc^2)G,$$

$$\hbar c(\frac{dG}{dr} + \frac{\kappa}{r}G) = (E - V + mc^2)F \;,$$

where F= r*f and G= r*g.

To solve, we rewrite it as one equation in the second derivative and solve for either component of the wave function. In order to reduce these equations into one we substitute G from the first into the second. After some algebra we get

$$F'' = \frac{1}{r}[-F'(k_1 + k_2) + (k_1(1-k_2) + A_1 A_2 r^2)\frac{F}{r} + (F' + \frac{k_1 F}{r})\frac{rV'}{A_2}]$$

where $k_1 = 1-\kappa$, $k_2 = 1+\kappa$ solving for f,g or $k_1 = -\kappa$, $k_2 = \kappa$ solving for F,G. $\kappa = \pm(j+1/2)$, j =total angular momentum and

$$A_1 = [(E + mc^2)/\hbar c + \frac{\gamma}{r} V_c],$$

$$A_2 = [(-E + mc^2)/\hbar c - \frac{\gamma}{r} V_c].$$

$V' = \frac{\gamma}{r^2} V_p$, $\gamma = \frac{e^2}{4\pi\varepsilon_0 \hbar c}$. V_p and V_c are the correctional factors for the force and the potential respectively. The equation is rewritten with a change of variable before implementation.

There are some difficulties in solving it due to discontinuities caused by the A-terms. The procedure is to first find them and then adjust the stepping in such a way that we encompass them in a symmetrical way. When we come close, the stepping is refined by a factor 1000 typically. There can be several discontinuities over the stepping region. It all depends on the shape of the correctional factors. The stepping is done in quadrature.

If the correctional factors are not smooth enough, we can get artefact solutions. A small kink can give a "ghost" signal.

Since we do not know what kind of states there might be, we do an energy scan. This means that we calculate the behaviour of the wave function as function of R for a given binding energy and investigate how it varies with energy. More precisely we check how the tail behaves by taking a sample of it at large R and plot that quantity. Instead of peaks we are looking for dips.

The procedure is to assume some value for the R_0 and look for a solution. The result will be some values of the binding energy and the peak of the distribution in R. We use the new value of R_0 as input and repeat until stable. If we have found the correct solution the process will converge, otherwise not.

There might be questions whether the result we get simply is what we put in. Solving for the case of the hydrogen atom, we know that the energy levels scale with the mass of the electron. This could be interpreted as if we used another value of the mass as input, we would get that as a result. However, in doing so the correctional terms will change leading to a different solution.

1.7 Field energy content.

The energy is given by

$$W = \frac{1}{2}\int(\varepsilon_0 E^2 + \frac{1}{\mu_0}B^2)dV . \qquad (2)$$

To calculate it we follow the procedure described earlier, with the difference that the point C is an empty cell in the left ball. For every point A (except C) we sum up the fields for E and B separately in point C. We calculate E^2 and B^2 and then sum up over all points C. We note that the integration is a bit sensitive to the actual binning. The errors given should reflect this.

Assuming the model with a constant field rotating inside the object we have calculated the energy content analytically. The speed v, being perpendicular to E, gives us the fields

$$\overline{E}' = \gamma_r \overline{E}, \quad \gamma_r = 1/\sqrt{1 - v^2/c^2} .$$

$$\overline{B} = -\frac{1}{c^2}\overline{v}x\overline{E}' .$$

Inserting this into (2) we get

$$W = \frac{\varepsilon_0}{2}E^2\int\frac{1+v^2/c^2}{1-v^2/c^2}dV . \qquad (3)$$

The energy density of the electrical field is (from the solution to the Dirac equation)

$$\frac{\varepsilon_0}{2}E^2 = \left[\frac{e^2}{4\pi\varepsilon_0}\frac{1}{4R_0}\right]\frac{1}{2\pi R_0^3} . \qquad (4)$$

The expression within brackets is equal to the particle rest energy (mc^2). However, there is a normalisation factor associated with the constant field itself. The field is the result of using a point distribution with weight 1/R. It is the component along any axis that counts as described earlier. This gives us a factor 2/3 for the field squared.

