Stability and decay: Mechanisms for stability and initiators of decay in the neutron

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Abstract

Why is the neutron stable in the nucleus? Why is the free neutron unstable outside the atom? This paper applies the cordus conjecture to address these questions. The proposed explanation is that in the nucleus the discrete field structures (cordus HED) of the proton and neutron fulfil each other, thereby providing a joint stability. When the neutron is removed from the nucleus, its stability becomes compromised. By comparison the single proton on its own does not need the neutron, so it remains stable. The free neutron is able to maintain a dynamic stability by moving its field structures around. It can do this indefinitely. However it is in a compromised state, and vulnerable to perturbation by external fields. Two initiators are anticipated for decay. One is randomly occurring field fluctuations from the external fabric, and these are proposed for the conventional decay route. The second is impact by another particule. In both cases it is the external fields that cause the decay, by constraining the neutron so that it cannot dynamically adjust. Hence it is trapped in a state that leads to decay at its next frequency cycle. The second path could involve any particule with sufficient energy to disturb the neutron. Also, the impact of a neutrino is specifically identified as a potential initiator of decay. The implications if this is correct, are that the neutron has two separate decay paths, which are mixed together in what we perceive as the beta minus process. The first is determined by the local density of the (spacetime) fabric, and the second by the number of energetic particules and neutrinos encountered. The significance of the two decay paths is that neutron decay rates are predicted to be variable rather than constant. A general set of assumptions are extracted for stability and decay of particules in general.

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1 Introduction

The standard concept in physics is that fundamental particles (electron, photon, etc.) are zero dimensional (0D) points without internal structure. In contrast the cordus conjecture [1] suggests that it is more helpful, in terms of explanatory power, to conceive of a two-ended internal structure.

This cordus particule model has been used to create a conceptual model of the discrete field structures of the neutrino and antineutrino [2]. An

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extension of the concept identified internal structures for the W bosons in the weak interaction [3].

This paper extends the conceptual model further, by exploring the criteria of stability for a particle, and the initiators of decay, with specific application to the neutron.

2 Background

Cordus particules

The cordus conjecture [4] proposes that the particle is *not* a zero-dimensional point as orthodox physics assumes, but rather a two-ended internal structure, called a cordus 'particule'.

Specifically, this model proposes an internal structure of a *cordus,* comprising two *reactive ends*, with a *fibril* joining them. The reactive ends are a small finite *span* apart, and energised (typically in turn) at a frequency, at which time they behave like a particle. Hence superposition of geometric location is also explained.

When energised a reactive end emits a transient force pulse along a line called a *hyperfine fibril (hyff),* which makes up the field. This consists of three hyff threads, one in each of three orthogonal axes [r], [a], [t]. These threads extend out into space from the reactive end. When energised, a hyffon pulse is transmitted along the thread, and hence the field is discrete. Positive and negative charge correspond to the direction of propagation of these pulses. The reactive ends are energised in turn at the frequency of the particule. Extensions of this idea accommodate the electric field, magnetism, and gravitation [5]. All the particules in the universe emit hyff, and these make up the fabric of the vacuum [6]. The hyff emission directions (HED) have a hand, called ma to differentiate it from other hand-like concepts in quantum mechanics, and this determines the matter and antimatter species [7]. A modelling method, called HED notation, is used to represent these discrete field structures [8].

Cordus model for the neutrino

The structures of the neutrino and antineutrino in HED notation [2] are:

Antineutrino: $\underline{v} = \underline{v}(r_{\underline{1}}^{\underline{1}} .a .t_{\underline{1}}^{\underline{1}})$

Neutrino $v = v(r_1^{1} .a .t_1^{1})$

In this notation x^1 represents a -1/3 charge in the x axis in the matter hand, x_1 is +1/3 charge in matter hand, $x^{\underline{1}}$ is -1/3 charge in antimatter hand, and $x_{\underline{1}}$ is +1/3 charge in antimatter. See Figure 1 for the equivalent physical representation.

