Neutrons in Atomic Nuclei : an Alternative Model of Atomic Structure

by

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A. Introduction

The reported characteristics of neutrons seem to contain some contradictions. The observations on which they are based are not themselves in question, but there are apparent conflicts in the conclusions drawn which suggest the presence of some more fundamental underlying phenomenon. This note proposes a reinterpretation which may shed new light on the structure of atomic nuclei themselves, and hence a new model of the structure of the atom.

B. The contradiction

Neutrons n are formed by the combination of protons p and electrons e^- at very high temperatures and pressures. So in general terms:

$p + e^-$ make n at very high temperatures and pressures

However, it is observed that neutrons decompose into protons and electrons at normal temperature and pressure with the production of electron antineutrinos. The neutrino and presumably its opposite have no mass or charge, although recent measurements suggest that it may in fact have a mass which can be considered as vanishingly small in this context. However, an equally likely explanation seems to be that the neutrino is in fact a form of electromagnetic radiation, probably of extremely high frequency, produced by the acceleration of particles during the rearrangement of the neutron's structure.

In this case the electron antineutrino would have no bearing on the particles which it left behind. There is some evidence to this effect, since the decomposition is not just a clean break, dependent on the kinetics of particle collisions and activation energies, as is assumed in chemical reactions, but a decay with a half-life of about 10 minutes. This is a time-dependent process, with some particles decaying earlier and some later, which may indicate the gradual loosening of an orbital interaction within each individual particle independently. This is the sort of effect which could be triggered by some stochastic influence external to the nucleus itself. However, the overall result is that:

n decomposes into $p + e^-$ at NTP with a half life of about 10 minutes

Taken together these two statements do not ring true; it seems most unlikely that a particle forged at the temperature of the stars will fall apart spontaneously in a glass jar in the laboratory.

Furthermore, neutrons appear to exist indefinitely in perfectly stable nuclei in all the naturally occurring atoms of the Periodic Table. It is only when a neutron is removed from a nucleus that it apparently becomes unstable. This is the reason why neutrons are not considered to be 'fundamental' particles. This behaviour is said to be the difference between neutrons which are 'free' and neutrons which are located among nucleons in the nucleus. But they are nevertheless considered to be the same neutron particles in both cases.

C. An alternative

However, it is possible to draw a different conclusion, namely that the term 'neutron' is being used to describe two different entities. Neutrons which are observed to decompose spontaneously are free and separated from nuclear structures in which they interact with other nucleons. It is interaction with other nucleons within the nucleus which gives them indefinite stability in the whole range of elements in which they occur. The interaction has a physical basis i.e. the particles are not simply keeping one another company, as implied by the description of being in the presence of other nucleons. The nature of this interaction must be electric charge i.e. the interaction of negative electron with positive proton.

It seems likely that this is the same interaction which is created at very high temperatures and pressures during the formation of a neutron. The deduction here is that an electron is forced by high temperature and pressure into association with two or more protons, which has been interpreted as a neutron plus a proton. The association with two protons occurs because this configuration is more stable than an electron in close orbit around a single proton, that is in effect the same as the 'free' neutron which is known to decay or be unstable even at low temperatures. Thus the additional protons are 'the other nucleons' whose presence is observed to be necessary to stabilize the neutron in a nuclear structure. The interaction of these extra protons with the first proton and the electron must be electronic in origin, because there are no known gravitational effects which do this.

The corollary is that atomic electrons come in at least two categories: extranuclear electrons which are shared between atoms in chemical reactions to form molecules; and intranuclear electrons which are in close association with protons in atomic nuclei.

Thus there need be no inconsistency between the equation for formation of neutrons at high temperatures and their stability in atomic nuclei over the whole range of temperatures, provided there is at least one extra proton in both cases with which the stabilizing interaction can occur. The minimum structure which is known to support a neutron is in fact the deuterium nucleus, and so it seems that what is at present known as a neutron can be formed by the close electronic association of a single intranuclear electron with two protons.

