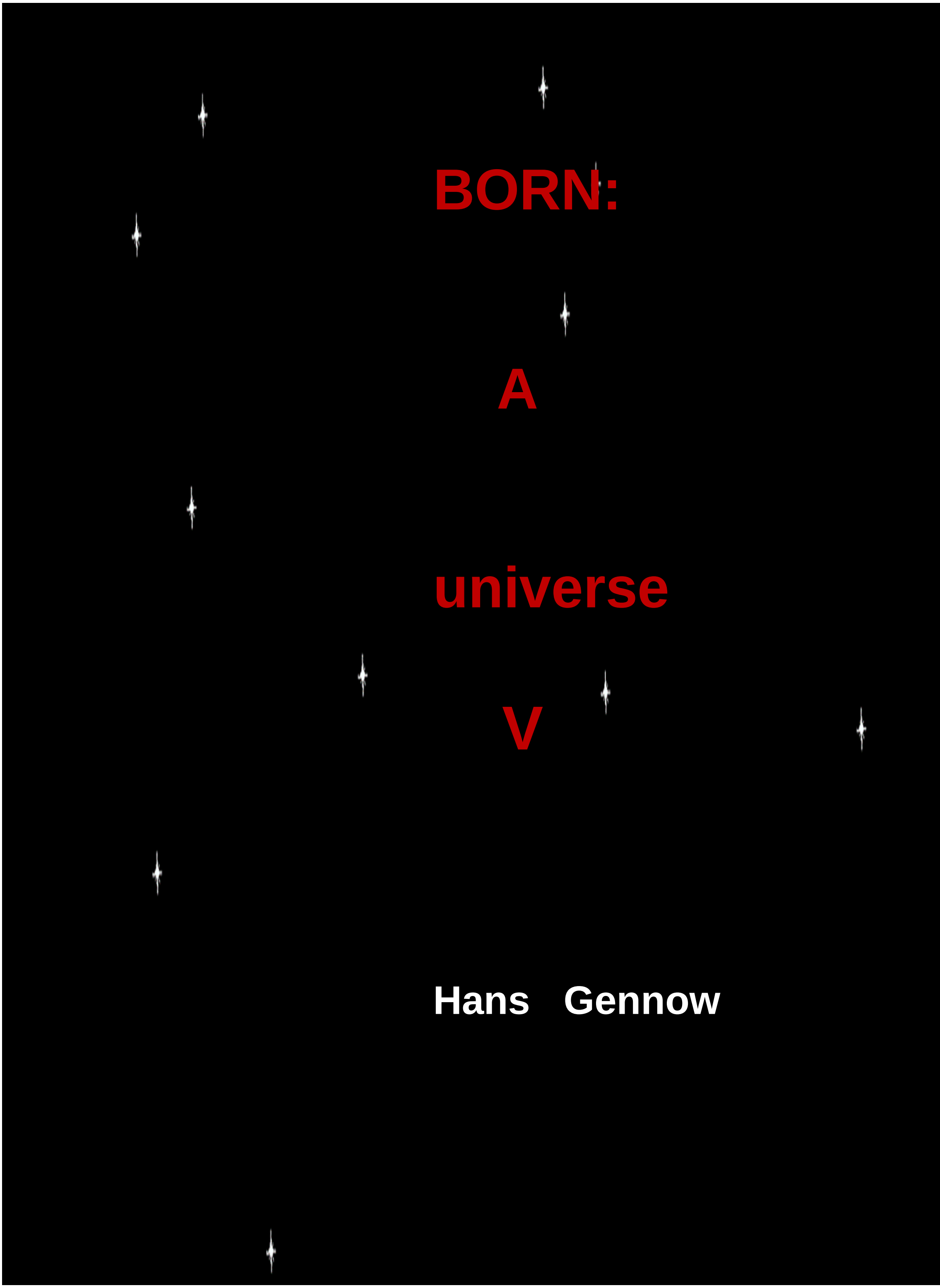

BORN:

A

universe

V

Hans Gennow

This book is our earlier books in a nutshell. The aim is to confront our findings with recent observations that have come available after our books were published. More detailed results will be given. It is interesting to note that the agreement is overwhelming.

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. As a biproduct this leads to galaxies having a massive core. The predicted mass range fits well with present observations of black holes. Especially we could mention the observation that younger galaxies have larger cores which we expect from the construct of the galaxy cores.

We also found that the atomic nuclei are produced at the beginning of the galaxy halo evolution long before stars are formed. We find a cosmic microwave background of a black body of 2.7K distribution due to photons scattering against free electrons. Analysing the CMB maps we find they are consistent with statistical fluctuations.

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.

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.

This book is an addendum to our earlier books on how a universe can be build. Our aim is to confront our findings with new observations that have come available after the books have been published. We have therefore augmented our presentation with more detailed results to compare with. We will only give a very short summary of the earlier books and instead we refer to them for details.

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.

In our third book we continued that simulation now augmented with the formation of the halo of a galaxy as well as stars and planets. We compared our findings with observations that have come available since our first book. It turned out that the outcome is in good agreement with these observations.

In our fourth book we continued that simulation now augmented with the formation of the atomic compounds, as well as atoms and the creation of photons. Due to photons scattering on free electrons it gives rise to the cosmic microwave background in agreement with a black body of 2.725K.

We also would just like to mention our study in the second book. We asked the question what kind of mechanism can give rise to exactly three forces other than the gravitational one. 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. When a vacuum bubble starts to open up to produce a pair of particles the gravitational force must be erected to assure the conservation of energy. Performing a quantum mechanical treatment of this process we could determine the couplings of all the forces with a very nice outcome.

We will begin with a short résumé of the relevant parts of our earlier books. It is needed for the understanding of what comes next. Please check out our books for a more detailed description. In chapter 1 we will give you the fundamentals of how the different species of particles can be produced. In chapter 2 we will continue with the build of the universe up to the creation of the CMB spectra. It begins with the creation of the atomic compounds and continuous with the creation of atoms and photons and finally an analysis of the CMB spectra together with a discussion.

1.The fundamental processes

1.0 Introduction.

We will follow the various stages of the evolution of the universe and compare to available observations. It starts with the production of the standard fundamental particles, protons, electrons, and neutrinos created out of vacuum. It is based on the Heisenberg relation. As a biproduct we get massive objects (cores) that are the building blocks of the galaxies. The cores will accrete debris that form the halo of the galaxies. When the halo builds up atoms may be created giving rise to photons that can scatter against free electrons and form the cosmic microwave background.

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.

1.1The creation of the fundamental particles.

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. This through a quantum mechanical process. This process is the very first step in creating a universe.

We investigated how a vacuum bubble could behave. According to quantum mechanics a bubble could explode into a pair of particle-antiparticle but only for a very short time. This as explained by Heisenberg. It is the corresponding force that ensures that the pair returns.

However, there is a complication. If say an electron-positron pair is formed they could in principle annihilate into a pair of photons. A fundamental force, the gravitational force, must always be erected to ensure that the photons return in order not to break energy conservation.

1.2 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.

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.

1.3 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.

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 1.3.1

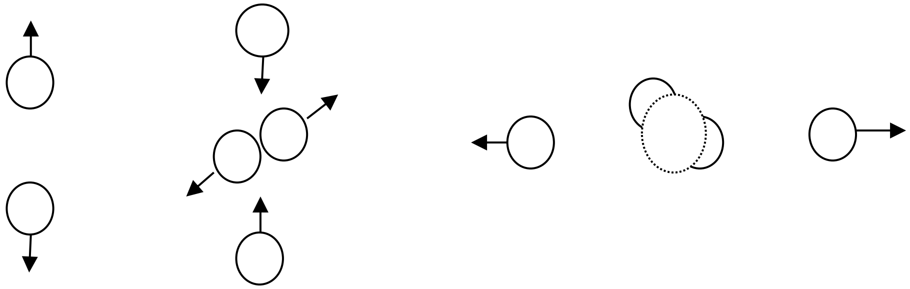

Fig. 1.3.1. The formation of a bound pair.

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. A complication is that the bound pair will have an angular momentum that was not present from the beginning. We thus need two such pairs produced that cancel out the angular momentum. To avoid the two pairs to crash into one other we found that if the force has an electric like and a magnetic like component this could be avoided. The spin of the particles created by the collision will make the balance fulfilled.

What says that we can have a pair in such a bound state? 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.

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 additional details we refer to our first book.