We evaluate the resulting integral by using spherical coordinates:

$$I = \frac{1}{2\pi R_0^3}\frac{2}{3}\int\frac{1+\omega^2 r^2 \sin^2\theta / c^2}{1-\omega^2 r^2 \sin^2\theta / c^2} r^2 dr \sin\theta d\theta d\phi, \qquad (5)$$

where we used v = ωr sinθ/c. r runs from 0 to R_0, θ form 0 to π and φ from 0 to 2π.

If everything fits, we should have I=1. Integration over φ gives a factor 2π. The rest becomes, setting b=ω/c

$$I=\frac{1}{R_0^3 b^3}\frac{2}{3}\left[-4\sqrt{1-b^2R_0^2}\,ArcSin(bR_0)+4bR_0-\frac{2}{3}b^3R_0^3\right]. \ (6)$$

bR_0 is simply the rotational velocity of the surface, β_0 (β=v/c). We have assumed that the surface will get the same speed as the particle has after collision, which is the speed it has in the bound state. Inserting the limits, we can write

$$I = -\frac{8}{3\beta_0^3\gamma}ArcSin(\beta_0)+\frac{8}{3\beta_0^2}-\frac{4}{9},$$

where γ is the Lorentz factor and β_0 corresponds to an energy of two masses worth, i.e. β_0 =0.9428. This gives

I=1.25.

Not quite unity, but the prescription for the normalisation is maybe not fully consistent with our original procedure. We must stress that we at first did not expect that we at all would get something reasonable out of such a simple assumption. We must remember that this is just a first attempt to find a description of the electron.

2. The strong force.

We will assume that the force can be described by the old Yukawa potential right at the threshold. It is adequate in this region:

$$\frac{G_Y}{R} * e^{-R/L},$$

where

$$G_Y = \frac{1}{4\pi} * \frac{G_{p\pi p}^2}{\hbar c},$$

and where $G_{p\pi p}$ is the pion-proton vertex coupling. L is the order of the pion Compton wavelength (h/mc= $.9*10^{-14}$ M).

The correctional terms are now defined through

$$U = \frac{G_Y}{R} V_c * e^{-R/L}.$$

$$F = \frac{G_Y}{r^2} V_p (1 + R/L) e^{-R/L}.$$

The procedure determines F and the potential U is then obtained by integration. To keep the field constant with R the weight factor, being 1/R in the case of the electron, must be slightly modified. This new factor is normalised to the boarder of the particle, i.e. for $R=R_0$. R_0 is the radius of the particle. This gives an overall normalisation of $(1+R_0/L)*e^{-R0/L}$.

3. The weak force.

Firstly, we assume that we can use the Yukawa type of potential just like the proton case since we are right at the threshold. It is adequate for the nucleon case in this region. More precisely we use the same Yukawa potential but with an effective coupling of

$$G_W = \frac{1}{4\pi} * \frac{G_F}{\sqrt{2}},$$

where the Fermi coupling G_F is $1.16*10^{-5}$.

4. The gravitational force.

The wave equations.

The implementation of the gravitational force in the wave equation turns out to be less obvious. How to deal with the Lorentz factors? We can hardly put them directly into the equation.

The only solution we find is that they must be implicitly included through the calculation of the correctional terms. A correctional factor just expresses how the force between the objects changes from a pure point like Coulomb type of interaction. And this is exactly what we need.

Dividing the objects into many pieces as before, we calculate the force between all pairs of pieces using the full relativistic formulation of the Newton law. This means that for every point A and C the force is scaled by a factor

$$f = \frac{1}{\sqrt{1-v_A^2/c^2}} * \frac{1}{\sqrt{1-v_C^2/c^2}} * (1-\bar{v}_A \bar{v}_C),$$

as obtained from equation (1), section 6.1 in part I. Due to this extra factor, the 1/r weight must be slightly modified to keep a constant field inside the object.

Summing all up using just the radial component we should get the net force. The final correctional factor is obtained by normalising to the Newton force between the pair of objects that now corresponds to the Coulomb force.

Appendix part 2.

1. The simulation.

The simulation done is a very crude one, but still quite complex. About 20 000 lines of code. A full simulation is not possible. Instead, we must work in another way, namely simulate the average effects. Everything is just the behaviour of average objects. This means that we replace certain details of a true simulation with estimates. We simply estimate, to our best knowledge, the outcome of more fundamental processes. The procedure was to construct simple algorithms.