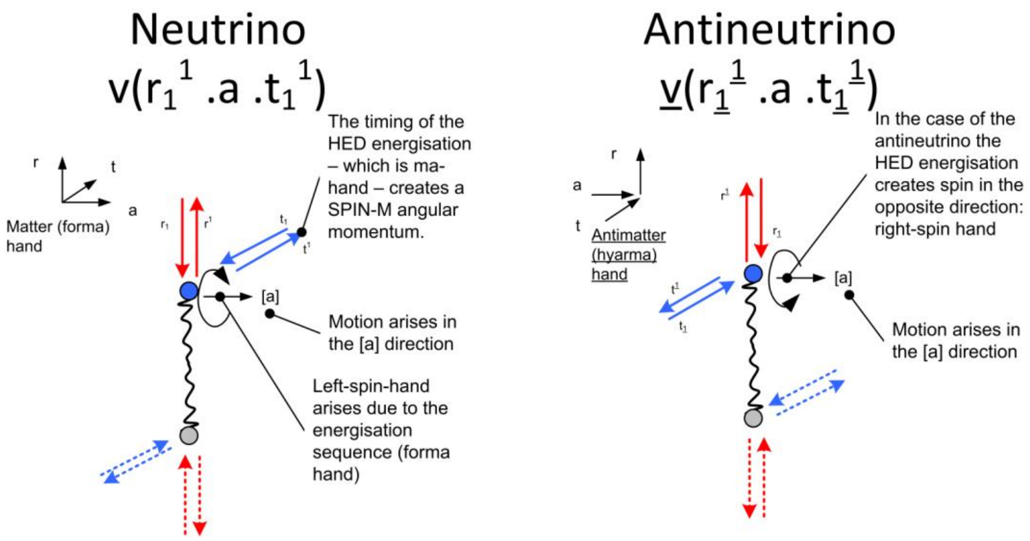

Figure 1: The cordus structure for the neutrino and antineutrino. The diagrams show the spatial arrangement of the discrete field structures (hyffons) in the three hyff emission directions (HEDS). The v(r_1 ^{1} .a .t_1^{1}) variants are shown, and other arrangements are considered possible via colour-change. The diagram also shows how the unique spin directions arise for these two particules. Note that the primary difference between matter and antimatter is the ma-hand, which is the energisation sequence of the HEDs.

Purpose of this paper

We now extend the work to determine why the neutron is unstable when isolated from the nucleus. Previously we have looked at *what* outcomes are produced in decay, and *how* those arise. Here we explore *why* instability arises in the first place, with a focus on the neutron. We develop candidate principles for stability and decay.

2 Neutron beta- decay

In β- decay, or electron emission, the free-neutron decays, after a relatively long life, into a proton, electron, and an electron antineutrino:

$$n \Rightarrow p + e + \underline{v}_e$$

We take beta decay for granted, but *why* does the neutron need to decay in the first place? Given that it is stable in the nucleus of the atom, why does it decay outside?

The conventional answer is in terms of energy. The deuteron (one proton and a neutron) has a total mass slightly less than that of its individual constituents of a proton and the decay products of the neutron. Specifically, the binding energy of the **np** deuteron is 2.2 MeV, whereas the energy yield in decay of the neutron is the lesser amount of 0.78 MeV, hence decay is not preferred.

We do not disagree with that energy interpretation, and cordus explains qualitatively why the masses of assemblies are different to those of the constituents [9]. However the energy explanation on its own is obviously not the entire story, as conventional physics is unable to explain *how* the energy effect works. Indeed, it is difficult to see how there could be any explanation if one stays with the conventional 0-D point paradigm.

The cordus HED concept provides another way to answer the *why* question, and the results complement the energy perspective.

2.1 Stable in, unstable out

Why is the deuteron stable?

First, we can use cordus to explain why the neutron *is* stable in the atom: because it forms a complementary frequency synchronisation (CoFS) state [10] with the proton. They effective bond together:

$$n(r\ .a_1^{\ 1}\ .t_1^{\ 1}) + p(r_{1.1}^{\ 1}\ .a_1\ .t_1) \Rightarrow O(r_{1.1}^{\ 1}\ .a_{1.1}^{\ 1}\ .t_{1.1}^{\ 1})$$

So the O assembly is the deuteron and from this we can derive some implied requirements for stability (see Lemma Ma.8 below). Specifically, it has full HED structures and therefore unitary charge structures. Also, the structures are all the same hand (forma). This stability is temporally enduring (hence 'strong') because it does not have to dynamically share this relationship with other partners.

Why is the neutron unstable?

With cordus we can see why the neutron on its own is going to have problems. We note that the HED structure of the neutron $n(r\ .a_1^{\ 1}\ .t_1^{\ 1})$ is unbalanced, in that there is no hyffon in the [r] axis. Thus it fails the stability criterion for completeness (Ma.8.1.3).

To fix this it may be able to shift some of the hyffons to different HEDS, e.g. $n(r^1\ .a_1\ .t_1^{\ 1})$, and we assume it can do this dynamically too, at the next frequency cycle of energisation. However that action then means that some of the HEDs carry only a single hyffon, which is inappropriate for an uncharged particule. Thus this evasive behaviour unbalances the charge neutralisation (Ma.8.1.6), making the neutron unstable in this configuration too. Dynamically changing between these various HED layouts $n(r\ .a_1^{\ 1}\ .t_1^{\ 1}) \Leftrightarrow n(r^1\ .a_1\ .t_1^{\ 1})$ prevents instability.

