<u>Infinite Particle Physics</u>

Chapter 6 - Why & How Particles Decay

The IPP Concept Of Particle Decay

Since IPP permits us to assign specific geometric structures to energy, and to each of the known particles and resonances, we can view particle decays as changes from one lattice distortion pattern to another (or to multiple others). Furthermore, since IPP provides plausible notions for a ubiquitous presence of various destabilizing agents, we can dispense with the prevailing concept of "spontaneous decay", and treat all decays as being *induced* by interactions of particles with one or more of these destabilizing agents. These agents are primarily ± *voids* & *void-pairs* (muon & electron neutrinos), which are assumed to be at least a billion times more abundant in space than protons or electrons. Other less-encountered destabilizing agents are collisions with energetic photons, the proximity of (or collision with) leptons & baryons, and the "jostling" of hadron structures when they pass through grain boundaries.

Five Things That Influence A Particle's Mean Lifetime

1) **Its structural stability**, which determines how close a destabilizing agent must approach in order to induce a particular structural change. Some structural aspects which enhance stability, or produce longer half-lives, are geometric symmetry, inter-defect-pair bonds, and, particularly, *inter-defect charge-exchanges.*

2) **The relative abundance of the particular destabilizing agent**, or agents, required to induce a specific decay mode. For example, *voids* act as destabilizing agents primarily with neutral defect-pairs, while *void-pairs* can destabilize both charged and neutral defect-pairs. If *voids* are greatly more abundant than *void-pairs* (see Chapter 8 for reasons), we should expect the lifetimes of isolated neutral defect-pairs to be much shorter than isolated charged ones. At the other extreme, some meta-stable states of nuclei may take millennia to decay to a ground state, because they require certain neutrons to change their "slants", as well as their locations. These slant changes may not occur until the nuclide passes through a grain boundary with exactly 45 degree shifts in cardinal axes of the lattice, with the nuclide plane entering this discontinuity in precisely the most vulnerable orientation; thus, their simultaneous occurrence is improbable, leading to long half-lives.

3) **The length of interaction time required** between the particle and the destabilizing agent to effect the change. Even simple lepton decays require some minimum interaction time vs. destabilizing agent proximity, so the geometry of the encounter is a factor in all decays. But hadron decays involving charge-exchanges between a *c-void* in the hadron and a visiting *void*, or *void-pair*, may require much longer interactions, because the implicated *c-void* may be changing polarity due to internal charge-exchanges, and the destabilizing agent may be able to interact only when the *c-void* has the correct instantaneous polarity. Since lone *voids* will be either repelled or accelerated by a charged particle, their residence time will be short compared to *void-pairs*, which, being neutral, can

approach quite close before their opposite-polarity *void* components suffer differential deflections.

We can infer that both *voids* and *void-pairs* tend to collapse in the vicinity of hadron particles, due to the presence of unutilized shrinkage in some of their charge-exchange states. This collapse greatly increases the void's masses (perhaps by six or eight orders of magnitude), and, hence, greatly decreases their velocity relative to the hadron. This speed retardation is obviously crucial toward prolonging the residence of these destabilizing agents long enough for them to interact. We will perceive, also, that, in stealing some of the particle's shrinkage, the destabilizing agent may induce defect-spacing changes in the particle, thereby altering bond spacings, or interfering with the existing charge-exchange sequences, either of which may be destabilizing.

4) **The spatial orientation of the destabilizing agent,** or agents, relative to the plane of the target particle. Some decays merely require that two opposite-polarity paired *c-voids* (of, say, a neutral pion) be displaced sufficient to interrupt pairing. This effect imposes few requirements on the position of the destabilizing agent. At the other extreme, in the conversion of a neutron to proton, for example, a minus *c-void* in the neutron must make an external charge-exchange with the plus *void* of a proximate *void-pair*, undergo metamorphosis to a minus *excess*, and then fuse with the *void-pair's* minus *void* to form a *replacement* defect. This exchange requires that the *void-pair* be in a face diagonal direction from the neutron's minus *c-void*, and remain close enough during the exchange so that the gradient for this external exchange exceeds that of the normal internal charge-exchanges. For the fusing to take place there may need to be another negative *void* close by to prevent mutual repulsion of the two fusing negative defects. These requirements for precise alignment, precise spacing, and the simultaneous presence of two destabilizing agent, can, perhaps, account for the neutron's mean lifetime of 15 minutes, compared to the mean lifetime of 8×10^{-17} seconds for the decay of the neutral pion.