However, it cannot be concluded that each intranuclear electron must have two protons to itself; two intranuclear electrons interact with three protons in the nucleus of tritium, though this does not occur naturally, and four intranuclear electrons interact with seven protons in the lithium nucleus, which certainly does. It is obviously more complicated than a simple ratio of 1:2. It seems that some kind of sharing of is going on, which suggests that the electrons are in orbits, and that these orbits encompass more than one proton.

D. New notation

The argument can be simplified as follows by using brackets in algebraic style to elaborate the logic in a simpler form without pre-empting the nature of the interaction which occurs. We have deduced that:

<$p + p + e^-$ > becomes <*p interacting with p which interacts with* e^->

When the interaction has occurred, it continues to exist over a wide range of temperatures, and can be written as:

<*p*> interacting with <*p interacting with* e^- >

This state of interaction is at present interpreted as

<*p*> co-existing with <*n*>

In this case the reaction at high temperatures and pressures forms not just a neutron but a neutron interacting physically with a proton. The question then is how does the electron know with which proton it is supposed to interact at any instant?

Spatial separation does not seem to be an option, because the orbits are 'close' i.e. much closer than between the nucleus and a conventional extranuclear orbital electron. In addition there is no reason to think that the electron would choose to interact with only one of the protons, having decided that one proton would not be enough. The conclusion is that an intranuclear electron must interact with at least two protons equally during and after formation of the nucleus. Hence the conclusion that the electron must orbit around more than one proton.

The process can be made more obvious if we adopt a simple full stop instead of the word 'interact'. In this case a proton interacting with a neutron would be *p.n* and a neutron would be $p.e^-$ etc. Thus:

p.n is the same as $p.p.e^-$

or alternatively

p.n is the same as $p.e^-.p$

If this reasoning holds good, it is probably better to abandon the term ‘nucleon’ entirely and refer only to intranuclear electrons and protons.

E. Application to the Periodic Table

All nuclei of atoms of the Periodic Table in which neutrons are found also contain protons. Using this notation, the structures of atoms can be built up form hydrogen as follows:

hydrogen	p
deuterium	$p.n$ which is the same as $p.p.e^-$
tritium	$p.n.n$ which is the same as $p.p.e^-.p.e^-$
helium	$p.p.n.n$ which is the same as $p.p.p.e^-.p.e^-$
lithium	$p.p.p.n.n.n.n$ which is the same as $p.p.p.p.e^-.p.e^-.p.e^-.p.e^-$,

and so on.

For deuterium $p.p.e^-$ may also be written as $p.e^-.p$, and the need for symmetry implies the following nuclear structure (Figure 1):

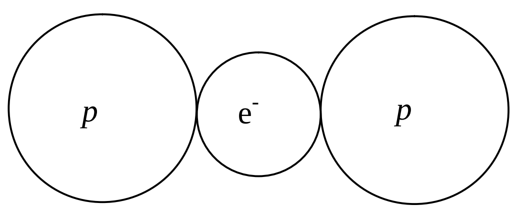

Figure1. The deuterium nucleus

Keeping all logical options open, the negative charge may remain attached to the mass of the electron i.e. located on the electron particle, or it may be separated in some way from the mass of the electron particle, and distributed as a negative aura or shell around the protons as in Figure 2.

The most likely model is that the negative charge is distributed around the protons by the rapid movement of the negative electron particles, which is in keeping with the observation that extranuclear electrons orbit nuclei at, say, a third of the speed of light. Intranuclear electrons would orbit much faster still, because they are much closer to the centre. This is the most likely model, and it can still be represented as some kind of aura or shell, because we do not know the nature of the orbits (Figure 2).