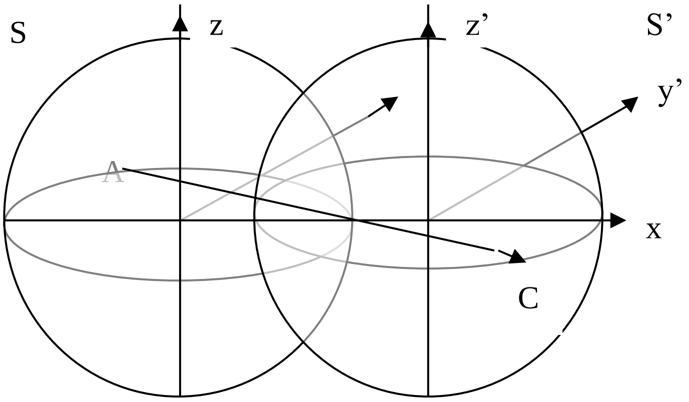

Fig. 1.3.2 Two objects in close encounter. S' is rotating around S.

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.

We note that the correctional factors are just geometrical factors due to the overlap. When the overlap is complete the resulting force is zero. Quite different from the coulomb force between points. We show in Figs 1.3.3-4 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 of all, we note that if the objects were points, the factors would be identically 1 ($R>2 R_0$ always).

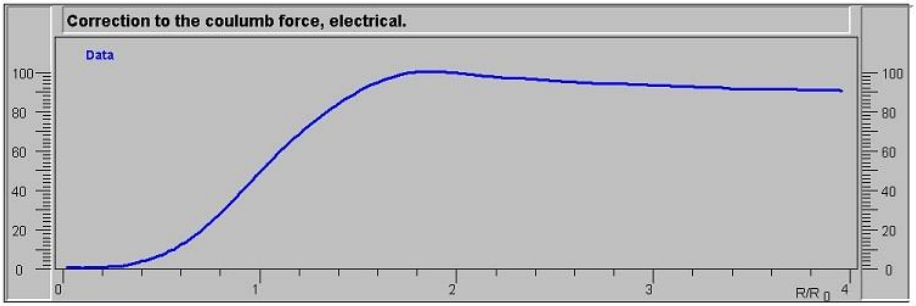

Fig 1.3.3. The behaviour of the correctional factor for the electrical part.

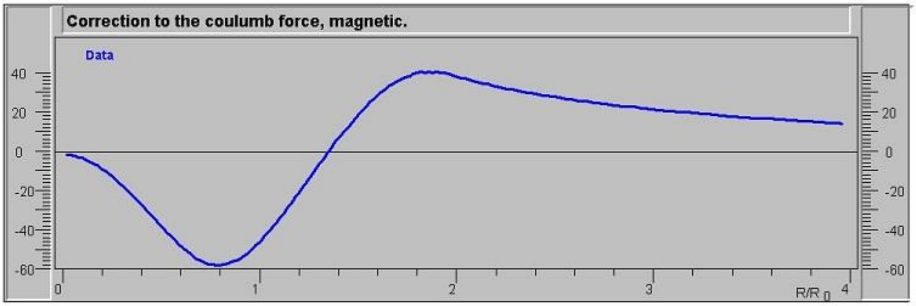

Fig 1.3.4. The behaviour of the correctional factor for the magnetic part.

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 have to add them together in the right proportions and apply them on the coulomb force. By integrating the force (the electrical and magnetic factors separately) we get net potential. The result you find in Fig 1.3.5.

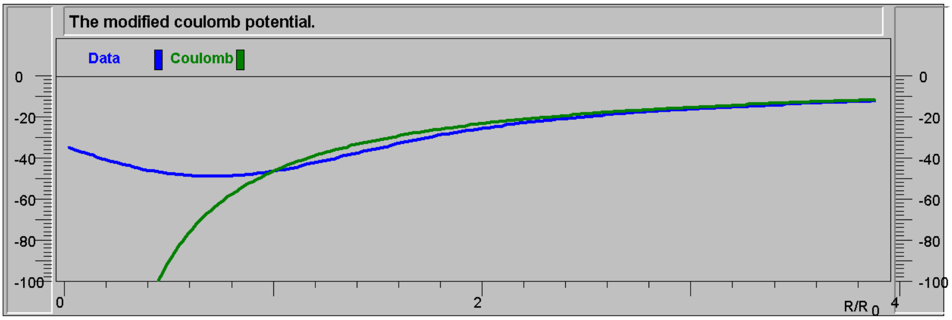

Fig 1.3.5. The effective potential with the correction applied.

We note that the coulomb potential now has turned into a shallow potential well. In the implementation in the Dirac equation the force and the potential are multiplied with these factors. For the implementation in the Dirac equation, we refer to the Appendix in our first book. 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 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.

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 1.3.6 and 1.3.7.

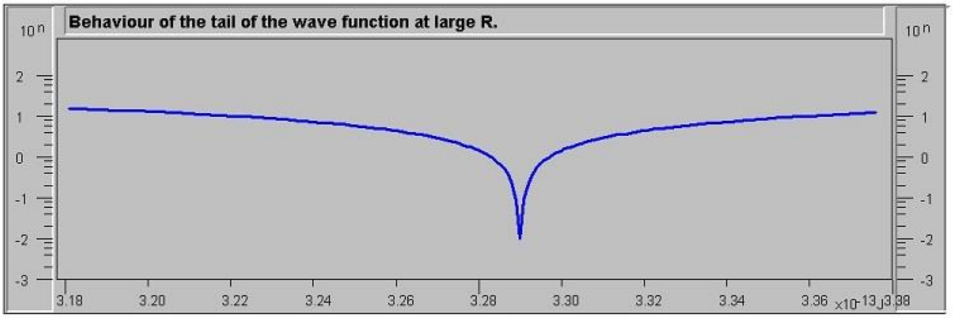

Fig 1.3.6. The behaviour as a function of the binding energy in units of joule.

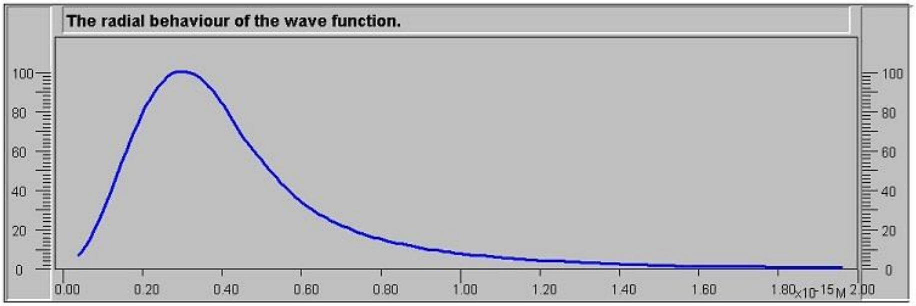

Fig 1.3.7. The radial probability density $R^2\Psi\ \Psi^*$.

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.

1.4 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.

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]	.70±.03	
Energy content [J]	.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. A constant field can be obtained from a homogenous charge distribution by weighting it with 1/R. It is interesting to note that such a distribution fit with a recent measurement of the proton charge distribution [1]. We can therefore make the following

Conclusion.

The picture of a charged particle being constructed by a confined constant field agrees with recent measurements of the proton charge distribution.

We do not know whether the charge distribution of the electron would look like the one for the proton. It is just an assumption, but it leads to the right result. 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.:

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

It is interesting to also note that the resulting spin of the electron agrees with a gyromagnetic ratio of 2.

The gyromagnetic ratio.

Calculated	2.02 ±.08
Angular speed	$4.0*10^{23}$ [rad/s]

[1] H. Gao and M. Vanderhaeghen, Rev. Mod. Phys. **94**, 015002 – 21 January 2022

1.5 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±.08*10^{-10}	1.50*10^{-10}

The gyromagnetic ratio.

Calculated	2.03 ± .08
Angular speed	3.1*10^{23}[rad/s]

The properties of the neutrino.

Radius [M]	2.9±.2 10^{-16}
Interaction length [M]	3.2±.2 10^{-17}
Mass [J] ([eV])	2.1±.4 10^{-20} (.13±.03)

The gyromagnetic ratio.

Calculated	1.60 ± .08
Angular speed	$9.4*10^{23}$[rad/s]

The ratio comes out a bit low. The calculations for the neutrino are a bit difficult due to the correctional factors looking more like step functions and are not easily parametrized. It is caused by the heavy boson exchange.

1.6 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 confined 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 $1/\gamma$ 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 of book 1, chapter I.4. In short, we arrived at the following expression for the force:

The general gravitational force.