5) **Charge ambience, or steric-hindrance, of the targeted particle.** *When neutrons are in nuclei*, they are further protected against charge-exchange decay by the presence of adjacent protons bound to them. The proton's plus charge tends to repel the plus *void* of the *void-pair*, making the external charge-exchange necessary for neutron decay much less likely. We can assume that the external exchange may require the synergistic presence of two or more charged *voids* in addition to the *void-pair* to offset the proton's influence. The requirement for perhaps three destabilizing agents in precise geometrical orientation may account for lengthening the neutron decay in Hydrogen 3 to a half-life of 12.3 years. Neutron decays with billion-year half-lives, as in Potassium 40, may be so protected by surrounding protons as to require four, or even more, destabilizing agents in precise patterns for decay to be effected.

Decays May Be Limited To Certain Relative Velocities

If we have surmised correctly that interactions between particles and destabilizing agents require discrete intervals of time, we can infer that these interactions may be limited to certain ranges of relative velocities between a particle and its destabilizing agents. There is supporting evidence for this conclusion in the extended lifetimes of relativistic unstable particles. You will perceive that, in order to provide an adequate time of interaction, the destabilization of a relativistic particle may require the proximity of a *relativistic* destabilizing agent with precisely similar velocity and direction, and this required synchronization will greatly reduce the probability of relativistic decays. Of course, another reasons for this extended lifetime may be the result of the accompanying "ghost-pair" cloud, which may, perhaps, shield the muon from destabilizing agents.

If we presume that destabilizing agents can have all possible absolute velocities, we perceive that those agents with "thermal" velocities will clearly have adequate time of proximity, when a particle, itself, has slowed to similar velocities. This is, perhaps, why muons are often observed to slow down almost to a stop in cloud and bubble chambers before decaying into an electron, numu, and @nue. Let's explore this "thermal" muon decay as our first demonstration:

I Suggest A Group Of Symbols To Analyze Particle Decays

We shall need to establish some conventions for the defects comprising leptons and hadrons in order to make this and other decays understandable. Let us consider that a charge sign (+ or -) represents *half* an electron charge, so that an electron will be represented by --, and a positron by ++. Then to differentiate between excess defects (muons) and void defects (muon neutrinos), we shall place the latter in parentheses, and to indicate a void-pair (electron neutrino) the opposite charges will be shown inside parentheses, separated by a comma. Thus, our roster of particles will be:

Table 6-1 Symbols Used in Decay Scenario Schematics

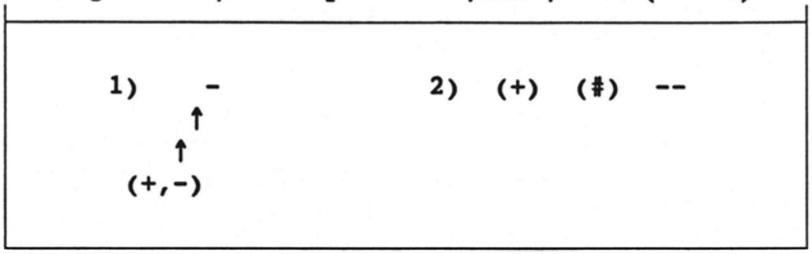
particle	defect composition	symbol
electron	-*excess* into -*void*	--
positron	+*excess* into +*void*	++
- muon	-*excess*	-
+ muon	+*excess*	+
muon neutrino	-*void*	(-)
muon @neutrino	+*void*	(+)
electron neutrino*	*void-pair*	(-,+)
or		or
electron @neutrino*	*void-pair*	(+,-)
defect-pair	2 paired ±*c-voids*	±·····±
momentary unpaired		±··
collapsed defect	±*c-void*	··±
gamma	none	#
undedicated shrinkage released in decay:		(#)

* IPP does not distinguish these as separate forms.

Muon Decay Scenarios

Using these symbols, we diagram the most common μ^- decay:

Fig. 6-1 μ^- decay into e⁻,@nue,numu (98.6%)



This decay scheme, at first appraisal, may seem somewhat crazy, due to the following:

1) The muon is assigned *a half-charge.*

2) The decay muon neutrino, *also, bears a half-charge.*

3) The neutral electron neutrino *initiates the decay*, rather than being an end product of the decay.

4) The interaction between the *void* pair and the *excess* results in the *fusion* of the two negative half-charge defects into a negative replacement defect, rather than the annihilation of the minus *excess* with the plus *void*, which at first thought seems more plausible.

These assumptions, while admittedly strange, are unavoidable, if we accept the validity of IPP; thus, it will be worth our while to analyze each of them in some detail. First, what are the implications of half-charge muons, and what evidence supports this notion?

Some Implications Of Half-Charge Muons

1) Since all muon mass determinations depend upon charge-to-mass ratios, a half-charge muon could possess only half the presently assigned mass.

2) The +muon/electron system, muonium, would not be neutral, but would possess -1/2e charge.

3) Muonic atoms, in which a -muon has displaced one of the orbiting electrons, would exhibit a +1/2e charge (or, perhaps, a -1/2e charge, if the displaced electron were weakly bound to the atom).