So in this cordus model, the neutron is vulnerable to two different forms of instability, depending on its structure, and it can stave off demise by rapidly changing between these structures before the decay processes can start.

2.2 Decay initiators

Perturbation/constraint mechanism of decay

However, this dynamic stability only exists while the external environment permits (Ma.8.2). Sooner or later something occurs to compromise that dynamic adjustment. We anticipate that might be:

(a) An external *perturbation*, i.e. injection of hyffons into the HEDs, e.g. from particule impact (Ma.8.2.1).

(b) Externally imposed *constraints* on the hyffons of the neutron. These external fields pin hyffons in certain HED directions and prevent their dynamic movement to other HEDs. These constraints may arise in bonding situations, from external fields, or the fabric (Ma.8.2.2).

We call this the *perturbation/constraint mechanism of decay*. The two methods are corollaries of each other, and both involve hyff constraints from outside the particule.

Applying this to the neutron, either way the neutron lingers one frequency cycle too long in the state of $n(r .a_1^1 .t_1^1)$ or $n(r^1 .a_1 .t_1^1)$, and the degradation process (beta decay) initiates. However it is relevant to note that the neutron itself is not unstable: it does not have any internal mechanism favouring decay. It has no internal timer counting backwards to zero. Quite the opposite, it has a perfectly adequate coping mechanism, of dynamically adjusting its structure to stay stable. However it is a compensated system, and is not a *strong* stability. Sometimes the external environment overwhelms it. When the neutron is locked into a bond with the proton, its vacant HEDs are filled with those of the proton, and therefore the instability does not generally arise.

The frequency of the neutron is very high, so it must survive very many frequency cycles for the life to be as high as it is. This and the nature of the proposed decay mechanisms means that cordus predicts that the degradation process is a random variable. The initiator is a chance external encounter with external hyffons. Being of external origin, these encounters are totally independent to the internal workings of the neutron. There is no reason to think that the rate of perturbations generated by the external environment is anything but an unstructured random variable. Therefore a logical consequence of the cordus model is that the decay initiators will be a uniform random variable with time, at least for natural decay (excludes high energy physics). At first this might seem at odds with the known exponential decay distribution of the free neutron, but this is not so, as explained below.

Why the Exponential distribution? Hazard rate perspective

Talking about the life of the neutron as an exponential density distribution with mean of 15 min (or half-life 10 min), which is how it is commonly represented, implies a determinism and central tendency that does not exist. We need to disentangle our concepts of the 'mean'. It is true that for a *normal* distribution the mean represents a 'true' estimate of the central tendency, with noise superimposed.[2] However, that is not a helpful concept to apply to the *exponential* distribution. The mean and its variance *can* be computed, but should not be considered as a 'true' value with noise.

From a reliability-engineering perspective, the exponential distribution has the unusual and unique property that the hazard rate is constant. This is the probability that the system will fail in the next time interval, given that it has survived up to the beginning of that time interval.

Applying this to the neutron: its exponential decay rate means that there is equal chance of failure at *any time*: whether a free-neutron has been in service for a long or a short time it still has the *same* chance of failing. Thus inspection of the empirically-derived exponential distribution shows that the mechanism, whatever it is, that drives the failure of the neutron *cannot* be time-dependent.

For any one neutron the chance of failure is a uniform distribution over time. Thus the individual neutron is not trying to decay in the *mean* lifetime: instead it will decay with equal probability anywhere between zero and infinite time. The 'mean' value only becomes apparent when the outcomes of many individual neutrons are aggregated.

There is no mechanism in the exponential distribution for central tendency towards a mean. Thus instead of talking about the mean lifetime of the neutron, we should be asking the more fundamental question: why is it that the neutron sometimes decays almost instantly, and at other times takes a relatively vast amount of time (cycles)? More importantly, why is time *not* a variable?

The cordus perturbation/constraint mechanism of decay fits this model: it is not time-based. The cordus mechanism provides for *an equal chance of failure at any time* which is consistent with the unique features of the observed lifetime characteristics of the free-neutron.

What determines the decay rate?

If time is not a variable, what determines the decay rate of the free neutron? We anticipate that the natural decay rate is dependent on the density of the fabric at that locality.

2.3 Implications of the two decay routes

Fabric induced decay

The fabric is the irregular mesh of background hyffons of (potentially) all the other particules in the universe [6]. All discrete field structures of a

[2] By comparison the underlying *reason* for the normal distribution is easy to understand: take a large number of variables, allow them each to vary randomly according to different density distributions, and the *sum* of those variables will tend towards a normal distribution, *regardless* of the density distributions of the individual variables.

particle, whether a fundamental particule or an assembly, and whether those are externalised or internally cloaked hyffons [2], contribute to the fabric. These hyffons all need servicing by their originating particules and hence a frequency requirement arises, hence mass.