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

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

$$E_k = GMm\gamma / R . \tag{2}$$

The total energy E of that object is

$$E = mc^2\gamma = mc^2 + E_k . \tag{3}$$

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

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

or

$$\gamma_L = 1/(1 - GM/Rc^2) \equiv \gamma_G . \tag{4}$$

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

$$\gamma_G^2 \cong 1/(1 - 2GM/Rc^2) . \tag{5}$$

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.

An interesting experiment was performed 2024 by Louis Rancourt1 & Philip J. Tattersall [1]. They let a beam of light pass close over a metal bar connected to a balance. That lead the metal bar to move towards the beam. This is in fact the same effect as the bending of light. This is exactly what would expect from our relativistic version of Newton gravity.

[1] Louis Rancourt1 & Philip J. Tattersall, Applied Physics Research; Vol. 7, No. 4; 2015

1.7 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 1.7.1. 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.

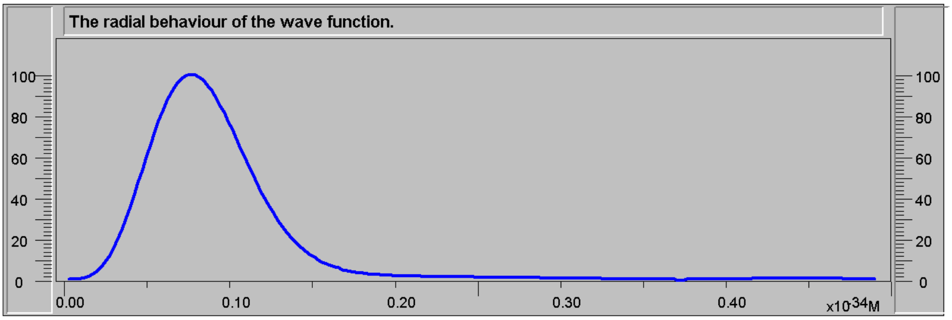

Fig 1.7.1. The probability density $R^2 \Psi \Psi^*$.

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. 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 or neutrinos. Due to the assumption of an associated quantum number of unity 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.

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. The mass and radius of the Gravs correspond to a certain value of the strong force.

We investigate the radial dependence and calculate the probabilities of the three lowest peaks. We integrate the peaks and take the square of these numbers. 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.

For details see the second book. We just note down the result.

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	$1.09\pm.04*10^4$	$1.117*10^4$

The Yukawa coupling is defined by

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

where $G_{p\pi p}$ is the pion-proton vertex coupling. It is about 15 for 10 Gev proton-proton collisions and order of 40 at the nucleon threshold.

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 Gy.

The question is whether this is just a coincidence or not. We have three numbers, very 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.

We also investigated the effect of letting the gravitational constant vary. For each new value we get another set of the values in the table. However when we plotted the strong Yukawa coupling vs the gravitational constant we found a nice minimum right at the present value of the gravitational constant. We interpreted this as we now could determine all the four forces.

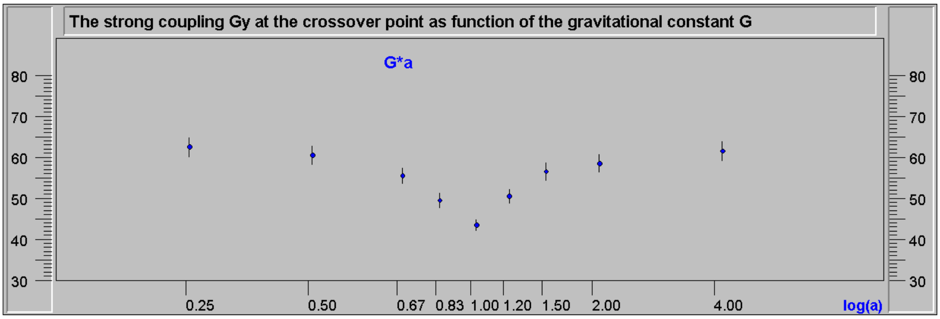

Fig 1.7.2. Yukawa coupling G_Y at the cross over point for various values of the gravitational constant. The abscissa is the log of the scaling factor.

The cross over point is the point where the strong to the electromagnetic ratio comes out to the expected theoretical value. For details see our second book.

2. Building a Universe.

2.0 Preludes

We will come back to the simulation of the universe we did in our earlier books. We will fill in with some new aspects of it in the following chapters. It starts off with the creation of the galaxy cores. That continues with the simulation of the formation of the galaxy halos and the stars and planets with quite a promising result. In chapter 2.7 we extend this with the creation the atomic elements which lead to the formation of atoms and the creation of photons. At the end we arrive at the cosmic microwave background as we see it today due to photons scattering on free electrons. We finish up by constructing the CMB map.

The existence of the free electrons is described in the next chapter. 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.

In the following chapters we will compare our findings with interesting new observations that have come along especially during the last year. The result is quite impressive.

2.1 The creation of the galaxy cores

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

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. 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 (the ice) would be formed while energetic particles escape (the vapour). That is the reason for calling the process “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.

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 2.1.1 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.

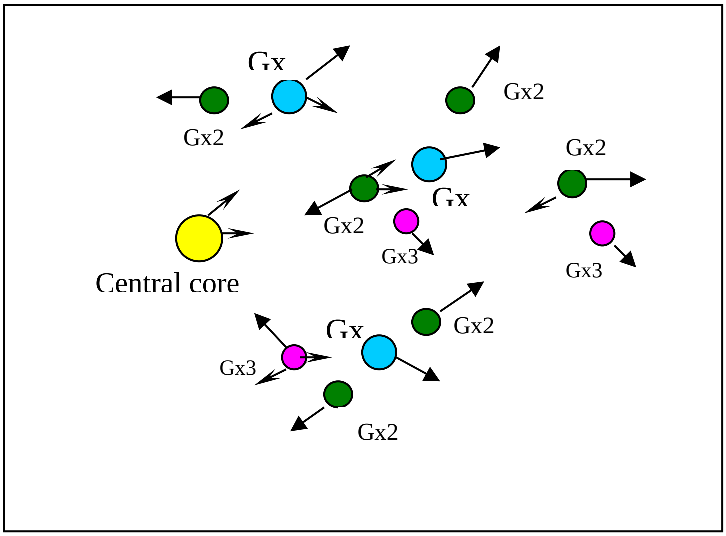

Fig 2.1.1 Production of miniverses (galaxies).

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 2.1.2 how a core first accelerates and then gently slows down. It shows the first few hours of the evolution.

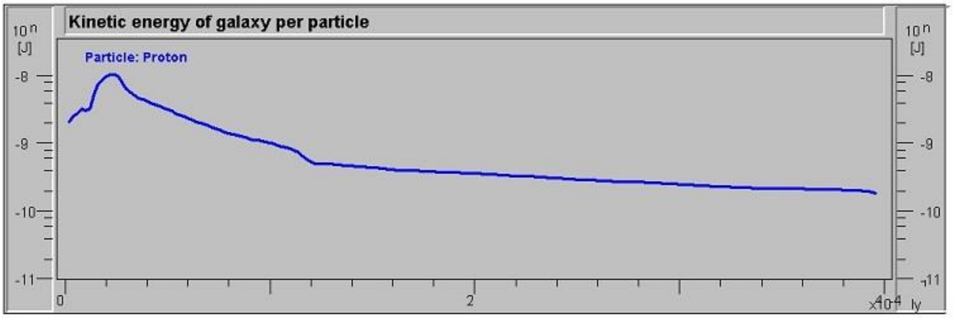

Fig 2.1.2 The kinetic energy of a constituent particle as function of the radial distance.

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.

A 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 2.3 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.

2.2 Confronting the galaxy cores

Observations now show that these massive objects were formed at an early stage of the universe. In a recent report a massive object named GNz7q was found in a Galaxy 750 million years after the big bang [1]. The data come from the Hubble space Telescope. It is a difficult task to pin down these early objects.

Another experiment reported the observation of a quasar caused by a supermassive object already after 670 million years [2]. It is interesting to note that the first pictures from the James Webb telescopes (July 12, 2022) also show such galaxies, all according to NASA.

Such observations tell us that the cores were formed quite early in the evolution just in line with our predictions. It has been discussed whether the massive objects can be formed by accretion. As we discussed in our third book this cannot be the case. There is not time enough. In our third book we concluded that a standard star has reach 2% of its final mass after 100 million years. After 700 million years the mass has increased to 90% about and thereafter the growth is more gently. How can an object some million times more massive grow faster? These new observations clearly show that the massive objects were created through another process, like the one we have presented. We will come back to this in the next chapter when the galaxy halo has been built.