Experimental Support For Half-Charge Muons

1) The great penetrating power of muons compared with electrons of similar kinetic energy hints of something anomalous in the muon's makeup. A half-charge muon should have less tendency to interact with matter when passing through it at high velocities, since it would cause lesser deflection of orbital electrons than a full-charge particle. It is only through raising the energy of orbital electrons to the next higher level (or above) that the muon can lose some of its kinetic energy to the matter through which it is passing. For any deflection less than this minimum amount, essentially all of the energy imparted to orbital electrons at closest approach will be returned to the muon as it leaves the atom.

2) A half-charge muon neatly explains the absence of certain "rare" decay processes:

   $\mu \rightarrow e\,\gamma$ (less than one in 10^{10} decays)

   $K_L^0 \rightarrow \mu\, e$ (less than one in 10^9 decays)

   In current theory, these decays are allowed by energy-momentum conservation and electric-charge conservation, and their lack of occurrence is attributed to the muon and electron belonging to different lepton families, and therefore unable to give transfusions to each other. In IPP, it is clear that these decays would be forbidden by their failure to conserve charge.

3) By identifying a muon as a half-charge *excess*, we provide a *rationale for two different kinds of neutrinos*, which is in harmony with experimental evidence. This assignment of half-charge also clarifies the changing ratio of hadrons/muons as a function of center-of-mass energy in $e^+\,e^-$ collisions, since the *excesses* and *voids* created by the collision can more readily collapse and pair to become hadrons, as the amount of undedicated shrinkage increases.

How Plausible Are Half-Charge Muon Neutrinos?

Now let us consider the plausibility of half-charge *neutrinos*. If we accept the argument for lesser interaction of half-charge muons with matter, we can see that a nearly massless half-charge particle has almost no possibility of deflecting orbital electrons sufficient to ionize atoms through which they pass. Of course, relativistic *voids* could be heavy enough, but they pass by atoms so rapidly that there is little probability of interaction. Thus, a ±*void* neutrino could be expected to pass through matter unobserved, and with very little energy loss, though we might expect it to be deflected substantially in a near-miss with a charged particle, or by passing through extended magnetic fields, such as that surrounding the earth. (Is this a possible explanation for the missing fraction of the sun's neutrinos?)

Evidence For Half-Charge Neutrinos

Steven Weinberg called attention to 1973 experiments at CERN in "Unified Theories of Elementary Particle Interactions" (SCIENTIFIC AMERICAN, July 1974, p.57), which could be interpreted as evidence of charged neutrinos. Two events were recorded in which muon anti-neutrinos were scattered by electrons, and several hundred events in which they were scattered by protons. Weinberg attributed these scattering events to the exchange of a neutral intermediate vector boson, or "Z" particle. The IPP explanation would be that half-charge *voids* (muon neutrinos) will collapse momentarily in the proton's immediate vicinity, gaining enough mass so that its half-charge will be able to deflect the massive unit-charge proton. Thus, both particles would experience altered momenta.

If we assume that the charged muon neutrino has mass, we should expect it to *lose energy* gradually through these momentum-exchanging interactions with other matter in its long journey through space, and eventually to slow to thermal velocity. Thus, there should be an abundance of low-velocity muon neutrinos of both charges coursing through space, ready to pair with another *void* of opposite charge to form an electron neutrino, providing their relative velocity is below a "capture" value. The *possibility of capture*, of course, depends upon the void-pair having a *lower mass* than two separated opposite-charge voids. This will clearly be true, because opposite charge voids have opposite "electrostatic" distortion patterns, so, in proximity, the two patterns will be mutually canceling. Thus, void-pairs will require less geometric shrinkage than would two opposite-polarity voids isolated from each other, so their joining will result in a release of energy. In Chapter 8 (a discussion of IPP's cosmology), page 8-7, I suggest that this released energy takes the form of photons which are plausibly in the energy region of the background microwave radiation.

Another compelling indication of the ubiquitous presence of charged voids is the phenomenon of quantum tunneling of electrons through thin insulating layers, or against voltage gradients in "tunnel" diodes. If we presume that half-charge thermal voids are a billion times more numerous than baryons, it is plausible that they permeate all matter, where their presence can result in *momentary reversals of voltage gradients* in discrete regions of semiconductors. These transient, and localized, polarity reversals explain how electrons can move against a normally-blocking semiconductor gradient.

Possibly the strongest, yet most subtle, evidence of charged muon neutrinos is the variation of decay half-lives as a function of particle types (currently classified as "strong-force" decays, and "weak-force" decays). If one eschews "spontaneous" decays, and assumes that all particle decays are "induced", then it becomes clear that there must be two different categories of decay causing agents. The many orders of magnitude differences in decay times of the two processes clearly suggests a charged agent for the fast, "strong-force" decays, and a neutral agent for the much slower "weak-force" decays. I offer persuasive arguments for this hypothesis in this chapter.