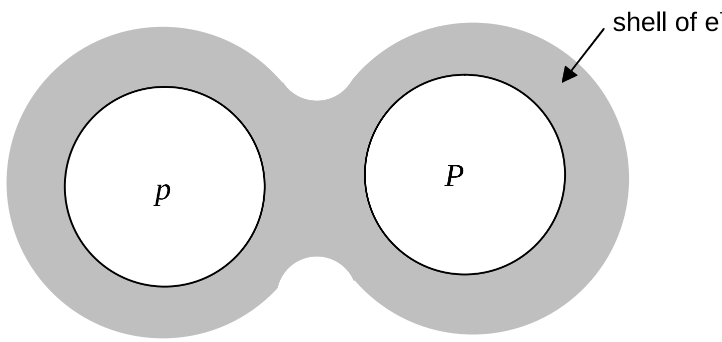

Figure 2. The deuterium nucleus with distributed negative charge

Pursuing the same logic, the tritium nucleus would be $p.p.e^-.p.e^-$ or $p.p.p.e^-.e^-$, which may be represented as:

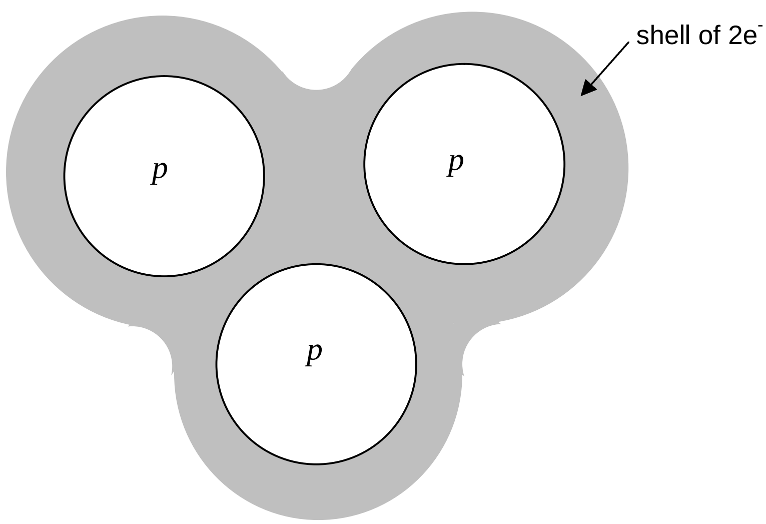

Figure 3. The tritium nucleus with distributed negative charge

F. The helium nucleus

The helium nucleus would then be *2p.2n*, which is $p.p.p.e^{-}.p.e^{-}$. This might be depicted in two ways, because there is the possibility of three dimensions. Previous analysis proposed that the nucleons should all lie in a plane as in Figure 4, because the contribution of the neutrons was to keep the protons apart (Reference). Any other configuration would allow the protons to come closer together.

However, since it is now proposed that all four nucleons are protons, their most likely configuration is a tetrahedron surrounded with two electrons in close orbit (Figure 5). This is a more compact structure, which would be in keeping with its survival outside the atom as an alpha-particle. It could also form a unit that repeats itself in the nuclei of the elements C-12, O-16, Ne-20, and Mg-24 which contain equal numbers of protons and ‘neutrons’. These also correspond to minima in the curve of packing fraction against mass number and to maxima in the curve of binding energy per nucleon against Mass number, which is an indication of stability. Progress up the Periodic Table is by the addition of more protons and electrons to the nucleus, until the next higher position of stability.