In a recent paper [3] SMBH:s in the center of the galaxies (galaxy cores) has been measured. They present it as function of z, i.e., the distance to the galaxies. A more distant, i.e., younger galaxy has a larger core! This means that the cores simply seem to shrink by time. A similar conclusion was made by [4]. In various publications people claim that the core should rather put on weight by absorption of material, but there is obviously no evidence for such a statement.

Another report [5] concluded that the only thing we are sure of is that these black holes were not created by the collapse of giant stars or the accretion of matter around them.

The behavior just so happens to be in line with our predictions. As we have seen the cores are built from bound pairs of particle-antiparticle (which is the cause of the original process where particles are created). When particles fall into such a core the bonds might break and particles being released. This means that the core will shrink. At beginning there are lots of debris that could cause such an effect. Later on, when the debris have been captured into the halo stars that come too close to the core may be ripped apart and partly fall in and the process will continue.

These observations should settle the question of how the galaxy cores are constructed and behave.

Conclusion.

The supermassive objects in the centre of the galaxies must be formed in another way then by accretion. The picture we have given seems to be the only alternative.

There is another consequence of these early galaxies. To be able for us to observe them we must move with a speed of .95c. Otherwise the light from the early galaxy would already have passed us. This is a simple geometrical problem. In our simulation we see that galaxies can have differentiated speeds. The ones in a later generation created directly outward comes out close to the speed of light.

If a galaxy on the opposite side of us is sending out light after 700 million years, the light has reached a distance of 13.8-.7=13.1 Gly from the center of the universe by now. To meet that light, we have to travel that distance in 13.8 Gyr. Our speed must thus be β=13.1/13.8=.95. Recently NASA reported on a galaxy as young as 300 million years, yet quite massive, (GLASS-z13) observed by JWST. To see it we must move with .98c. Earlier a galaxy 400 million years old, GN-z11 was reported by Hubble [6].

Is all this reasonable? Looking at cores ejected straight outwards, a galaxy from generation 3 (Fig 2.1.1) would also fulfill the last case (.98c). Our results are thus consistent with the new observations.

It could be interesting to see the expected speeds of the cores from different generations.

Generation	Speed v/c straight outward.
1	.87
2	.95
3	.991
4	.998

We note that these numbers holds soon after the creation. By time they will slow down due to the gravitational pull of those behind. As we note the slowdown seems to be quite gentle. Generation 1 is given by the requirement that a core acquires 75% of the speed of the debris which in turn is a consequence of the outcome of the wave equation when debris are generated.

In a recent more detailed observation of the Sgr A* [7] it is claimed that they could determine both the mass and radius of the massive object in the center of our galaxy. Unfortunately, we find their conclusions a bit questionable. They observe a luminous ring around the object. The inner radius they equate to the Schwarzschild radius $R_S = 2GM/c^2$. It is deduced from general relativity and is a kinematical limit. No photon may escape from inside R_S to a distant observer. This results in a mass of about 10^{37} kg. Whether the radius of the inner ring must be exactly equal to R_S is not quite clearcut. There might be some cold gas just inside. If the radius shrinks a bit, the estimated mass becomes smaller.

The real strange conclusion they do is that they claim that the radius of the object must be equal to R_S. R_S is just a kinematical limit independent of the radius of the object, it only depends on the mass of the object. They thus claimed the radius to be 30 times that of the sun. In our simulation we find that an object of mass $1*10^{37}$ has a radius of $2*10^{9}$ M, about three times the sun.

In 2019, astronomers reported on a tidal disruption event detected by the TESS facility and denoted ASASSN-19bt [8]. 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.

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

[1] S.Fujimoti et.al,*Nature* **volume 604**, pages261–265 (2022)
[2]Wang et al, APJ Letters 907L1, 2021 January 20
[3] Vestergaard and Patrick S. Osmer , APJ, 699:800–816, 2009 July
[4] A-C Eilers et al, APJ, 938:17, 2022 October 10
[5] Tabasi_2023_ApJ_954_164
[6] https://www.nature.com/articles/s41550-020-01275-y
[7] Kazunori Akiyama etal, APJ Letters, 930:L12 (21pp), 2022 May 10
[8] T. Holien et al, APJ, 883, no2, 2019.

2.3 The formation of the 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.

We let the cores accrete debris as described in detail in our third book. Debris are generated when the cores build up but also produced by colliding cores. 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.

It turns out that the halo mass varies up to 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 to hundred up or down.

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 2.3.1 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.

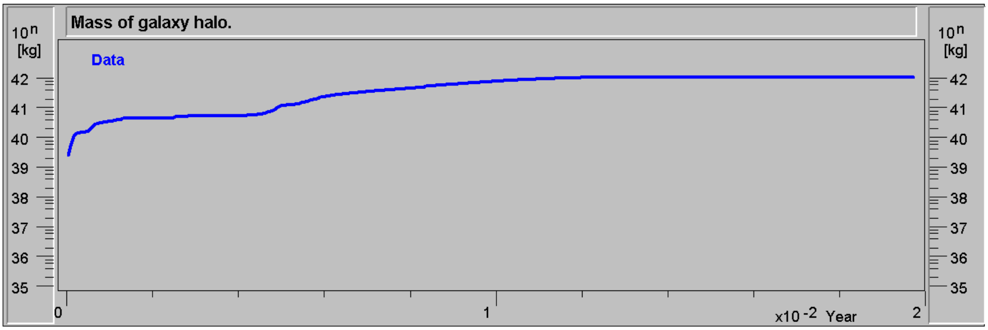

Fig 2.3.1. The evolution of the halo of a galaxy.

The size of the halo will grow in a slower pace. 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 2.3.2 the evolution of the size of the halo. It shows the first 5 million years.

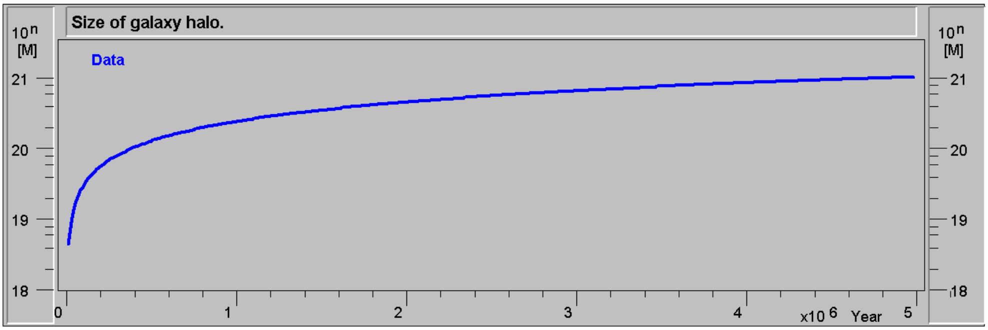

Fig 2.3.2. The evolution of the halo of a galaxy.

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 3*10^{-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 10-100 up or down as with the mass. In the latter 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.

In summary we have.

Typical structure	Mass [kg]	Size
Galaxy core Galaxy halo	10^{37} $5*10^{40}$	Like Sun 300 000 Ly

In next chapter we will give examples of how they may spread out.

[1] P.Swaczyna et al, APJ, Vol 903, no 1, 2020
[2] N. Lehner et al, APJ 900:9, 2020.

2.4 Confronting the galaxies

Some examples.

Galaxy core Mass [kg]	Galaxy halo Mass [kg]
$3.0*10^{36}$	$2.1*10^{39}$
$2.5*10^{37}$	$8.3*10^{42}$
$2.0*10^{35}$	$7.3*10^{37}$
$4.7*10^{36}$	$1.0*10^{41}$
$5.7*10^{37}$	$4.0*10^{40}$

We note that the values given can vary a bit. We see variations of a factor 10-100. We are investigating a sample of galaxies that are produced under various conditions. Later generations of galaxies seem to become smaller.

Generally, we see that the heavier the core the larger the galaxy. Since we are dealing with stochastic processes, we should expect to see variations. It is interesting to note that a study of galaxies and their cores arrived at the same conclusion [1]. They called their finding “totally revolutionary”! Being a bit less bombastic we note that our predictions are in good agreement with observations.A more recent study lead to the same conclusion [2].

January 2022 NASA reported on two smaller galaxies with supermassive cores. This was achieved by the Hubble and the Chandra telescopes. One, denoted Mrk462, was estimated to be about 100 times smaller than our galaxy and with a core about $2*10^5$ suns [3].