Exploring Various Possibilities of Muon Decays

For a μ^- considered to be a -*excess*, we see immediately five possibilities for interactions:

Interactions of Excesses with Voids & Void-Pairs

-*Excess* reacting with:	**Could conceivably yield:**
+*void*	two gammas
-*void*	electron, gamma
+,-*void-pair*	-*void*, gamma
+,-*void-pair*	+*void*, electron
+,-*void-pair*	+*void*, electron, gamma

Of these five possibilities, only two are found experimentally (98.6% #4, and 1.4% #5), and both of these decay modes require creative reinterpretation from the IPP perspective to justify them. Thus, we have two tasks — to show why the first three do not occur, and to rationalize 4) and 5) with the experimental findings.

Why Doesn't A -Excess Merge With A +Void?

In decay #1, above, *the failure of a -excess to merge with a +void* is somewhat baffling, because we see that they would obviously be attracted to each other, and their merging would "heal" the lattice of both defects. However, we do know something which may account for this failure - namely, the substantial *mass disparity* between the *excess* and the *void* (LBL data suggests the ratio is > 200/1, and I show, in Chapter 8, page 8-7, that the ratio is more plausibly $\approx 10^{10} / 1$).

This mass disparity causes a *void* to approach an opposite-charge *excess* as a comet approaches the sun; therefore, the two particles could pass through each other's centers only if their initial trajectories were aimed precisely at each other; lacking this precision, the *void* would simply orbit the *excess* in a parabolic path, miss it, and disappear. (Notice that the mutual collapse of the two defects, which might equalize the mass of the two particles, is prohibited by the absence of transferable undedicated shrinkage in the excess defect, since it has no charge-exchange states). Even though unpaired *voids* may be by far the most abundant "particles" in the universe, co-linear trajectories of opposite charge *excesses* and *voids* are so unlikely that the chance of decay 1) is remote.

Decay #2, having impediments similar to Decay #1, *is even more unlikely*, because the two interacting defects *repel* each other.

Decay #3, *the interaction between the -excess (muon) and a neutral void-pair (electron neutrino),* is more probable. However, there can be no attraction between the two until their paths bring them so close together that the spacing between the -excess and the void-pair approaches the oscillatory amplitude of its two opposite-charge components. At this proximity, we can imagine a tendency for the three particles to move into a linear arrangement, with the +void component in between the -excess and the -void:

- (+) (-)

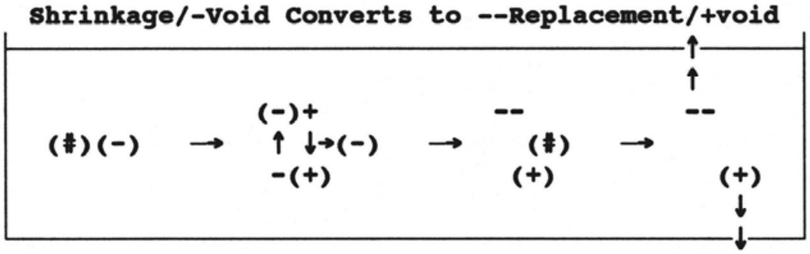
Since both negative particles will be attracted to the +void, and the linear arrangement shields each of the outer defects from the field of the other, we can expect the three defects to end up in a tight cluster:

$$-(+)(-) \quad \rightarrow \quad (\#)(-)$$

The logical thing to expect, as shown above, is for the *+void* to annihilate with the *-excess*, creating a high-energy blob of undedicated shrinkage, centered very close to the residual *-void*. This shrinkage cannot divide into a gamma plus a highly accelerated *-void*, because the *-void* will immediately collapse to accept all of the shrinkage. This "collapsed" defect, however, cannot retain this shrinkage, because (1) it has no nearby void to pair with, and (2) it will have acquired the summation momentum that the interacting particles brought to the annihilation center, and must, therefore, move away from the center of the annihilation-released spherical shrinkage, which is *inherently static* in the space lattice.

Decay #4: What happens, then, is that the *void-captured shrinkage diminishes* and the *undedicated portion* of the released spherical shrinkage *grows*. Almost immediately, there is more than enough energy to create an electron-positron pair. However, the close proximity of the *-void* will interfere with the formation of a positron, because the *-void* will be a more attractive destination for the circling +ECE, than the *+void* vacated by the circling -ECE. An annihilation results, leaving a blob of undedicated shrinkage, a *+void*, and an electron, both of which leave the scene in opposite directions:

Fig. 6-2 More Details of π^- Decay
Shrinkage/-Void Converts to --Replacement/+void



If this second annihilation is reasonably well centered between the two remaining defects, the resulting undedicated shrinkage can split into two oppositely directed "dynamic" components (hemispherical shrinkage), which are assimilated as momentum by the electron and *+void*, leading to their separation. This splitting of the shrinkage removes its undedicated character, and prevents its assimilation by provoking collapse of the *+void*. It is the presence of the electron, and its inability to collapse, that accounts for the splitting of the shrinkage, which, in turn, prevents the repetition of the first part of this scenario.