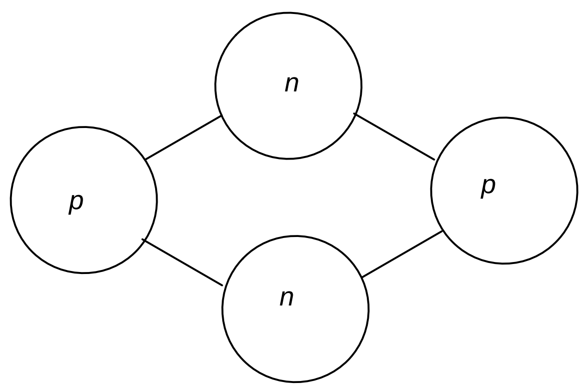

Figure 4. The planar configuration of the helium nucleus

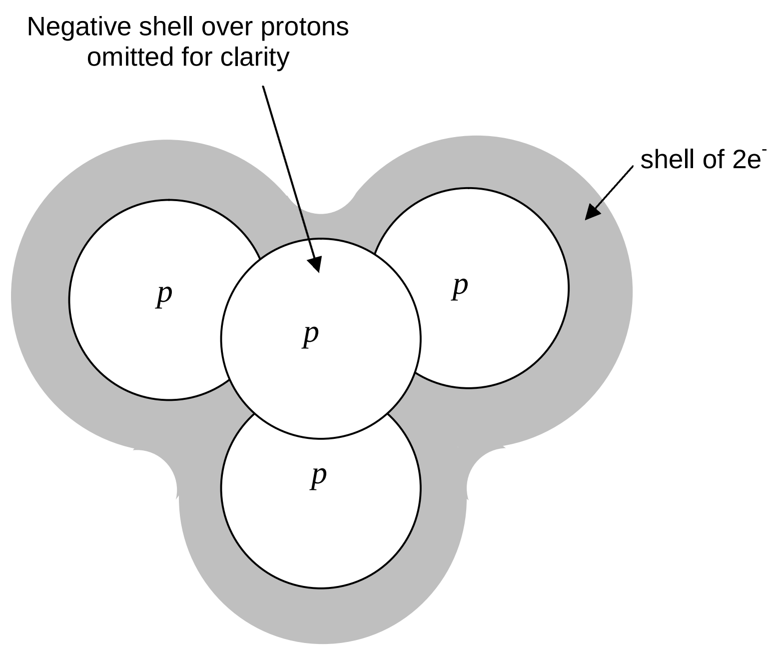

Figure 5. The tetrahedral form of the helium nucleus with distributed negative charge

G. New model of the nucleus

The corollary of this analysis would be that neutrons as distinct entities do not exist inside atomic nuclei. When applied to a nucleus, the term ‘neutron’ in fact describes the interacting structure of intranuclear protons with intranuclear electrons. When a proton is expelled from a nucleus by a missile, it takes an electron with it in close orbit which is in effect an entity that we call a neutron.

The ‘free’ neutron is therefore the only true ‘neutron’ as a distinct species of particle, and it does not last very long. Its half-life can be explained by the unwinding of the close orbit of the electron around the proton stochastically over time, about 10 minutes, into an orbit which is much bigger and more sustainable. In this orbit the electron is much more loosely bound and extranuclear. In other words it becomes a hydrogen atom.

The model of the atomic nucleus which results from this analysis is as follows:

- at the core is a structure of protons which are all repelling each other because of their like charges, so that the structure is trying to explode,

- intranuclear electrons closely orbit the protons, and exert an attractive force between adjacent protons, which pulls them together to form the nucleus,

- the orbits of the intranuclear electrons around the protons are synchronized to keep their like negative charges as far apart as possible at all times, and

- the velocity of the electrons is even greater than that of extranuclear orbital electrons, which are said to orbit the nucleus at about a third of the speed of light.

This model of the nucleus may explain the emission of X-rays and gamma-rays under some conditions. The new model of the atom, which was described elsewhere (op.cit.) proposes that electromagnetic radiation, for example in the visible region, is emitted as a result of the acceleration of an orbital electron through the medium of space during its transit from one orbit to another. Orbital electrons are the extranuclear electrons which take part in chemical reactions and are considered to occupy shells in the Bohr model of the atom.

The intranuclear electrons in the model of the nucleus which is proposed here are in even faster orbits, this time around the protons in the nucleus, so that when they accelerate on transit from orbit to orbit within the nucleus or on ejection from the nucleus, they will emit electromagnetic radiation of even higher frequency. This will be in the X-ray or gamma-ray region, and could extend to even higher frequencies which current instrumentation may be unable to detect, though there is the possibility of mixing frequencies to form beats which can be measured. These high frequencies relate to changes in the structure of the nucleus, and could give information about its structure.

H. New model of the atom

The result is a model of the atom itself which is composed, at least down to the level of nucleons, of particles with positive or negative charges in two distinct but interacting systems.