However, as things evolved, more and more of these estimates could be replaced by actual simulations. It is nice to note that our estimates could be verified by the simulations. It gives us confidence in what we are doing.

We try to break down the evolution process into as many pieces we could think of. The more pieces, the more stable is the result. One process we cannot estimate, namely the probability of creating a miniverse. We simply have assumed that ones the process have started as many miniverses there is space for will be produced.

However, the situation is not quite as bad. If the amount of galaxies is wrong, the universe might not build. The amount of galaxies affects the feedback, especially back to the central core. If the amount is too small, the central core will go berserk and swallow everything. If it is too large the galaxies will do that job. A nice balance indeed!

We should perhaps mention that the proper amount fits well with the observed one.

The simulation itself is quite simple. We make small steps in time and start by adding layer to layer to the central core. After a certain time, we allow galaxies to start to form. The starting time we let vary and just repeat the whole calculation. This is the price to pay with this type of simulation.

Also, other parameters we allow to vary to get a feeling for how things behave. Normally a change in one does not do much. The absolutely most important is the one we mentioned above.

The starting time also affects the result. If a galaxy starts to build too late, it will simply be killed by the mother. If it starts too early, it will behave like a new central core. The two cores would just melt together into a core that would eat everything.

After further time has passed, sub galaxies can start to form. One outward and one inward in a chosen direction (normally 30^{o} from the centrum line). The best would have been do draw a random number and create them along we go. However, as said, we do not have that resources. Instead, we again have to repeat for some typical directions.

For every step we apply various feedbacks. Halos are built by capturing particles that are not too fast. If so, they will pass by. If they are too slow, they will be captured by the core. It is all steered by how and where they are produced. The most important source in the beginning is the mother of a galaxy. Neighbouring daughters will also contribute as well as close by galaxies from the same generation as the mother.

The gravitational impact of other objects is taken into account leading to energy loss/gain (on the average off course). The calculation of energy loss is done by a “simple” algorithm. This algorithm was checked against a full simulation of how an object is affected by some milliards of other objects in form of a broad halo. We just let one object pass through the halo to see how it behaved. Off cause, if we are dealing with the effect of just two interacting objects (mother and daughter), we will not need the algorithm.

Part of the debris will continue outwards. When they are slowed down and return, they will be absorbed by the cores (or end up in a halo). They could also take a new turn around the universe. When the later generations start to form the amount of debris around them will be quite substantial and finally prevent any later generations to build.

We think that we have taken the major and most important processes into account. Again, in an average sense. By studying this process from various aspects, we have become confident that we have a product that is working quite well. The limited precision is a bit disturbing, however.

As you might understand, by varying the parameters the net result will change, although not too much. However, we have managed to build a universe that did not last more than some milliard years. Now you may say that are simple model is a flaw, but then you have not got the point. The variation of the parameters corresponds to statistical fluctuation. If you are religious, you might say that God through a pair of dices in creating our universe and this time he got it right.

Some details.

At the beginning a bubble explodes creating two pairs of bound particle-antiparticle while a particle and an antiparticle escape. Just in the moment before they get quantized the fields are at maximum. We assume that it is in this moment nearby bubbles gets triggered and continue the creation process. It is like a chain reaction.

The particles that were created can only to a part escape. One of them can move outwards while the other will move inwards. The latter can scatter and, in this way, move outwards, but not all of them. We assumed that 60% escapes. The trapped one can to a part cause annihilations by breaking the bonds of the pairs. However, do be able to do so it first must have got a kick from other debris to have enough energy. We assumed 70 % of the inwards ones can do this.

We mention these examples just to emphasis on what ones needs to estimate when we do not have a full simulation. There are many more numbers like these, but we cannot mention them all. The numbers above affect the final mass of a core, but from what we see the effects are not major, the order of a factor 2 or so.

When time passes on, newly created bubbles might get a kick from debris and escape from the core. We could compare to the corona of the sun, which might throw out particles all the way to earth. We have assumed that their speed will be about 75% of the debris. Again, this is not crucial. What happens is that a slow one will get a larger energy transfer than a faster one. Again, the difference shows up in the final size of the core. The slow one tends to get a bit smaller due to the annihilations caused by absorbed debris.