Thus, the above scenario fits our decay #4 possibility, which is the most often observed decay of the μ^- (98.6%), and, as well, accounts for the non-occurrence of decay #3. We should see that it can account for **decay #5**, if we assume that the geometry of the second annihilation is less symmetrical, such that the undedicated shrinkage is out of a direct line between the electron and the *+void*. In this case, as the shrinkage splits into momentum components, there will be an off center component of spherical shrinkage, which cannot split so as to be assimilated by the two separating particles. This unassimilated shrinkage will split into two equal components of hemispherical shrinkage, one leaving the decay site as a gamma, the other adding another momentum component each to the electron and the +*void*. We should expect these two components of momentum to be distributed unequally and variably, according to the specific decay geometry. This decay of the μ^-, initiated by an electron neutrino *(void-pair)*, into electron, muon antineutrino (+*void*), and gamma constitutes about 1.4% of the observed μ^- decays.

Why IPP Decays Violate Lepton Conservation Laws

You have probably noticed that decays 4) and 5) violate the so-called Lepton Conservation Law, which would call for decay products of an electron, an electron antineutrino, and a muon neutrino. We should not be surprised to find that the radical assumptions of the Ether Theory of Physics requires us to re-examine, and perhaps confute, some of the accepted conclusions of QCD.

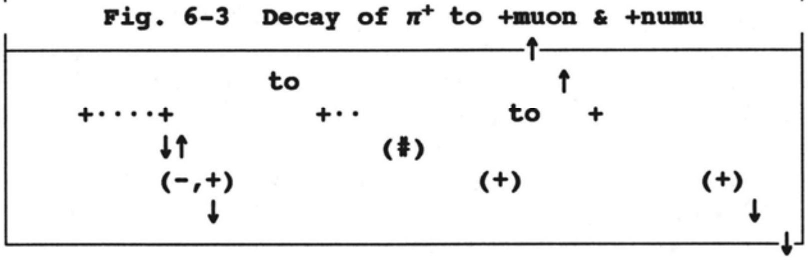
The Pion Decays

Let us proceed to the meson decays, deferring our exploration of the tau decays (since we consider the tau to be a four-defect-pair meson in IPP). We shall begin with the positive charge pion, which in IPP is a defect-pair comprised of two +c-voids:

π^+ Meson Decays

The π^+ meson decays nearly 100% into μ^+/numu. This decay can be understood as a reaction of the pion with an approaching *void-pair*, in which the minus *void* of the *void-pair* undergoes charge-exchange annihilation with one of the plus *c-voids* of the pion, thereby creating undedicated shrinkage mid-way between the remaining *c-void* and the plus *void* residue of the *void-pair*. The *c-void*, having no pairing partner, converts to an +*excess* (+muon) and leaves the scene in the opposite direction from the plus *void* (numu):

Fig. 6-3 Decay of π^+ to +muon & +numu



The two particles acquire equal and opposite momentum from the undedicated shrinkage released by the charge-exchange annihilation, supplemented by the shrinkage released by the conversion of *c-void* to *excess*.

The Rare π^+ Decays

Five rare decay modes of the π^+ are observed:

1) In one decay in 8000, the above normal π^+ decay spawns an additional gamma. This may be understood as analogous to the muon decay, where the released undedicated shrinkage is too off-center to be assimilated entirely as increased momentum by the +*excess* and the +*void*; the unassimilated part forms a gamma.

2) e^+/nue (also 1/8000) This decay can be imagined as a variant of the μ^+/numu scenario, in which the approaching *void* pair has a trajectory nearly through the midpoint of the pairing axis of the collapsed voids. Here, as the -*void* moves through the gap, it draws its +*void* mate along with it, bringing the latter so close to one of the two +*excesses* that it will merge to form a positron. As we have discussed in an earlier example, the inability of the positron to collapse leads to the splitting of the released undedicated shrinkage into two equal momentum components. Thus, even though the two opposite charge *voids* may initially collapse to assimilate their half of the undedicated shrinkage, there will not be enough energy available for them to form a collapsed pair. Indeed, since they will assimilate equal amounts of shrinkage, each will have insufficient mass-energy to form an *excess*; therefore, they will pair, as *voids*, to form an electron neutrino.