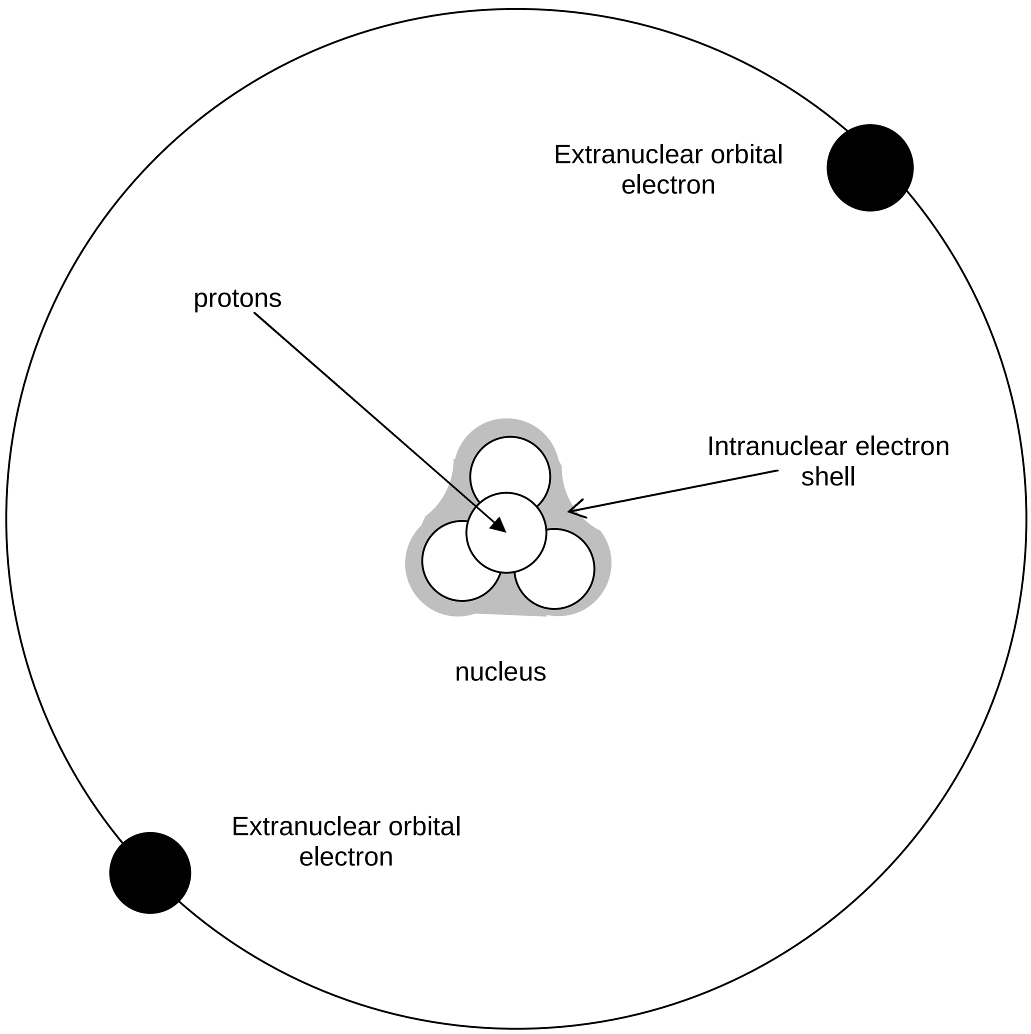

Figure 6. New Model of the Atom (Helium) with Distributed Negative Charge

There is the atom as an entity with its positive nucleus circled by orbiting electrons, which are the means of interaction with other atoms at the chemical level. Then there is the nucleus with its overall positive charge composed of a structure of protons stabilized by electrons which are in close orbit and equal in number to what are now called neutrons. This new model of the atom is shown in Figure 6.

I. Binding energy

The proposed model of the nucleus has a bearing on the concept of binding energy. Binding energy is defined as the potential energy that holds a nucleus together, and it is usually presented as a graph of binding energy per nucleon against Mass number A. This treats protons and neutrons as equivalent, and averages over all the nucleons.

The model of the nucleus proposed above suggests a complex process. All the nucleons are indeed alike; they are all protons. The potential energy that holds a nucleus together is a balance of three components:

- repulsion of each other by protons,

- repulsion of each other by electrons, though at least they are mobile enough to get away from each other, and

- attraction between electrons and pairs of adjacent protons, which holds the nucleus together in a definite spatial configuration.