Every particule contributes to the creation and replenishment of the fabric, and is actively embedded in it. Therefore particules have to engage with the fabric. This also means that the fabric can affect the particule. A free particule, such as the neutron outside the nucleus, no longer has its HED vulnerabilities shielded by its assembly bonds with the proton, and is therefore more exposed to external constraints on its HEDs from the fabric hyffons (Ma.8.2.2).

The implications are that decay should proceed quicker in situations of higher gravitation or acceleration, relative to other locations. This is because the actual or apparent fabric density increases in such situations, so the neutron encounters more fabric, and hence more opportunity to be constrained. This may be testable. Alternatively such an effect could also be explained as conventional time-dilation, so there may not be a big point of difference. The fabric density would also have been greater in the early universe, but this is not expected to change decay rates as time also flowed faster in the cordus interpretation [5] and there is no other contemporary location from which to observe.

Perturbative decay

We anticipate that the other mechanism for neutron decay is active perturbation, i.e. the injection of hyffons into the HEDs, e.g. from particule impact (Ma.8.2.1). Obviously one candidate for this is high-energy-physics (HEP), where nucleon particules are smashed into each other at high speed. From the cordus perspective, these situations are expected to also accelerate the decay process, though this might be difficult to distinguish from all the other decay activities going on.

Neutrino induced decay of neutron

Cordus also suggests that certain types of impacts could be more likely to accelerate β decay. This suggestion arises from inspection of the field structures. In particular the cordus HED notation suggests that the impact of a neutrino into a neutron could cause decay as follows:

$$n + v = n(r\ .a_1^{\ 1}\ .t_1^{\ 1}) + v(r_1^{\ 1}\ .a\ .t_1^{\ 1})$$
$$=> O(r_1^{\ 1}\ .a_1^{\ 1}\ .t_{1.1}^{\ 1.1}) => |_{\%} => O(r_{1.1}^{\ 1.1}\ .a_1^{\ 1}\ .t_1^{\ 1})$$
$$=> p(r_{1.1}^{\ 1}\ .a_1\ .t_1) + O_1(r^1\ .a^1\ .t^1)$$
$$=> p(r_{1.1}^{\ 1}\ .a_1\ .t_1) + e(r^1\ .a^1\ .t^1)$$
$$=> p + e$$

Thus adding the neutrino at the outset provides some economy, and it may be that this encourages the decay reaction. So in principle cordus predicts that a neutron plus a neutrino could decay to a proton and an electron. Substituting an antineutrino does not have the same effect. Likewise it may be shown that neither β+ decay of the proton¸ nor electron capture (EC), have any economy from having the neutrino or antineutrino pre-supplied, see Appendix A. It is specifically β- that appears to be amenable to this effect. This is an unexpected result, but may be testable.

Conventional physics assumes that decay rates are strictly constant. The above work suggests the otherwise. Thus cordus predicts that beta decay rates could vary depending on the fabric density (not easy to change experimentally), acceleration, gravitation, HEP impacts, and neutrino loading. Most of these are probably not easy to experiment with, but the neutrino loading idea should be testable. Indeed, it might already have been observed, as the next section explores.

Odd neutrino effects

There has been ongoing discussion in the community about the possible interaction of neutrinos with the decay process. Controversially, it has been suggested that neutrinos may initiate 'transmutation' in a cold-fusion reaction [11]. Also controversial is the idea that solar neutrinos may affect decay rates. A meta-analysis of decay rates led to a suggestion that the variability in decay rates (^{36}Cl and ^{32}Si via β-) is correlated with the seasonal variability in distance to the Sun [12]. The decay rates reduced when the distance to the sun increased. The Sun is thought to produce neutrinos rather than antineutrinos. A correlation with the rotation rate of the sun's core has also been suggested. A correlation has also been found between reduced decay by electron capture in ^{54}Mn during a solar flare [12]. Those authors proposed that one explanation could be that solar neutrinos exchange energy with the decaying nucleus.

However other studies would seem to refute the idea. No significant deviations in decay rates were observed for Earth–Sun distance on the Cassini spacecraft [13]. That experiment used ^{238}Pu, which decays by alpha emission (not β-, which is significant in the present context). Likewise [14] found 'no evidence for correlations between the rates for the decays of ^{22}Na [β+ and electron capture EC], ^{44}Ti [EC], ^{108}Ag [EC], ^{121}Sn [β-], ^{133}Ba [EC], and 241Am [α] and the Earth–Sun distance.' However they were only checking for correlation between the data and one other hypothesis: the Jenkins seasonal curve. Therefore there remains the possibility that some other curve might fit the data. Indeed, there was noticeable periodic variability in the data, especially for electron capture, though the significance of that was not tested against alternative hypotheses.