These miniverses will speed up by absorbing debris especially from its mother. Part will end up in the core and partially annihilate thereby decreasing the core while its kinetic energy increases. Another part will be captured into a halo. The miniverses will create debris of their own. Part which will hit the central core and other miniverses, part which will move outwards with a speed larger than the ones from the central core.

Another source of debris come from colliding cores. Since we have assumed that it will be quite crowded this will happen. We expect that the result at least will be of the order of the normal production of debris from a growing core. When we calculate the contribution from nearby cores, we just scaled up that result a bit to account for this source. However, this contribution has now been properly included in the full simulation. This was necessary to get a correct simulation of the galaxy halo. Which in turn affects the creation of stars and planets. The effect is that with more debris absorbed, the galaxies will speed up a bit more. However, when they become faster the rate of absorption will diminish. This balance makes the result more stable than one at first could think.

The debris we divide up in two parts. One that has passed by the daughters and one that has not yet come so far. The reason for doing so is due to the calculation of energy loss. Instead of just one average lump the calculation will be more correct.

When we create a new generation, we just make two representatives. One that moves outwards and one inwards. In all interactions we let them have an angle towards the radial line through the centre of the universe. In the next generation the inward one again gives rise to two cores, one outward and one inwards. The same goes for the outward one.

We only treat one hemisphere. When galaxies or debris cross over to the other side they are reverted. In this way we take into account objects coming from the other side of the universe.

We make four generations plus two partial ones that will represent the remaining generations. In principal we could have made more generations, but the problem is that the energy becomes so large that we cannot calculate relative velocities because of the limitations in the precision.

When loss or gain of energy takes place due to the interaction with other objects, these representatives are handled as if there were milliards of them. We simply treat each representative as a halo of some milliard objects. This does not mean that we make a big loop over them, but instead we use a “simple” algorithm. That algorithm was checked against a full calculation using some milliards of objects in form of a halo of some width and letting a test object pass through. The match was quite good.

In all what we are doing the interplay between cores (galaxies) are crucial. They will affect their neighbours in one way or another. Either through the debris generated or through the gravitational force. This leads to a nice balance that make the whole story work. We see that the universe will expand in form of a halo, compare to an inflated balloon.

2. The Hubble plot.

We will describe the procedure behind it. The drawing shows a galaxy moving outwards and sending a light ray towards earth.

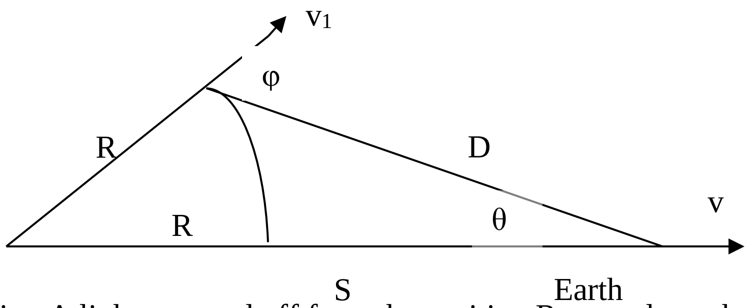

Fig. A light ray send off from the position R towards earth.

$$\cos\phi = -\frac{R^2 + D^2 - S^2}{2RD} = \frac{D^2(1+\tilde{v}^2/c^2) - 2SD\tilde{v}/c}{2(S - D\tilde{v}/c)D}.$$

$$\cos\theta = \frac{D^2 + S^2 - R^2}{2SD} = \frac{D^2(1-\tilde{v}^2/c^2) + 2SD\tilde{v}/c}{2SD}.$$

Here we made the replacement R=S-$\tilde{v}$ D/c. In these formulas $\tilde{v}$ is the average velocity (as function of distance) obtained from our simulation. The relative velocity becomes

$$v_{rel} = \frac{v\cos\theta - v_1\cos\phi}{1 - vv_1\cos\theta\cos\phi/c^2}.$$

This is what has been plotted versus the distance D.

Appendix part 3.

1.The Dirac equation.

It is the same as in Part I. We need it to investigate whether gravitational structures can be formed in the same way as for the fundamental particles. The only difference is that the net correctional factors change a bit why we show them below. The electrical and magnetic contributions have been added together in their right proportions.