This describes the effect of only the electric component. Magnetic, mechanical and gravitational effects must also be taken into account.

Removing a proton from the structure, say by bombarding it, also removes an electron if the ejected particle is a neutron. This changes the remaining electronic component of the nucleus proportionately more than the removal of the proton, because there are always more protons than electrons in the nucleus, which is by definition positive and so electron-deficient. The proton structure as well as the electrons' orbits will change to adopt the new lowest energy configuration. There will be new magnetic properties and new spins in a new structure. The helium tetrahedron suggests that there are parts of large structures which are particularly stable, and the preferred option might be to lose a complete tetrahedral unit as an alpha-particle rather than a single proton. When the electrons have all been removed by this process, there would no longer be any electronic glue and the remaining protons would simply fly apart, a negative contribution to binding energy!

J. Structure of the nucleus

The structure of the nucleus which emerges from this analysis is that of a continuously vibrating assembly of protons kept in a particular spatial configuration by intranuclear electrons orbiting them at close to the speed of light. The positive charges of the protons are continually pushing them apart. The negative charges of the electrons are continually pulling the assembly back together again, circling the protons and squeezing between them at their points of closest approach, because that is where the forces of electrostatic attraction are greatest,. The protons are all oscillating about mean positions, the electrons are all orbiting them in orbits which are determined by their like, repulsive negative charges which force them to choose orbits that keep them as far from each other as possible. The electrons are also oscillating in the senses that they are travelling in orbits around the 'fixed' masses of protons, but also in the sense that their orbits can precess under each others' influence or because of some outside intervention e.g. an imposed magnetic field.

The proposed model is a vibrating structure but it is held in a definite shape, because it is tightly controlled by the orbits of its intranuclear electrons. When it is struck by a 'neutron', the electron of the 'neutron' clashes with an intranuclear electron and disrupts its orbit. As soon as the 'glue' of opposite charges is broken at one point, the positive charges on the two large fragments force them apart. Fission occurs at the weakest point, either because that is the point at which the missile strikes, or because the velocity of intranuclear electrons is such that the force of the blow is transferred to that point at nearly the speed of light. The intranuclear electrons in the two fragments adjust their orbits at nearly the speed of light, and immediately force the protons which they are shepherding into a new, lower energy structure. The transition of the nuclei to more stable structures is accompanied by the release of considerable energy, far greater than in chemical transitions, because it involves intranuclear electrons which are orbiting much faster than the extranuclear electrons on the periphery of the atom. As such the energy of nuclear transition is not conveyed directly to other atoms and so become heat energy and an increase in bulk temperature, because it has first to influence extranuclear electrons of its own. Until that happens the energy of the nuclei takes the form of their intense vibration and their acceleration through space.

The model also suggests reasons why the nuclei of hydrogen atoms i.e. protons acquire neutrons very readily. If protons and neutrons come into close proximity, the negative electron which is orbiting the proton of the 'neutron', draws the other proton into the range of its close orbit because of the opposite charge. By similar reasoning it can be seen that the triangular structure of the tritium nucleus is likely to be less stable, because of the problem of two intranuclear electrons avoiding one another in close orbit around three protons.

K. Relation to historical theories of the nucleus

The concept of electrons in the nucleus was first postulated when protons were discovered. The relative atomic masses of elements were found not to be related by simple additions of protons to the nucleus, and the conclusion was that some protons in the nucleus were being neutralized by electrons inside the nucleus, without postulating their distribution. However, the theory could not account for the fact that the atomic weights of naturally occurring elements had odd fractions which appeared to bear no relationship to any kind of summation of the masses of protons and electrons in any proportions. This was before isotopes were discovered, and even longer before it was realized that different isotopes of the same element occurred in regular proportions.

However, two events put an end to the theory. The first event was the discovery of the neutron. It was no longer necessary to postulate the existence of electrons in the nucleus to neutralize the positive charges of the protons, because the positive charges were not there; the protons were in fact neutrons. This explained how different isotopes of the same element could exist. They were the same element because they had the same number of orbital electrons, which engaged in chemical reactions. They had different atomic weights because they contained different numbers of neutrons, which did not need electrons to balance them.