Detection of neutrinos and antineutrinos

There is some evidence to suggest that muon neutrinos and muon antineutrinos are detected or disappear (oscillate) differently [15, 16]. Those MINOS results were reported in terms of different disappearance rates for the two particles. The work inferred that the oscillation rates (rate of change between the generations) were different. Possible explanations provided, other than experimental error, were violation of CPT symmetry, or that the interactions with matter could be different for neutrinos and antineutrinos [15].

If a cordus explanation is sought, it would tend to be the latter: that the interaction of neutrinos and antineutrinos with matter is asymmetrical. The MINOS data were collected by measuring the muon and antimuon by-products of collision with matter (steel). The raw results show lower production of antimuons than muons [15][Fig 2]. Such an empirical method and results are consistent with the cordus concept of *perturbative decay* which suggests that neutrinos and antineutrinos have different reactivity with neutrons, and hence with matter generally. That there were some antimuons produced at all, may be a consequence of the *energy* of the antineutrinos rather than antineutrinos per se.

Many of these effects mentioned: cold-fusion, non-constant decay rates, and the MINOS results, are tentative and lack universal acceptance. It is difficult at this time to know whether they are real effects or spurious artefacts. If real, then new explanations will be required, since the effects are well outside of the standard models. Confirming or refuting one of these effects would neither validate nor falsify the cordus conjecture. However until these effects are convincingly refuted, there is value in keeping alive a discussion of alternative conceptual explanations.

Regarding decay rates in particular, cordus suggests that we might expect to see decay rates for β- increase with neutrino loading, but not for β+. The empirical evidence in support of this is slim at worst and mixed at best, and we leave it as an open question. But the main point is that it seems prudent to take a more thoughtfully open-minded position of scepticism about the possibility that neutrinos might interfere selectively with decay rates, rather than automatically assume it is impossible simply because it is not accommodated in the standard model of QM.

Twin decay paths for neutron

The implications are that the neutron has two separate decay paths, which are mixed together in what we perceive as the β- process. The first is determined by the local density of the fabric, and the second by the number of neutrinos encountered.

1: Fabric constraint induced neutron decay:

$$n \Rightarrow p + e + \underline{v}_e$$

This is the β- process, as conventionally represented.

2: Perturbative neutron decay, with neutrinos as the perturbers:

$$n + v \Rightarrow p + e$$

We propose this also contributes to the β- process.

Taken together, if these are true, then we expect to see the neutron decay faster in high gravitation or high acceleration situations, or under higher neutrino loading.

3 Stability and disassembly lemmas

We made several assumptions for how stability is gained and lost, and these are summarised below as a set of lemmas.

Ma.8 Stability and disassembly of particules

Ma.8.1 The criteria for stability of a cordus particule or assembly structure are assumed to be:

Ma.8.1.1 The hyffons must all be of the same hand (1 or $\underline{1}$ but not a mixture.

Ma.8.1.2 The structure must have an overall unit charge of zero or +3/3 or -3/3. This means at least three hyffons of the same hand in either the negative or positive directions. Countering hyffons are possible.

Ma.8.1.3 For positional stability, the structure must have a hyffon in each of the HEDs, e.g. (r^1 a^1 t^1).

Ma.8.1.4 It may make this allocation dynamically, while the external environment permits.

Ma.8.1.5 If the structure does not have a hyffon in each of the HEDs, then it may be stable if it can move on the fabric.

Ma.8.1.6 For stability the particule must have its opposite charged hyffons (if any exist) located on the same HED. For example (r_1^1 a t) not (r_1 a^1 t). (It needs a balanced firing order to maintain charge neutralisation. This lemma is tentative)

Ma.8.1.7 Energy is related to frequency of the cordus, i.e. the refresh-rate for the reactive ends. Lower-frequency configurations tend to be more stable, all else being equal.

Ma.8.1.8 For any one particule there may be multiple alternative assemblies or configurations, i.e. combinations of hyffon arrangements. These may not all be dynamically stable.

Ma.8.1.9 The relative energy attractiveness of these configurations corresponds to the generations (tentative). In which case the number of generations is determined by the number of configurations available.

Ma.8.2 Perturbation/constraint mechanism of decay. Dynamic stability only exists while the external environment permits (Ma.6.7.3). Events that compromise that dynamic adjustment include:

Ma.8.2.1 An external *perturbation*, i.e. injection of hyffons into the HEDs, from particule impact.

Ma.8.2.2 Externally imposed *constraints* on the hyffons of the neutron. These external fields pin hyffons in certain HED directions and prevent their dynamic movement to other HEDs. These constraints may arise in bonding situations, from external fields, or the fabric.