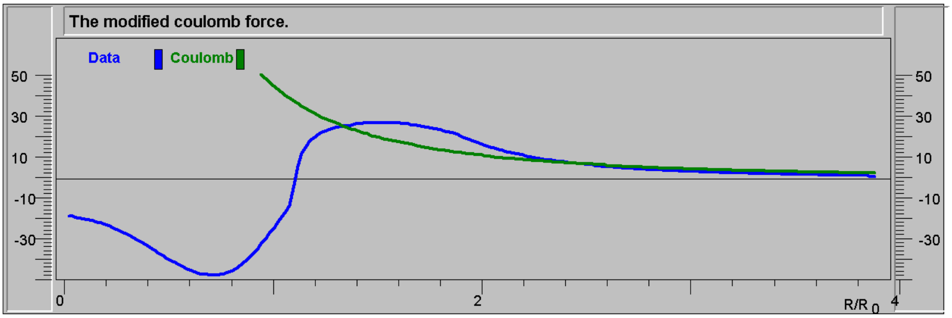

Fig 1.1. The effective force with the correction applied.

This one looks a bit shaky compared to the distribution in Part I. It is caused by limitations in the precision. In the implementation the two contributions are treated separately and parametrized. This will remove kinks that otherwise could cause ghost signals in the solution.

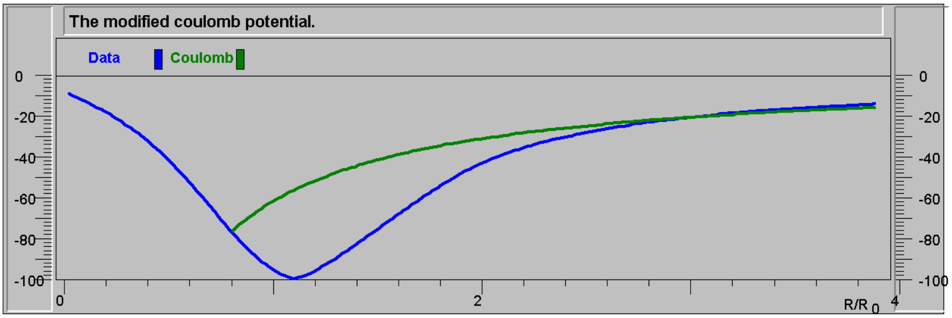

Fig 1.2. The effective potential with the correction applied.

2.The Klein-Gordon equation.

To treat the linear case for the gravitational force we use the Klein-Gordon equation. This equation can, for a free particle, be written

$$(\frac{\delta^2}{\delta x_\mu{}^2} - \frac{1}{c^2}\frac{\delta^2}{\delta t^2} - \frac{m^2c^2}{\hbar^2})\psi = 0\,.$$

We introduce a Coulomb like potential by the normal replacement

$$p_\mu = (\frac{\delta}{\delta x_\mu} - \frac{ie}{\hbar c}A_\mu)\,,$$

with $A_\mu = (0,0,0,iA_0)$, $eA_0=V(x)$. This gives

$$\frac{\delta^2}{\delta x_\mu{}^2}\psi = (\frac{\delta}{\delta x_\mu} - \frac{ie}{\hbar c}A_\mu)(\frac{\delta}{\delta x_\mu} - \frac{ie}{\hbar c}A_\mu)\psi =$$
$$\frac{\delta^2}{\delta x_\mu^2}\psi - \frac{ie}{\hbar c}\psi\frac{\delta A_\mu}{\delta x_\mu} - \frac{ie}{\hbar c}A_\mu\frac{\delta\psi}{\delta x_\mu} - \frac{ie}{\hbar c}A_\mu\frac{\delta\psi}{\delta x_\mu} - \frac{e^2}{\hbar^2c^2}A_\mu^2\psi\,,$$

where δA_μ=Div A=0.

With $\psi = \varphi(x)e^{-\frac{iE}{\hbar}t}$ and $A_\mu\,\delta\psi/\delta x_\mu = iA_0\delta\psi/ic\delta t$ we get

$$(\frac{\delta^2}{\delta x_k{}^2} + \frac{1}{c^2}\frac{E^2}{\hbar^2} - 2\frac{-V}{\hbar c}\frac{1}{ic}\frac{-iE}{\hbar} + \frac{V^2}{\hbar^2c^2} - \frac{m^2c^2}{\hbar^2})\phi = 0\,.$$

Or

$$(\frac{\delta^2}{\delta x_k{}^2} + \frac{(E-V)^2}{\hbar^2c^2} - \frac{m^2c^2}{\hbar^2})\phi = 0\,,$$

where $V = \frac{V_c}{r^2}$.