The other one, Henize 2-10, size 1/10 of our galaxy and a core of 10^6 suns. This is the first observation of smaller galaxies having super massive cores [4]. They are not easy to spot. Before that one thought that only large galaxies could have such massive cores. The astronomers concluded that the core accretes material that form stars. This is just in agreement with our description.

The first indications came already 2011 [5] by observation of distinctive x-ray emission.

We conclude that our predictions seem to fit well with present observations. A survey of small galaxies was performed by [6]. Turning back to the object GNz7q [7] it is noted that the halo is rich in star formation which fits well with our description.

Looking at the very young galaxy (GLASS-z13) observed by JWST, it is noted that it is quite massive. Similar young candidates have been observed. As we have seen galaxies can be build quite early, within around 5 million years and still massive in agreement with these observations. The reason that they can build quite fast is due to the massive cores. There is plenty of material available at the beginning. The cores can accrete material much faster than it takes to build a star e.g. A star starts off from density variations which are much smaller.

Very recent observations from JWST now reveals galaxies with very high z, z>11 in fact. This is quite amazing. To determine their age, we need a precise value of the Hubble constant. Various estimates exist in the literature, however.

Two candidates at z>16 was reported [8] being about 250 million years old but a bit small, estimated to $10^{8.8}$ suns. As we found in our fourth book a star has reached 2% of its final mass after 100 million years. Since the stars are still building up we can understand the reason for a smaller galaxy. This fits very nicely with our predictions. Another article [9] report that galaxies in the range z 7-9 are quite small but still quite massive, 10^{10} times the sun.

Summary

Young galaxies observed at large z are quite small. As we have found this agrees with our finding that a star has reached 2% of its mass after100 million years.
The true mass we cannot see since it is due to cold gas.

A star has reached 90% of its mass after a Gyr about. Even then we cannot determine the exact mass of a galaxy. We do not know how much cold gas there might be.

[1] Magorrian et.al,APJ , 115:*2285*-2305, 1998 June

[2] Jennifer I-Hsiu Li et.al., APJl, 954:173 (19pp), 2023 September 10

[2] NASA, Chandra, Jan 11 2022

[3] Zachary Schutte and Amy E Reines,*Nature* **vol601**, pages329- 333 (2022)

[4] A.E Reines etal, *Nature* **volume 470**, pages66–68 (2011)

[5] M.Molina etal,The Astrophysical Journal, 922:155 (23pp), 2021 Dec. 1

[6] S.Fujimoto etal, Nature, volume 604,p.261-265(2022)

[7] H.Yan etal,The Astrophysical Journal Letters, 942:L9, 2023 January 1

[8] Hakim Atek etal,MNRAS 519, 1201–1220 (2023)

[9] J. Baggen et.al, APJ 955:L12,2023 September

2.5 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 at the beginning. 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, 90% after about 1Gyr. In a review by NASA it is said that theoretical estimates expect stars to appear around that time. The time to fully build a star is close to 10 Gyr (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 10-100 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 2.5.1 the evolution of a star. It shows the first $5*10^9$ years.

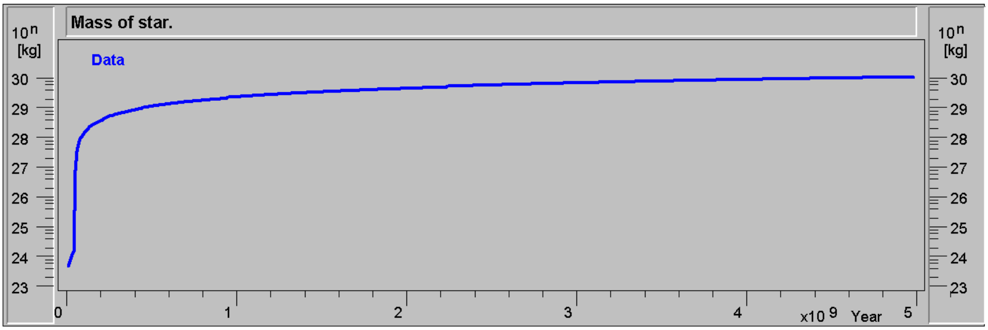

Fig 2.5.1. The evolution of the mass of a star.

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. 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). A planet has acquired 2% of it mass after about 100 million years, 90% after 1 GYr. The time scale is about the same as building stars for the simple reason that the basic process is the same. 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.

The evolution of the planets looks similar to the evolution of stars. 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.

We could summarize by

Typical structure	Mass [kg]	Size
Galaxy core	10^{37}	Like Sun
Galaxy halo	$5*10^{40}$	300 000 Ly
Star	10^{30}	Like Sun
Planet	Like Jupiter	Like Jupiter

2.6 Confronting the planets.

Below we will give a more detailed chart of the planets we find.

Distribution of planets.

Mass [kg]	Size[M]	Distance[kM]
$2.0*e^{25}$	$3.5*10^{7}$	$2.1*10^{7}$
$2.0*e^{23}$	$7.5*10^{6}$	$7.1*10^{8}$
$2.0*e^{26}$	$7.1*10^{7}$	$1.0*10^{9}$
$1.4*e^{27}$	$1.4*10^{8}$	$1.1*10^{10}$
$2.3*e^{27}$	$1.6*10^{8}$	$5.9*10^{11}$
$1.1*e^{28}$	$3.0*10^{8}$	$1.2*10^{12}$

We could compare to Earth with a mass of $6*10^{24}$ kg and radius $6*10^{6}$ M at a distance $1.5*10^{8}$ kM. We note that these are not exact values, just some samples. They in fact stem from different galaxies. It looks like larger planets are further away from the star than smaller ones. It should be easier to collect debris away from the star. Observations show that planets are divided into two groups. Earth sized planets constituting order of 30% and closer to the star. Larger planets, Neptune like, is found further out from the star [1-5]. Recently ESO discovered an earth-sized planet in the habitable Zone of Proxima Centauri , the nearest star [6]. Our sample is too small to make any conclusions, but perhaps an indication.

An interesting observation of two visible planets around a sun-like star was reported 2020 [7]. The planets are very young and still hot so they could be observed directly. The star is only 17 million years old and some 300 ly away.

Two directly visible planets.

NASA Exoplanet Archive	Mass [kg]	Distance[kM]
TYC 8998-760-1 b	$2.7*e^{28}$	$2.4*10^{10}$
TYC 8998-760-1 c	$1.1*e^{28}$	$4.8*10^{10}$

As a comparison the distance sun- Jupiter is about $8*10^{8}$ kM.

According to NASA (2022) some 5000 exoplanets have been found so far. What we are awaiting are observations that can give a chart of the population of planets around a given star. Perhaps the James Web telescope could provide us with that.

[1] D.C.Hsu et.al,APJ, 860:101 (15pp), 2018
[2] E.J.Lee et.al,APJ, 941:186 (17pp), 2022 December 20
[3] Petigura_AJ_160_89, 2020
[4] Hsu etal, AJ_158_109, 2019
[5] W.Zhu, etal,_2018_ApJ_860_101.
[6] Anglada-Escude et.al, to be published, 2022.

2.7 The formation of the atomic elements.

We have seen how the debris created during the evolution of the cores leads to the halo of the galaxies. We have shown how stars and planets can be formed from the debris. We are now going to investigate that process in more detail. We would like to find out how the various atoms can be formed. It all starts with the formation of compounds already after some hours of the halo evolution. The particles flying around right at the beginning are simply too energetic to bind.

Due to collisions between the original protons, neutrons can be formed. Protons can also turn into neutrons by interacting with electrons, which are quite numerous. The particles will lose energy and slow down while the halo expands. The distances between particles are quite small at the beginning but increase along the expanding halo, fig 2.7.1.

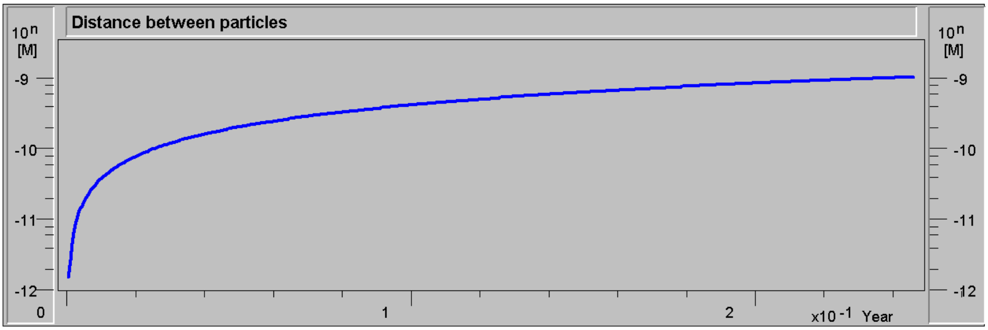

Fig 2.7.1. The distance between particles during the first few months.