Ma.8.3 If a structure does not meet the stability criteria, then it decays to the nearest accessible structure.

Ma.8.3.1 This is one that is (a) permitted as per Ma.8.1, and (b) one for which sufficient energy exists.

Ma.8.3.2 The nearest accessible structure is a HED stable structure, and the HED negotiation process thus naturally selects this structure. One could figuratively say that the composite intermediate structure is pulled into the accessible structure. It may manifest as injection of ↑ and ↓ hyffon pairs into the HEDs.

Ma.8.3.3 The left-over energy and hyffons are pushed into a residual composite structure, O. That has the ability to create further hyffon-antihyffon pairs and partition off another accessible structure.

Ma.8.3.4 There needs to be enough energy (related to cordus frequency) in the first place. Thus decay to higher energy (higher frequency) daughter products cannot commence until the input particule has sufficient energy. This energy may be native to the particule, i.e. embedded in its frequency, or added via photons or field transfer.

Ma.8.4 When a particule breaks down or decays, the apparent output products do not necessarily represent the actual original internal structures. Nonetheless the conservation of hyff applies.

Ma.8.4.1 Decay is more accurately a disassembly process, due to the conservation of hyff, except where annihilation occurs.

Ma.8.4.2 The $O(r_1{}^{\underline{1}} .a_1{}^{\underline{1}} .t_1{}^{\underline{1}})$ structure comprises the assembly of the notelectron $!e(r_1.a_1.t_1)$ and antinotelectron $!\underline{e}(r^{\underline{1}}.a^{\underline{1}}.t^{\underline{1}})$ both of which are forbidden structures in a forma cosmos. However the assembly may convert to two photons through annihilation (tentative).

4 Discussion

What has been achieved?

The main conceptual contributions of this work are:

- An explanation is given for the stability of the neutron inside the atom, and its instability outside, using the cordus concept. This is in terms of its field structures.

- The criteria for stability of a particule are identified, in terms of the HED field structures.
- The initiators of decay for the neutron are identified as disturbances in the external environment, which could be the vacuum fabric, or the local bonding arrangements, or the HED fields of an impacting particule.
- An explanation is provided for the constant hazard-rate decay of the free neutron, i.e. why the decay lifetime has an exponential density distribution rather than any other shape.
- It is predicted that the neutrino and antineutrino may interact preferentially with different types of matter, and thus influence decay rates.

Answers to common questions

The cordus model permits answers to be fielded to some puzzles about the weak interaction.

Why is the neutron stable in the nucleus?
The neutron's stability is due to its field structures being a good match to those of the proton. This results in a strong bond, and thereby resistance to the forces of decay.

Why is the free neutron instable outside the atom?
Once free of the atom, the neutron has the problem that the arrangement of its field structures is statically unstable. It can avoid the instability by dynamically changing those structures. However that dynamic stability can be interfered with by external fields, resulting in decay of the neutron.

What causes the decay?
There is no clock that counts down to decay. There is nothing in the neutron that has a finite life. The free neutron is stable, providing it is left alone. The forces that interfere with it and precipitate decay are field forces that arise in the external environment. Those include the natural variability in the fabric of spacetime, and the effect of incoming particules. These forces, represented as cordus hyffons, upset the dynamic stability of the neutron, and thereafter its own energies remanufacture it into more stable components, as in beta minus decay.

Why does the beta minus weak interaction decay follow the exponential distribution?
This is because the decay process for the neutron is fundamentally not dependent on time. Statistically, it is a constant hazard-rate system. This automatically produces the exponential distribution.

Could the decay rates be variable?
Yes, in principle. In this model the decay rate is not dependent on time. Instead the underlying initiators of decay are the disturbances in the external fabric, and the effect of the fields of impacting particules.

Implications

Conventional physics interprets the decay processes to be independent of the external environment. In other words, the half-lives are assumed to be constant. The cordus conjecture suggests that picture is too simple, and the constancy is only approximate. This is quite a large departure from orthodox theory, and will require further research to confirm or deny. It is probably going to be difficult at present to falsify the cordus explanation for the stability/instability of the neutron inside/outside the atom, for lack of competing explanations. However it should be possible to test the proposed perturbation/constraint mechanisms of decay. It may also be possible to test the idea that neutrinos interfere with *some* decay rates but not others.

Clearly, and as the name *cordus conjecture* implies, this work is conceptual and conjectural in nature. There is no guarantee that the above ideas are valid, and instead they should be considered part of an extended thought experiment, hence *conceptual model.* Much further work would be required for validation, the more so as the model is unorthodox and contrary to QM. Several lines of empirical research are suggested as being potentially interesting, particularly the possibility of neutrinos selectively affecting decay rates.