In this case we only need one type of the correctional terms. We show in figs 3 and 4 the "electrical" and the "magnetic" respectively.

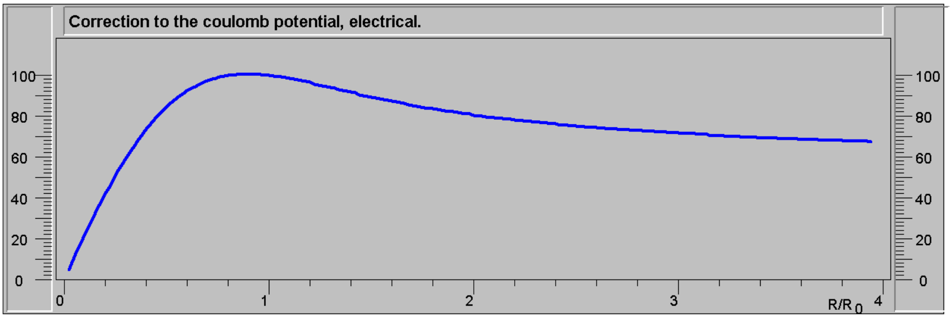

Fig 2.1. The behaviour of the correctional factor for the electrical part.

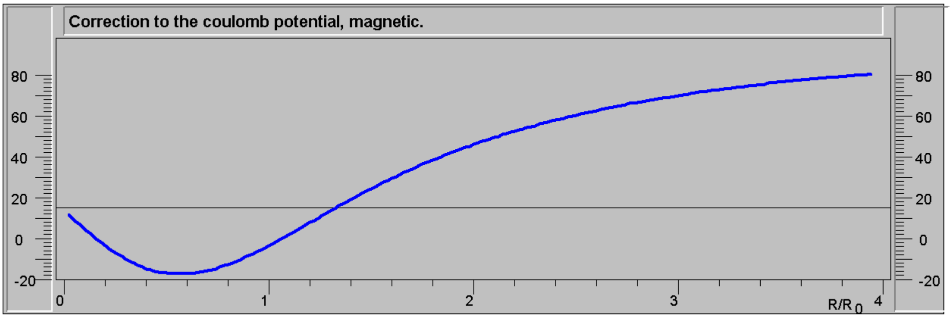

Fig 2.2. The behaviour of the correctional factor for the magnetic part.

In difference to two objects turning around each other we do not need to bother about the complications with the orbital motion, like the Thomas frequency. Else we can use the same formulas if just change the velocity vector from orbital to linear.

We add them together in their right proportions in the next figure. It is slightly different from the one shown in part I.

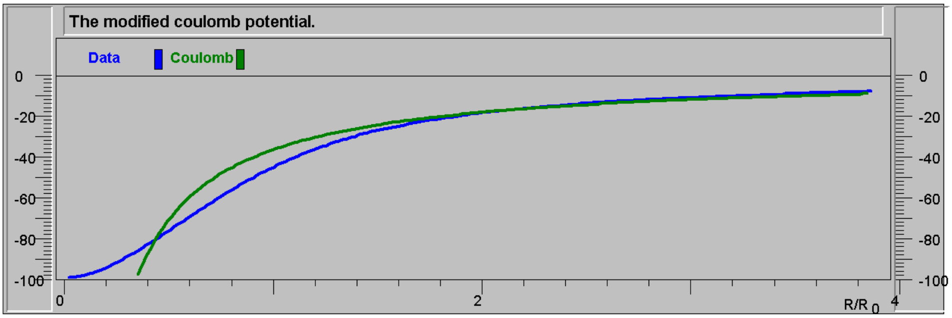

Fig 2.3. The effective potential with the correction applied.

3. Extracting data on the ratio of strong to electromagnetic forces.

We will here describe the procedure to extract the values. It involves two kinds of corrections. One is the corrections due to background. Such corrections are about 30% for smaller values of the Yukawa coupling G_Y but drops to about 10% at the largest values. The other one is a correction we make when the electromagnetic to weak ratio is off from the known value. At lower G_Y it is normally zero while becoming 5-10% at most at the larger values of G_Y.