The distance will continue to grow when the halo expands further. After a year it comes up to 10^{-8} M. This is the time when we start to form the atoms.

For each debris we calculate the cross section for an interaction. From the distribution of nuclei, we choose one by drawing a random number. The size of the nuclei is estimated from the formula $R=A^{1/3} * 1.2\text{ e-}15$ M. We add a proton or a neutron, again by drawing a random number. We check that it does not lead to an unstable nucleus. If there is a neutron deficiency we eject an alpha particle. If the other way around we eject one or more betas turning neutrons into protons. We have assumed there is about the same number of protons as neutrons to begin with. The procedure will make sure that we achieve the right neutron to proton balance irrespective of the mixture of incoming protons and neutrons.

In fig 2.7.2 the result is displayed.

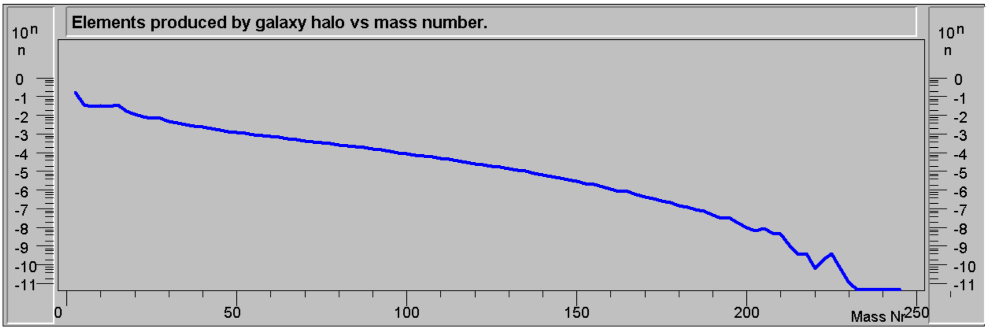

Fig 2.7.2. The abundance of elements as function of the mass number.

As seen, the spectrum ends at a mass of about 245. The reason is that we need a more refined stepping. Unfortunately, the execution time simply becomes too large. When we started off, we used a courser stepping but quickly realised that by refining it we could reach further. When we compare to recent observations [1] for the above region, we anyhow find an acceptable agreement. The middle region is perhaps slightly too large. However, when stars start to contribute the shape might change a bit. Fig 2.7.2 just shows the primordial distribution which we will not observe today.

The procedure does account for more subtle details like energetic incoming protons that might split a nucleus. We split it into one piece of 2/3 and one 1/3. In doing so we must take care for the varying binding energies. A deuteron has 2 MeV binding energy rising to 8 MeV for elements above around 20. However, we see just a small effect, probably because the frequency of protons with enough energy is not too large.

It is interesting to note that the spectrum measured [1] is from our solar system. As we see, the spectrum we arrive at is created long before stars are built. By time, the stars will help filling it out. We have not tried to simulate that process since it is a bit tricky, but in principle the same. The curve will continue to drop, and the higher elements will not contribute in any noticeable way since they are rare. The spectrum we build starts as soon as the galaxy halo builds up. Particles are quite energetic and if we convert it to a temperature, we find it to be the same as in the centre of a star, in fact a bit hotter to begin with.

Having this noted, we can make a more profound conclusion. The energies the particles have is due to the original process of creating the particles. When the halo starts to build by fragments from i.e., colliding cores, released particles can have an energy worth of a mass. Due to collisions when trapped into the halo their energy will drop to a level corresponding to the conditions in the centres of the stars. Thus, we can take this as a proof that our description of how the universe was created is correct. If it would be wrong we would hardly achieve the result shown.

As soon as the halo starts to build up compounds can be created. Half the spectrum in fig 2.7.2 is filled within a few hours, the spectrum will be close to be filled after less than a day, but it will continue for about a year. The halo is reaching its maximum density at the first moment, namely 10^9 kg/m^3, just about a million times the density of our earth. The size of the halo is only of the order of 10^{10} M while the mass of the halo is close to its final value. As mentioned earlier we are investigating various galaxies produced under different conditions. They vary in size and mass. We see that the net number of elements that come out may differ a bit (10% or so). A smaller galaxy can give less elements and the cause for this is that the density at the beginning is somewhat smaller.

Summary

Compounds are created just at the beginning of the evolution of the galaxy haloes before stars appear.

This means that the belief that compounds only are created by the stars is not quite correct.

Having elements, we can start to construct atoms, which we will do in the next chapter. But we will have to wait some time. There is simply no space for atoms to form.

[1] John J. Cowan et al, Rev. Mod. Phys. 93, 015002 – February 1 2021

2.8 The formation of atoms and photons.

It will take some time before atoms can be formed. The moment when the compounds are formed the density of the halo is close to its maximum. There is simply not space enough for atoms to form. Also, things must calm down because otherwise the atoms will lose any captured electrons within the next nanosecond or so. In fact, atoms start to build after half a year about. The size of the halo is still only about 10^{-2} ly but the density has dropped to .2 kg/m^3 about. This is the requirement we will apply to start to build atoms. We will have a look on what this means concerning the distance between particles below.

The created nuclei can accumulate free electrons which will lead to the production of photons. There are many more electrons available then there are other types of particles (not counting the numerous neutrinos). The completed atoms will also be bombarded by especially protons thereby ripping off one or more electrons or all if a direct hit on the nucleus. We consider the energies of the protons to estimate that process. We will also have full atoms colliding. We look at the energies involved to estimate how many electrons might be ripped off.

We will need a chart of binding energies of the various elements. The problem is that it is not easy to get the levels of heavier atoms due to the effect of screening. Outer levels are screened by the innermost electrons. We simply start off from hydrogen using the Dirac relativistic formulation of energy levels. To get the energy levels for heavier elements we apply the Hartree-Fock model to calculate the screening effects. We approximate it by a simple algorithm as discussed by for instance [1].

The electrons captured can jump directly to a matching hole or true a ladder depending on their energies. This happens when there are unfilled lower levels. The hole might also be filled by those in higher levels before capture. We look at the wave function to judge the probability for such events. As you understand things are getting quite complex. The ladder is traversed in steps such that the rule $\Delta l = ^{\pm}1$ is fulfilled, but occasionally through a double step as judged from the wave function. The weight of the event will drop by every step taken.

We check out that we fill the levels according to expectations. We show in Fig 2.8.1 how the spectrum of photons comes out. The vertical scale just shows the relative number of entries (weighted).

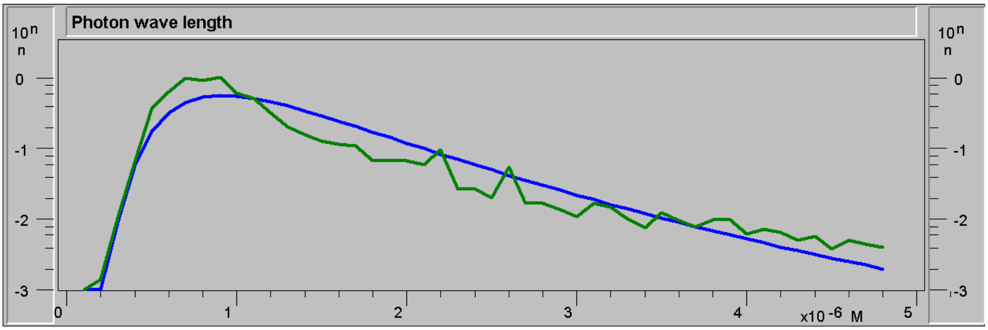

Fig 2.8.1. The distribution of photons created as a function of the wavelength. The curve is a blackbody with 3000K.

The data is shown in green. The blue curve is a black body spectrum with temperature of 3000K. Our calculated curve falls off a bit steeper, but we must stress the fact what you now are looking at is the primordial distribution of photons. That distribution you will not observe today. We must be aware that by time photons will scatter around and smear out the distribution. There are plenty of free electrons available to scatter the photons. We will investigate that process in the next chapter.

[1] E.B. Paul, Nuclear and particle physics, North-Holland, 1969.

2.9 The cosmic microwave background.

The cosmic microwave background (CMB) was discovered in 1965. [1,2]. We will now describe how it may be created.