Other close approaches lead to other outcomes:

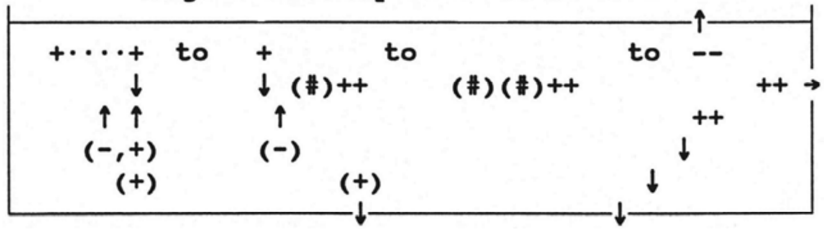
3) e^+ / nue / γ (5/100,000,000) Results from trajectories producing off-center undedicated shrinkage.

4) e^+/nue/ π^0 (1/100,000,000) If the -*void* orbits the newly formed positron, it may end up outside, leaving a central positron. In this event, almost all the released undedicated shrinkage can divide equally among the two opposite charge *voids*, giving them enough mass-energy to pair, forming a π^0. In this scenario, the nue is the initiator, but not the product of the decay.

5) e^+ / e^+ / e^- /nue (less than 5 billionths) If the trajectories lead both to fusion into an e^+, and annihilation of the -*void* with a metamorphosed +*excess*, this second released undedicated shrinkage can spawn an electron-positron pair, with the result that the three leptons separate from each other. Again, the nue is the initiator, but not a product of the decay.

Here is a possible scenario for this rare #5) decay. Note that the missing mass is carried away by a plus void (muon antineutrino), whose presence is required to catalyze the first positron formation:

Fig. 6-4 Decay of π^+ to $2e^+$ & e^-

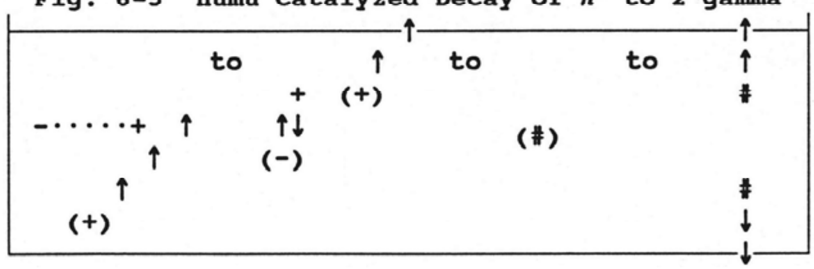


Decay of Neutral Pions

Although the charged and neutral pions are very similar in structure, the lifetime of the neutral pion is more than eight orders of magnitude shorter. This anomaly should excite our curiosity, since it clearly suggests that different decay mechanisms may be involved. In searching for these, we should note that the neutral pion, in contrast to the charged pions, has a dipole moment, because of its separated opposite-charge defects. Thus, electrostatic and magnetic fields can exert a torque upon the π^0, even though its trajectory is not influenced by them. However, man-made fields are so feeble in comparison to electrostatic fields between nearby defects, that we shall confine our discussion to the latter.

Let us imagine that the path of the π^0 nearly intersects the trajectory of a unpaired *void*. Being neutral, the π^0 will not alter the *void's* velocity, but the *void's* charge will tend to de-synchronize the diagonal translations of the π^0. In many of the possible angles of approach, there will be a tendency for the passing *void* to cause one collapsed-void to lag behind the other, which means that one will tend to be in the collapsed condition while the other is in the *void* pattern. Since this de-synchronization will tend to interfere with the cancellation of expansion-contraction distortion, there will be an increased tendency for the two defects to be attracted toward each other, as well as for the two collapsed-voids to revert to their precursor status of *void* and *excess*. Thus, we can expect that the two defects may merge, and annihilate each other, with the released undedicated shrinkage splitting into two photons:

Fig. 6-5 numu Catalyzed Decay of π^0 to 2 gamma



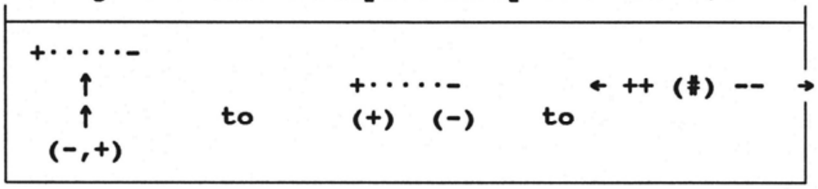
Two gammas are produced in 98.8% of π^0 decays. Obviously, either polarity of *void* will catalyze the two-gamma decay with equal probability. And the shorter lifetime of the π^0, compared to the charged pions, may simply reflect the greater abundance of unpaired *voids*, compared to paired *voids* (say by a factor of 100,000, there being perhaps another factor of 1000 in the closer proximity of approach necessary for the *void-pair* to interact with a charged pion, than with a neutral pion). This rarity of paired *voids* could be easily understood, if their binding energy were equivalent to only 2.7° K (the energy of cosmic microwave background radiation photons), since only a weak electrostatic field would then be necessary to separate them.