The first correction takes the raw value down while the second goes the other way around. This is a lucky situation since it tends to move points towards the line, not away. This means that we do not create the effect observed.

The background turns up like oscillations above the largest peak in R, fig 3.1. We clearly see how that peak is distorted when the background increases. Compare to fig 2.2 in part III. In that case the energy was lower and the dip in energy much sharper why we got rid of the background.

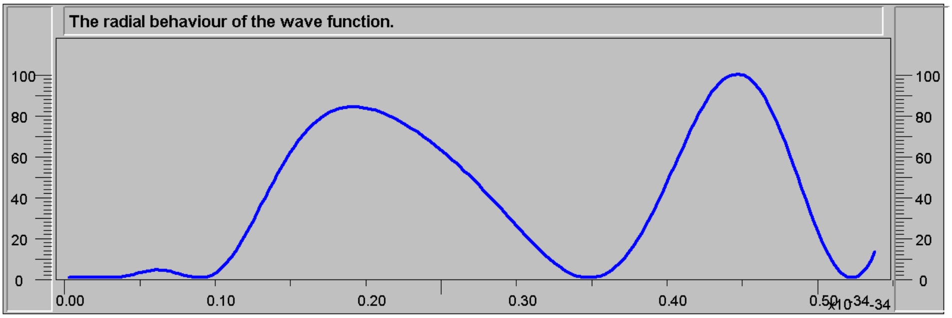

Fig 3.1. The probability density $R^2 \Psi \Psi^*$.

The procedure is to use the first oscillation above the peak and subtract a certain fraction of it to obtain a distribution that falls off nicely. The position of the peak of the oscillation is shifted down by twice the half width. This is the spacings of the oscillations. The oscillation itself is subtracted as well as a check-up. We show the result in fig 3.2.

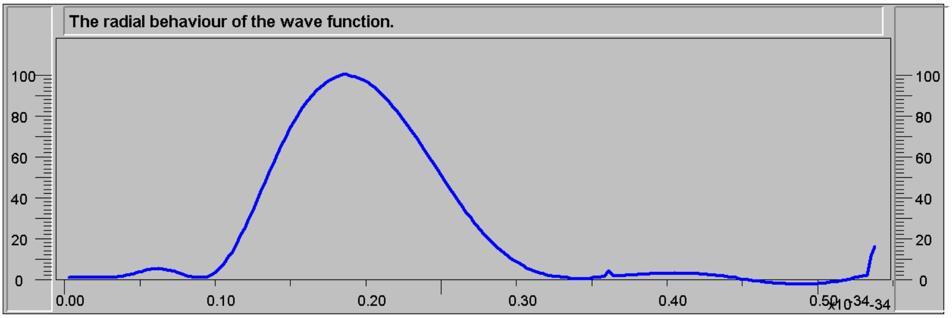

Fig 3.2. The probability density $R^2\ \Psi\ \Psi^*$ with correction.

The subtraction is perhaps not perfect, but we add an error of 5% to the total error to cope with the uncertainty in the procedure.

We note that the distribution of R at larger energies seems to have a faster fall off than at lower energy. Which means not quite like the one in fig 2.2, chapter 2, part III. That one was taken at lower energies with no background. We had a case at larger energies where the background was estimated to only 1.3% and which looked like the one above. We also discussed this in connection with the Dirac equation that the tail will be suppressed when the energy goes up, Fig 6.1, part I.

Concerning the second type of correction, we have investigated points close by in the Yukawa coupling G_Y, but which differ in the raw value of the electromagnetic to weak ratio. We find that the correlation between the two ratios is in practise one to one when the electromagnetic to weak ratio is off by less than about 5%. This means that one unit of correction of the electromagnetic to weak ratio is applied on the other ratio. However, when the correction becomes larger, we use a reduced amount. The reduction will gradually decrease to about 85% when it is off by about 10%. Points with larger discrepancies are rejected. Instead, we try other values or parametrisations to find a better ratio. The result is that close by points agree after applying the correction (within a few per cent). The error in this procedure is estimated and added to the total error.