The second event was the Theory of Relativity. After the neutrons and the isotopes were established there were still small but significant fractions of atomic mass which did not quite match the sum of the parts. Relativity supplied the answer: mass was becoming energy, according to the famous relationship $E = mc^2$. Hence binding energies etc.

However, the analysis of my other papers suggests that the Theory of Relativity is probably based on false premises. The famous dilation of time, length and mass is a misconception. The apparent dilation of time is an electromagnetic effect; it does not occur, indeed it cannot occur with other methods of measuring elapsed time, such as radioactive decay. In fact it is also incompatible with a particle theory of light, whether my Rotating Electromagnetic Dipole or the photon.

There are other potential causes of the very small apparent discrepancies between calculated and observed atomic masses i.e. after isotopic variations have been included. For instance the relative atomic masses are measured with considerable resolution by mass spectrometry, which is the deflection of the paths of nuclei by magnetic fields. The presence of electrons orbiting in nuclei at velocities close to the speed of light might well cause an electromagnetic interaction which is wrongly being attributed to a Newtonian mass.

A liquid-drop model was first worked out in detail by Bohr in 1936 to explain how a particle could be emitted from the nucleus. Collision of particles within the nucleus might at some stage and at random concentrate enough energy on a single particle to cause it to fly out. This might account also for the ejection of an assembly of particles in the form of an alpha particle. Similarly, wobbling of a large liquid drop might also lead to its splitting into two drops when struck by a neutron, which is nuclear fission.

The dilemma of the neutron's nature has led to an exchange theory of particles. An electron is a fundamental particle in a way that a neutron is not. As such an electron cannot be subdivided, and so if a neutron decays to give a proton and an electron, the electron must be present in some way in the neutron.

The first idea was that a proton and neutron in some way exchange their character, so that a proton instantaneously transforms into a neutron and just has quickly changes back. Thus if a neutron was observed to decompose into an electron plus a proton, the transformation had simply been caught on camera. A development of this concept is that there exists some unknown particle which is shunted from proton to proton. The proton holding the particle at any instant is the neutron. The exchange model has even been extended to gravity with the graviton postulated as the particle which confers gravity on some particles of matter but not others.

The model proposed in this paper seems far simpler, which makes it all the more convincing.

L. The meaning of absolute zero temperature

Absolute zero temperature is a thermodynamic concept. Temperature is used to describe the average kinetic energy of particles in a bulk material. Absolute zero temperature implies that the particles have no kinetic energy, though this is refined to the proposition that it is entropy, not energy which is reduced to zero. We can examine this using the new model of the nucleus as follows.

Heat is transferred between particles, say atoms, by the vibration of the orbits of their extranuclear electrons. The circular orbits of one atom become distorted, and collision causes distortion of the electrons of adjacent atoms etc. As the bulk is cooled, the collisions become less energetic, less vibration is passed on from atom to atom and the temperature drops. As absolute zero is approached, there is less collision and distortion, until at absolute zero temperature itself there is none.

However, this does not mean that nothing in the atom has kinetic energy. The structure of the atoms remains with all the empty space inside it, which confirms that extranuclear electrons are still orbiting the nucleus. Electrons have mass, and so they have kinetic energy according to the Newtonian equations, quite a lot when travelling at a third of the speed of light. It seems clear from this that what is described as kinetic energy is in fact potential energy. Kinetic energy is realised only when a moving body strikes another.

In the model proposed in this paper, if the structure of the nucleus is not symmetrical in three dimensions, it must also influence the orbits of the atom’s extranuclear electrons, because it is the electrical attraction between them and the nucleus which keeps them in orbit. If this force varies with the orientation of the nucleus within the atom, which is the corollary of the analysis, then so must the size of their orbits, the magnetic orientation etc.
Absolute temperature can therefore be reached only when the orientations of the nuclei are stable and identical. Any difference would lead to perturbation, which would be transmitted and manifest themselves as heat and temperature.

Absolute zero temperature therefore means that particles transmit no kinetic energy.