The preponderance of the remaining π^0 decays are $e^+ / e^- / \gamma$ (1.2%). This decay mode very likely is initiated in the same manner as the two-gamma decay, but with the π^0 experiencing a closer brush with the *void*. Because of the stronger influence of the *void* field, the undedicated shrinkage released by the inward spiraling of the two collapsed-voids would be more contorted, and, hence, more likely to produce an electron-positron pair, than simply two gammas. But, at the same time, the proximity of the passing *void* could permit it to "steal" some of the undedicated shrinkage by temporarily rearranging, so that the created electron-positron pair would not be able to translate all the excess shrinkage into momentum. Instead, the component of undedicated shrinkage which is left behind by the departing *void* would leave the scene as a gamma.

The rare three-gamma decay (seen less than once in 2,500,000 decays) could possibly be the result of a close approach by the *void* in a direction parallel to the pairing axis of the π^0. In this event, the undedicated shrinkage would remain rather symmetrical, so that it would tend to break into two gammas, but the passing *void* could again "steal" undedicated shrinkage, momentarily, leaving behind a component far enough removed to produce a third gamma.

A slightly rarer decay, e^+ / e^- without accompanying gamma (once in 5,000,000 decays) probably derives from interaction between the π^0 and a neutral *void-pair*. We can imagine this to result from a fortuitous spiraling interaction between the void-*pair* and the π^0, such that the negative *void* joins with the negative *c-void*, and the positive *void* with the positive *c-void*, producing an electron and positron directly. In this case, the excess undedicated shrinkage appears midway between the electron and positron, so that it splits into equal components of momentum leading to their separation:

Fig. 6-6 nue Catalyzed Decay of π^0 to e^+/e^-



A much more common outcome to the interaction between a π^0 and a neutral *void-pair* is one producing $e^+ / e^- / e^+ / e^-$ (once in 30,000). Here we imagine that the neutral *void-pair* approaches from almost any direction except normal to the pairing axis, and reacts in the most plausible way, with opposite polarities attracting and annihilating. However, because the two annihilations are not simultaneous, the undedicated shrinkage is not produced in the center, but rather is half produced in the first annihilation center, and then the remaining half produced in the second annihilation center. Because the two annihilations are not simultaneous, the two centers of undedicated shrinkage are skewed sufficiently so that each devolves into an electron-positron pair. The excess undedicated shrinkage converts to momentum to drive the four particles apart.

Fig. 6-7 nue Catalyzed Decay of π^0 to $2e^+/2e^-$

```
                                                   ↑
+·····-   to          to          to    ++
        (#) ···-         (#)          ← --
(-,+)           (+)         (#)               --  →
                                               ++
                                                ↓
```

When a void-pair approaches nearly normal to the pairing axis (a rare possibility), the two annihilations will be essentially simultaneous. This will lead to two relatively symmetrical centers of shrinkage, each of which splits into two gammas. This four-gamma decay occurs about once in 500,000 decays.

An unusual π^0 **decay** possibility was added to the LBL table in 1982, a decay into two neutrinos. Because this decay leaves no detectable products, it must be inferred from the inferred production of a π^0 and the absence of any of the other π^0 decay modes. Current evidence indicates that two neutrinos occur no more often than once in 40,000 decays. Probably the most plausible scenario which could produce neutrinos is a close approach of a charged *void*. What we should imagine is that the *void* trajectory takes it near enough to the two *c-voids* that it collapses and steals a substantial fraction of their undedicated shrinkage. This action, combined with the disruptive influence of the odd charge sum of the group, could lead to a denial of any stable pairing combination, such that all three defects fly apart as muon neutrinos:

Fig. 6-8 numu Catalyzed Decay of π^0 to 4 numu

```
                                          ↑
+·····-          +··               (+)
           to        ··-    to         (#)  (-) → → →
  ↑              ··+                      (+)
 (+)                                       ↓
                                           ↓
```

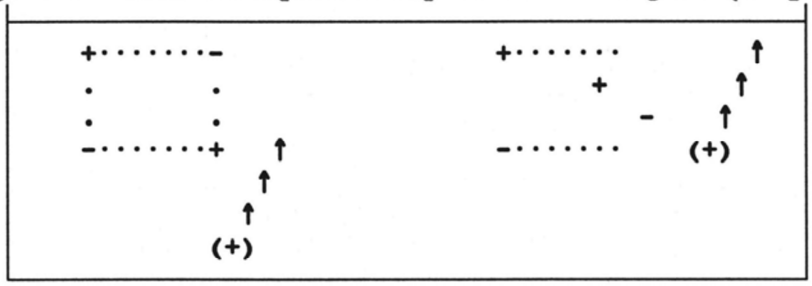
Although this scenario has three muon neutrinos departing from the decay site, rather than two, it satisfies the need of producing undetectable decay products.