5 Conclusions

This is the third paper of a bracket on the beta decay processes. In the first we used beta minus decay to work out a cordus structure for the neutrino and antineutrino. In the second we determined structures of the W and Z bosons. The purpose of this third paper was to explain *why* the neutron is unstable at all. The related question is *why* the neutron is stable in the deuteron nucleus.

The answer to those questions, from the cordus perspective, is that in the nucleus the HED discrete field structures of the proton and neutron fulfil each other, thereby providing a joint stability. When the neutron is removed from the nucleus, its stability becomes compromised. By comparison the single proton on its own does not need the neutron, so it remains stable. The neutron is able to maintain a dynamic stability by moving its HED structures around. It can do this indefinitely. However it is in a compromised state, and vulnerable to perturbation by external HED fields.

Two initiators are anticipated for how that perturbation may arise and cause decay. One is randomly occurring field fluctuations from the external fabric, and these are proposed for the conventional decay route. The second is impact by another particule. In both cases it is the external HED fields that cause the decay, by constraining the neutron so that it cannot dynamically adjust its own HED fields. Hence it is trapped in a state that leads to decay at its next frequency cycle. The second path could involve any particule with sufficient energy to disturb the neutron. We also specifically identify the neutrino as a possible initiator of decay. The significance of the two decay paths is that neutron decay rates are predicted to be variable rather than constant. If this is true, then the implication is that neutrino loading becomes a variable in empirical tests of decay, and will need to be controlled for.

Although most of the work specifically addresses the neutron, we also extract a set of assumptions for stability. Since these are of a general nature and do not require the specific structure of the neutron, we expect that these will apply to decay in particules in general.

A Appendix: Other beta decays

The possible effect of neutrinos and antineutrinos on several forms of decay are documented below. These are detailed for completeness, though most of the interactions do not show usefully different outcomes. This is not an exhaustive analysis and it is still possible that other effects may exist: neutrinos may have other catalytic roles not represented by HED notation; additional impacts with secondary particules could create different outcomes from these processes.

The analysis is done with HED notation, and relies on several lemmas, so the results are only as strong as that logical structure might be valid.

A.1 Beta minus decay n => p + e + v

Beta minus decay is assisted by an input neutrino

The body of the document derives the HED process for the proposed neutrino-induced decay of the neutron:

$$n + v \Rightarrow p + e$$

Beta minus decay may be diverted by an input antineutrino

$$n + \underline{v} = n(r\ .a_1{}^{1}\ .t_1{}^{1}) + v(r_{\underline{1}}{}^{\underline{1}}\ .a\ .t_{\underline{1}}{}^{\underline{1}})$$
$$\Rightarrow O(r_{\underline{1}}{}^{\underline{1}}\ .a_1{}^{1}\ .t_{1.\underline{1}}{}^{1.\underline{1}}) \Rightarrow +\uparrow\downarrow \Rightarrow O_1(r_{\underline{1}}{}^{\underline{1}}\uparrow\ .a_1{}^{1}\downarrow .t_{1.\underline{1}}{}^{1.\underline{1}})$$
$$\Rightarrow O_1(r_{\underline{1}}{}^{\underline{1}}{}_{\underline{1}}{}^{1}\ .a_1{}^{1}{}_1{}^{\underline{1}}.t_{1.\underline{1}}{}^{1.\underline{1}})$$
$$\Rightarrow |_{\%} \Rightarrow O_1(r_{\underline{1}}{}^{\underline{1}1}{}_1\ .a_1{}^{1\underline{1}}{}_{\underline{1}}.t_{1.\underline{1}}{}^{1.\underline{1}})$$
$$\Rightarrow e(r^1\ .a^1\ .t^1) + \underline{e}(r_{\underline{1}}\ .a_{\underline{1}}.t_{\underline{1}}) + O_2(r^{\underline{1}}{}_1\ .a_1{}^{\underline{1}}.t_1{}^{\underline{1}})$$
$$\Rightarrow e + \underline{e} + O_2(r\downarrow\ .a\downarrow\ .t\downarrow)$$
$$\Rightarrow e + \underline{e} + 2y$$

This nominally produces an electron-antielectron pair, and the O_2 structure which is tentatively thought to collapse to two photons (Ma.8.4.2). A further assumption is that the HED structures of the neutron and neutrino are indeed the same, which is still uncertain. The result is a type of annihilation, not any of the known α, β or γ decay processes, so it appears that the antineutrino does not affect the β- decay process, other than possibly reducing it by re-direction.