In the first process investigated, the photons we generated in the last chapter can scatter against atoms thereby kicking up electrons in higher orbits. The electrons will fall down creating one or more photons of lower energy. We know the phenomenon as fluorescence.

In doing so we keep track of how many electrons have been captured. An incoming photon most likely excite the outmost ones, but an energetic photon could hit an electron in a lower orbit. It may also eject one completely.

The second process we have considered is the one where photons scatter on free electrons thereby losing energy, namely the Compton scattering. They may also scatter elastically (Thomson scattering) but this is of no interest at present. That will just spread them around.

It turns out not to be very easy. In the first time step we must treat 10^{10} collisions. We must go through every single collision. We split it up in say 10 000 thousand smaller steps. This means that we still have a million collisions to treat for every small step. However, the number of collisions will drop drastically when the halo expands. To achieve this goal, we must find an algorithm (based on recursion) to process a million collisions in single statement. We used the Compton process which can be described by the Klein-Nishina formula [3]. In fig 2.9.1 we plot the result.

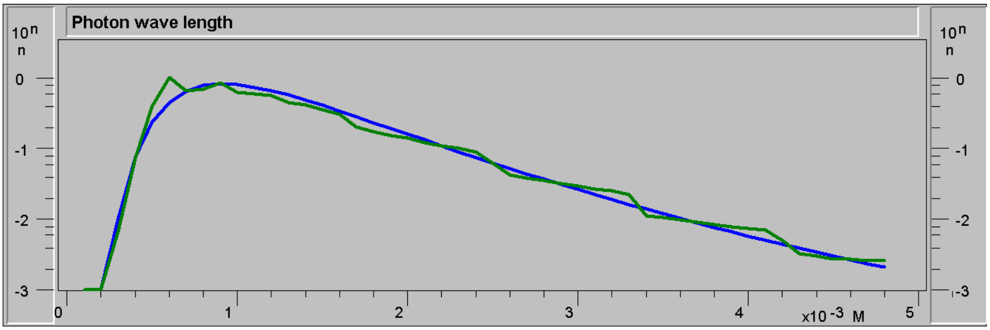

Fig 2.9.1. The distribution of photons after scattering as a function of the wavelength. The curve is a 2.725K black body.

The blue curve is a blackbody with 2.725K. The fit looks quite nice. The statistics we have is meagre. The problem is simply that the computing time runs away if we try to refine it. The mentioned algorithm should not distort the result but just take the runtime down. A precise measurement quotes a value of 2.728K[4].

Thinking on our approximate procedures we were a bit surprised. The procedure has been scrutinized not just once but many times and we find it solid. To get a feeling of the accuracy we let the number of collisions we apply very a bit. It results in an estimated error of .12 in the temperature. We must emphasise that without the scattering against free electrons we would never achieve a reasonable curve. Photons absorbed by atoms have quite a small effect, if any, on the spectrum and we have not bothered about that process.

In the Big Bang story, it is claimed that after atoms have been formed (the recombination) the universe was transparent. The problem is that there are no free electrons in that story that can do the job.

[1]. A.A. Penzias and R. Wilson, Astrophys. J. 142, 419 (1965); R.H. Dicke et al., Astrophys. J. 142, 414 (1965).
[2]Mather *et al.* 1994, *Astrophysical Journal*, 420, 439,
[3] E.B. Paul, Nuclear and particle physics, North-Holland, 1969.
[4]D.J Fixsen et al, APJ, 473:357-587,1996 Dec 20

2.10 The CMB spectra.

As we have described, the elementary particles are created in the very early processes before the galaxy haloes are formed. They fly around in all kinds of directions and are quite energetic. This is not a stable condition under which atomic nuclei can be formed, even less to form atoms. It is not until particles get trapped into a galaxy halo these fundamental processes can begin. As have been noted it still takes some time before the conditions are the right.

The consequence is that it is the galaxies themselves that create the photons that constitute what we now call the microwave background radiation. When this happens, the galaxies are not more than about a few light years from each other. This means that we could expect to have a large contribution of photons coming from other galaxies. The scenario we have pictured is completely different from cosmological models where the evolution starts by an unspecified soup.

However, as we have noted we see no direct difference of the photon spectra between various galaxies. To remind you, we are looking on a sample of galaxies produced under somewhat different circumstances. By the time we observe the photons they will have spread out, that is the condition today is not the same as it was earlier.

The conditions at their creation will be completely masked by now. Photons will scatter on free electrons. To remind you there are about 2000 more electrons created than protons at the beginning of the evolution. Part of them will bind in atoms, but only the lightest will count which means that the main bulk will survive. For each10th hydrogen atom a helium atom will be made binding two electrons, which means that the number of electrons counted per proton will not change. The consequence is that there will be numerous scatterings going on since the beginning which certainly will smear out the distribution of photons. In contrast, in the Big Bang scenario it is claimed that there was no scattering after the so-called recombination. In difference, we expect that the distribution of photons should become quite even by time. No trace of what happened once upon a time. That is the reason why we just assume that the density fluctuations will be random. As a result, we just draw a random number to get an estimate of the fluctuations. In fig 2.10.1 we plot the result over the hemisphere.

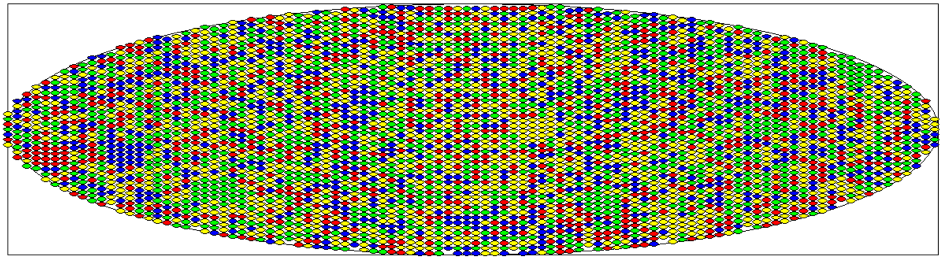

Fig 2.10.1. The CMB spectrum.

The colour encoding is as follows, red means 1σ larger energy/temperature, yellow 0-1σ, green 0-1σ lower and blue below that. We have not tried to find an absolute scale since that is a bit tricky. We need to know the various sources of photons and their intensities.

The spectra shown look like observations. That is, just a random distribution. This means that the anisotropic behaviour that has been claimed seems to be just statistical fluctuations. To investigate the behaviour, we made an analysis in terms of spherical harmonics in the same way as data have been treated. The result is shown in fig 2.10.2

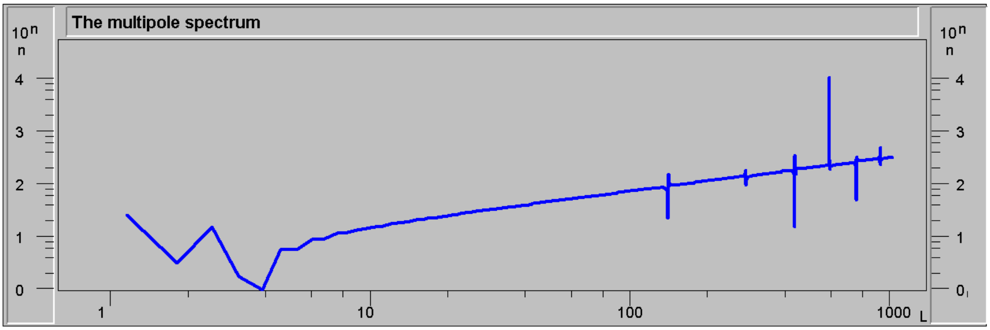

Fig 2.10.2. The multipole spectrum. The y-axis is logarithmic.

As seen we have a level (l=1 is just the starting value) with structures at l=2 and 4 followed by a rise. The y-axis is logarithmic to visualize the low l-region. In difference, data also exhibit a decline for l larger than 300 but else looks similar. However, our fitting procedure does not seem to be very sensitive to large l-values. It was designed for fits with much smaller number of parameters (order 10-15) and works well in these cases. We have not tried to change it. We thought we should mention it in case this might be the cause for the difference. However, we just do not see the physical importance of the analysis of larger l-values.

There may be another cause for the discrepancy. Acquired data are manipulated in various ways. In at least one case the background from our own galaxy was withdrawn. As we have seen it is the galaxies themselves that create the cosmic background. If we subtract it what will the result be? We also note that one is correcting for our motion around the galaxy. It means that some absolute reference frame has been assumed. If the galaxy itself is creating the photon distribution one can think it as such also follows the rotation. We must remember that the atoms creating the photons is moving along with the galaxy rotation. If the cosmic background does not stem from our galaxy but from an earlier event, should we then not correct for the motion of our galaxy as well? The question is with respect to what.