M. Astronomical implications

The model implies that the rates of the processes by which hydrogen in stars is consumed may need to account of the possibility that metallic elements above the level of helium are being turned back into hydrogen. The reasoning is that:

- High velocity collisions are being used experimentally on Earth to recreate fundamental particles, at least down to nucleon level.

- It is most unlikely that any process which can be carried out on Earth does not occur elsewhere in the Universe. Indeed there are reports of regions of space which seem to act as particle accelerators.

- If neutrons are ‘freed’ by some mechanism, there is the likelihood that they will decay under some conditions to form free electrons and free protons.

- Free electrons may re-associate with protons to form hydrogen atoms, which will combine eventually to form hydrogen molecules.

If this regeneration of hydrogen occurs in galaxies, stars might continue to shine much longer than current predictions. This would be yet another factor to take into account in the theory of the expanding Universe, but for the steady-state theory it would be all grist to the mill.

The model may also have some relevance to the phenomenon of neutron stars, which are thought to be stars which have collapsed to a very high density, and have lost atomic structure because of very high gravitational forces. It is conceivable that free electrons on their surfaces which are thought to move at velocities approaching the speed of light, and generate magnetic fields of immense intensity, may be connected with neutron decomposition.

N. Conclusions and outstanding questions

The model of the nucleus here is the parallel of the atom itself, but it would be surprising if Nature abandoned its successful model just because particles became too small for us to detect readily, and so below the level of the nucleons, there may be a yet more fundamental structure within the nucleus which also reflects similar systems composed of electric charges, orbital interactions, very high velocities etc. The Super Hadron Collider is to be used to investigate the particles of which protons are thought to be composed.

However, the model of systems within systems also raises questions about the structure of protons, and the reason why it is positively charged particles which are orbited by negative charges and not vice versa, both at atomic and at first level within the nucleus. It also raises the question why the positive charge on protons exactly balances the negative charge of the electron, not a little more or a little less.

Electrons as fundamental particles are indivisible. Thus if particles more fundamental than nucleons exist, it must be the protons which are composed of the smaller particles,.

Such fundamental particles would be identical, unless we postulate a range of fundamental particles, which would raise the question of what the term fundamental really meant. The corollary is that a fundamental particle would have a very much smaller mass than a proton and a charge much less than an electron, though in the opposite sense. Moreover, for the concept of fundamental particles to be meaningful, then at some stage in their existence there must have been free fundamental particles, as well as electrons, which would result in a plasma of electrons and fundamental particles. At some stage, the smaller particles would have begun to agglomerate into the precursors of protons. So:

- What would be the driving force behind the agglomeration, if the particles are all positively charged?

- Why would the agglomeration produce exactly the same positive charge as is equivalent to the negative charge of the electron?

- If it always produced the same final proton mass, does it follow that the mass of a fundamental particle and its charge is linked?

- How does theory account for a charge which is so much less than the charge on an electron, which is thought to be the standard minimum.

- Would positively charged fundamental particles have been circling negative electrons in the earlier stages?

It can be envisaged that, after protons have been formed, most electrons would enter into a loose, extranuclear bond with a proton to form a hydrogen atom. In addition, since such a plasma might have a high temperature, a proportion of electrons would go into close orbit around a proton i.e. form a nuclear ‘neutron’ entity. This would readily pick up another proton to form a stable nucleus around which an extranuclear electron could orbit. The implication would be that ‘neutron’ formation is a vital intermediate step in the formation of the heavier elements of the Periodic Table, which is not quite how current theory describes it.

However, the problem that remains is how the proton forms in the first place from a crowd of smaller particles, each with a small positive charge. One possible mechanism which can be envisaged is as follows. It is possible that such particles would adhere en masse to the surface of an electron, because of opposite charges, until the charges exactly balanced. If the particles were then sloughed off as a mass, that would be a proton. This would suggest that the proton has a resonating structure with positive fundamental particles struggling to explode but retained as an entity in some way by negative charges. What seems indisputable is that there must be an interaction between the electron and the fundamental particles during formation of the proton for the eventual charges to match exactly.

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Reference: An Electromagnetic Model of Atomic Structure by A.C. Sturt 3 October 2003
www.churingapublishing.com/dynamat_1.htm .