A.2 Beta plus decay p => n + $\underline{e}$ + v

Beta plus decay is not assisted by an input neutrino

$p + v = p(r_{1.1}^{1}\,.a_1\,.t_1) + v(r_1^{1}\,.a\,.t_1^{1}) + (\uparrow\uparrow\uparrow)$
$=> O(r_{1.1}^{1}{}_{1}^{1}\uparrow.a_1\uparrow\,.t_{11}^{1}\uparrow) => O(r_{1.1}^{1}{}_{1}^{1}{}_{\underline{1}}^{1}.a_{1\underline{1}}^{1}\,.t_{11}^{1}{}_{\underline{1}}^{1})$
$=> \underline{e}(r_{\underline{1}}\,.a_{\underline{1}}.t_{\underline{1}}) + O_1(r_{1.1}^{1}{}_{1}^{11}.a_1^{1}\,.t_{11}^{11})$
$=> \underline{e} + n(r\,.a_1^{1}\,.t_1^{1}) + O_2(r_{1.1}^{1}{}_{1}^{11}.a\,.t_1^{1})$
$=> \underline{e} + n + 2v$

This outcome does not appear to have any advantage: the input neutrino simply comes out at the end again. If it precipitates the decay, we cannot tell with HED notation.

Beta plus decay is not assisted by an input antineutrino

$p + \underline{v} = p(r_{1.1}^{1}\,.a_1\,.t_1) + \underline{v}(r_{\underline{1}}^{\underline{1}}\,.a\,.t_{\underline{1}}^{\underline{1}}) + (\uparrow\uparrow\uparrow)$
$=> O(r_{1.1}^{1}{}_{\underline{1}}^{\underline{1}}\uparrow.a_1\uparrow\,.t_{1\underline{1}}^{\underline{1}}\uparrow) => O(r_{1.1}^{1}{}_{\underline{1}}^{\underline{1}}{}_{\underline{1}}^{1}.a_{1\underline{1}}^{1}\,.t_{1\underline{1}}^{\underline{1}}{}_{\underline{1}}^{1})$
$=> \underline{e}(r_{\underline{1}}\,.a_{\underline{1}}.t_{\underline{1}}) + O_1(r_{1.1}^{1}{}_{\underline{1}}^{\underline{1.1}}.a_1^{1}\,.t_{1.\underline{1}}^{\underline{1.1}})$
$=> \underline{e} + n(r\,.a_1^{1}\,.t_1^{1}) + O_2(r_{1.1}^{1}{}_{\underline{1}}^{\underline{1.1}}.a\,.t_{\underline{1}}^{\underline{1}}) => |_{\%}$
$=> \underline{e} + n + v(r_1^{1}\,.a\,.t_1^{1}) + O_3(r\ {}_{\underline{1}}^{\underline{1}}.a\,.t_{\underline{1}}^{\underline{1}})$
$=> \underline{e} + n + v + \underline{v}$

This outcome does not appear to have any advantage: the input antineutrino simply comes out at the end again.

A.3 Electron capture p + e => n + v

Electron capture is not assisted by an input neutrino

$p + e + v$
$=> p(r_{1.1}^{1}\,.a_1\,.t_1) + e(r^{1}\,.a^{1}\,.t^{1}) + v(r_1^{1}\,.a\,.t_1^{1})$
$=> O(r_{1.1}^{11}{}_{1}^{1}\,.a_1^{1}\,.t_1^{1}{}_{1}^{1})$
$=> n(r\,.a_1^{1}\,.t_1^{1}) + O_1(r_{1.1}^{11}{}_{1}^{1}\,.a\,.t_1^{1}) => |_{\%}$
$=> n + v(r_1^{1}\,.a\,.t_1^{1}) + v(r_1^{1}\,.a\,.t_1^{1})$
$=> n + 2v$

This outcome does not appear to have any advantage: the input neutrino simply comes out at the end again.

Electron capture is not assisted by an input antineutrino

$p + e + \underline{v}$
$=> p(r_{1.1}^{1}\,.a_1\,.t_1) + e(r^{1}\,.a^{1}\,.t^{1}) + \underline{v}(r_{\underline{1}}^{\underline{1}}\,.a\,.t_{\underline{1}}^{\underline{1}})$
$=> O(r_{1.1}^{11}{}_{\underline{1}}^{\underline{1}}\,.a_1^{1}\,.t_1^{1}{}_{\underline{1}}^{\underline{1}})$

$$=> n(r\,.a_1{}^1\,.t_1{}^1) + O_1(r_{1.1}{}^{11}{}_{\underline{1}}{}^{\underline{1}}\,.a\,.t_{\underline{1}}{}^{\underline{1}}) => |_{\%}$$

$$=> n + v(r_1{}^1\,.a\,.t_1{}^1) + \underline{v}(r_{\underline{1}}{}^{\underline{1}}\,.a\,.t_{\underline{1}}{}^{\underline{1}})$$

$$=> n + v + \underline{v}$$

This outcome does not appear to have any advantage: the input antineutrino simply comes out at the end again.

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