At the beginning of the evolution the density of galaxies was quite high. When we look into the details we see that when the haloes developed they could almost overlap. The influx of photons from neighbouring galaxies should have been large. On the other hand, the photons should have spread out by now. However, influx later in the evolution could give raise to grains/asymmetries in the photon distribution that have not yet been washed out. We have not tried to implement such a scenario.

Conclusion

We find that the observed CMB distributions seem to be consistent with statistical fluctuations.

However, we cannot exclude there may be sources of photons that impact more limited regions on top of statistical fluctuations.

We see no reason to assume a perfect isotropic distribution. Possible variations outside of statistical ones seem quite natural. We do not know how the electron cloud is distributed. We could expect that variations in that cloud lead to variations in the photon distribution. We do not need to invoke any fancy exotic mechanism. We must clarify why we arrive at quite a different view than cosmological models based on the Big Bang. No one can deny that the universe is built on the elementary particles. Unfortunately, the Big Bang does not explain how these particles were created, especially the free electrons that are important for the photon spectra. In contrast we have given a possible scenario in chapter 1 and the consequences there off in chapter 2. It is what happened right at the beginning that leads to the different results.

2.11 Discussion.

The CMB spectra is always discussed in terms of cosmological models all based on the Big Bang. As we have tried to point out there are problems with the latter. The major point is that it does not explain how the elementary particles were created but just assume there was an amount of atoms available before some kind of potential was erected giving rise to an exponential expansion of the universe. All within the Planck time. This led to the so-called recombination from where on no scattering of photons took place.

In difference to our model, we explained how the fundamental particles could be created. Due to the Heisenberg uncertainty principle much more electrons than protons were produced. Neutrinos even more. Even after the formation of atoms there will be a good deal of electrons floating around. This means that there is no last scattering of photons. They will scatter even today and continue to do this for ever.

Our process leads to supermassive objects (SMBHs) that constitute the cores of the galaxies. The creation of these cores evolves quite quickly, in fact around 15 minutes but much slower than the Big Bang. A bit more realistic we would say. There is nothing mentioned about these cores in the Big Bang.

It is interesting to note that in accordance with present observations most galaxies have such a super massive core. These cores are different from the black holes that are formed by dead stars. However, the difference between the two models is more profound. As we explained in our first book the galaxies will move outwards in form of a broad band, which means that the centre of the universe would be more or less empty (except for the very first core and some that might be captured in orbit around the central core).

Exactly how the impact on the CMB might differ we have not tried to figure out. We could just mention that the effect of lensing should come out differently. An outgoing photon would sense the changing gravitational potential in the Big Bang scenario, the ISW effect [1]. In our scenario the outgoing photon would see a gravitational potential close to zero. This means that the incoming and the outgoing photon would be unchanged except for a deflection.

Especially the presence of numerous electrons flying around affects the whole picture. There will be much more scatterings of photons than in the Big Bang scenario (none as claimed). This is the main reason why we expect the effects of various sources to be washed out. Thus, a randomized distribution.

Finally, we note that new results from BICEP3 [2] tell us that inflationary models seem to be unlikely. It would be interesting to see how cosmologists would treat the picture we have given.

[1] Sachs, R. K. & Wolfe, A. M., Perturbations of a Cosmological Model and Angular Variations of the Microwave Background. 1967, ApJ, 147, 73

[2] P.A.R. Ade et al., Phys. Rev. Lett. 127, 151301 (2021)

2.12 Confronting the CMB

As we have discussed the photon distribution of a black body of 2.7 K is caused by numerous electrons floating around. Photons will scatter on the electrons and loose energy by the Compton process. How do we know there exist free electrons?

An article [1] has reported on evidence for dense electron clouds in the interstellar region. A typical density of 100 electrons/cm^3 or 10^8 electrons/m^3 is reported**.** Another article [2] report an electron density of 300 electrons/cm^3.How does this compare to our estimate of the number of electrons?

A measurement of the hydrogen density outside of the solar system found a density of 3*10^{-22} kg/m^3 [3]. That corresponds to roughly 10^5 protons/ m^3 and with our estimate of 2000 electrons per proton we get 2*10^8 electrons/ m^3. Not to far from the 1-3*10^8 electrons/m^3 now reported. We take it as our calculation of the scattering of photons against electrons giving a black body distribution of 2.7K is very reasonable.

[1] A. B. Pushkarev et.al, arXiv:1305.6005v1 [astro-ph.CO] 26 May 2013
[2] Y. isobe et.al, APJ, 956:139, 2023 October 20
[3]. P.Swaczyna et al, APJ, Vol 903, no 1, 2020

3. The Dark sector and missing particles.

We discussed this in our last book, but we think a reminder would not be wrong. We like to clarify the connection to our findings. New observations come along all the time. We will also come back to the question of missing antiparticles.

3.1 Black holes.

From chapter 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 2.2 recent observations confirm our result. The more observations that come along, the stronger the statement that in practice all galaxies have a massive core becomes.

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. But it all depends on the mass of the core.

An example. A proton in the core that is released from it bonds can have a kinetic energy of 1 Gev. If we say have a core of 10^{37} kg and a radius of 10^{10} m the binding energy of a proton at the surface is roughly 1Gev! It can certainly leave the core.

It has been discussed whether the supermassive black holes can be explained by accretion. As we discussed in chapter 2.2 very young galaxies, around 700 million years and recently observed, has massive cores. At that time not even stars have reached their final mass, so how can an object some million times heavier have built up? An earlier review also came to the same conclusion [1].

[1] A D Dolgov, Physics-Uspekhi, Volume 61, Number 2

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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 [2,3,4] all report negative results. Likewise, a search for WIMPs reports a negative result [5]. This also holds for leptophobic dark matter searches [6].

A recent report [7] 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 [8] 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] PhysRevLett.129.061801
[5] A.Aguilar-Arevo et al., Physical review Letters 125,24803 (2020)
[6] A.Aguilar-Arevalo etal.,arXiv;2109.14146v1 [hep_ex]29Sept2021
[7] E.April et al., Physical review D102,0720004 (2020)
[8] M. Menighetti et al., Mon. Not. R. Astron. Soc. 472,3177(2017)

3.3 Where did the antiparticles go?

Rest assures, they are there. From part 1 we have seen how particles can be created. A vacuum bubble can burst into a number of particles leaving bound pairs of particle-antiparticle. When the process evolves it leads to massive cores again containing equal amounts of the species. Debris that are produced during this process we let annihilate to 80%. We assume the rest will get separated so that we have islands of pure matter respectively antimatter.

As we stated in our first book a neighbour solar system might be made of antimatter. Before we try to travel to another system we should investigate what holds. Such travels will most likely take place in some not-too-distant future. Our statement has recently been strengthened by the possible detection of antihelium nuclei by AMS-02 according to [1].

[1] Simon Dupourqué, Luigi Tibaldo, and Peter von Ballmoos

Phys. Rev. D **103**, 083016 – Published 20 April 2021

4. Summary.

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

In our first 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 the centre of the galaxies. Very recent observations now show that the cores do not grow by accretion over time as has been generally believed. Younger galaxies have larger cores. What happens is that material falling in on a core may break the bonds of the bound particle pairs which lead to annihilations. The core will thus shrink by time, not grow.

In the third book we augmented that study with the formation of the halos of the galaxies as well as the creations of stars and planets. We note that the results are in good agreement with observations. These observations show that the mass of a galaxy scales with the mass of the core.

Observations show that planets are divided into two groups. Earth sized planets constituting order of 30% and closer to the star. Larger planets, Neptune like, is found further out from the star. We do have such an indication in our small sample.

In our fourth book we have shown how the atomic nuclei are formed when the galaxy halo is building up, long before there are stars. A bit later, atoms are formed giving rise to a primordial photon spectrum of a black body of 3000 K. Due to scatterings on free electrons the photon distribution boils down to 2.7K. At end we find that the observed CMB spectrum is consistent with statistical fluctuations.

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. 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 comes up as the most likely candidate.

We also like to mention our findings in our second book. Through a specific quantum mechanical process, we could predict the known forces, specifically the magnitude of their couplings. The forces are created by the gravitational force. It is the most fundamental force of them all and must always be erected when particles are created.

In all we have a consistent physical picture of how nature can create a universe with the known fundamental particles and their corresponding forces. It starts off from the production of real particles from which we build our universe.

5. 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 20 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).