Eta Decays

The neutral eta particle has a mean lifetime several hundred times shorter than the π^0. This suggests that a weaker electrostatic influence can induce breakdown in the eta; hence, a decay initiating *void* can be considerably more distant from an eta, than from a π^0, thereby making eta decay a more probable event. The most likely mode of decay is through increased spacing between the two diagonally bonded defect-pairs, which, of course, leads to diminished defect spacing and the consequent release of undedicated shrinkage. About 60% of the observed decays appear to follow this pathway. The remaining 40% of the decays seem to derive from charge-exchange annihilations of opposite-charge collapsed defects across the diagonal bonds.

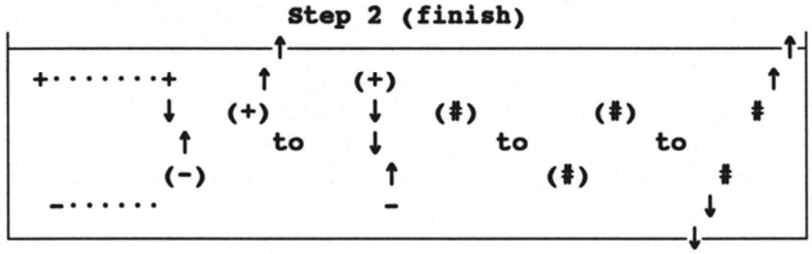
An example of the latter decay mode is the two-gamma decay (39.1%). In the diagram below we shall assume that the pairing axes of the two defect-pairs are horizontal, that the diagonal bonds are vertical, and that we are looking at the pair in a face diagonal direction of the lattice. We shall assume that both defect-pairs are in the 8ü state when a charged *void* comes into their vicinity. The *void* field will tend to alter the up-and-down charge-exchange trajectories of the closer defects, so that they fail to arrive at the usual 9ü spacings, but arrive, perhaps displaced, as shown below, right:

Fig. 6-9 numu Catalyzed Decay of eta to 2 gamma(step 1)



The result of these displacements will be to decouple the paired *c-voids* momentarily, and place the two right-hand defects at different distances from the eta particle center. Both of these effects can lead to a devolution of these two *c-voids* into an *excess* and a *void*, which will be drawn together and annihilate, as the stray plus *void* leaves the particle vicinity. This first annihilation deprives the left-hand defects of their partners, so that they, too, devolve and annihilate each other. The final result is the evolution of two photons:

Fig. 6-10 numu Catalyzed Decay of eta to 2 gamma
Step 2 (finish)



There is a small probability (less than 1 in 100), most likely when the eta is in the 9ü/9ü state, that the left-hand defects will be displaced by the passing *void* field from their face-diagonal relation into a cardinal alignment. In this eventuality, the two defects may collapse and pair to form a π^0, so that the decay is $\pi^0\,\gamma\,\gamma$. The frequency of this decay is less than 0.3%. Note that two gammas are formed because the asymmetry of the passing *void* scenario precludes a geometry in which the annihilation center is equidistant from both of the remaining *c-voids*. This fact also ensures that the two gammas differ in energy.

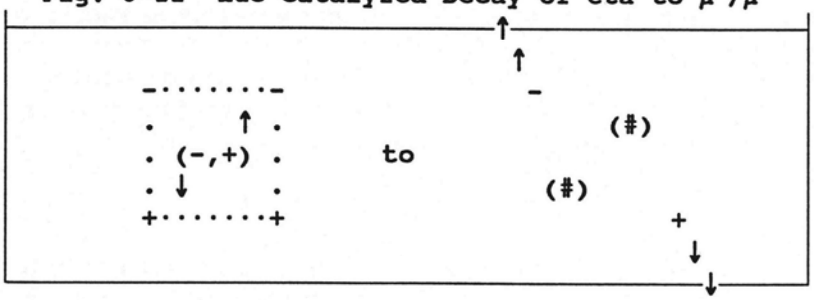
Occasionally the annihilation center in the above scenario will spawn a e^+/e^- pair, instead of breaking down into two gammas. This will lead to a $\pi^0/e^+/e^-$ decay (1/20,000).

This dual annihilation scenario can lead to decay modes other than γ/γ. Closer proximity of the passing *void* may force the two zones of undedicated shrinkage closer together, and produce sufficient contortion in the local ECEs that an e^+/e^- pair is generated from one of the shrinkage centers. This will lead to $e^+/e^-/\gamma$, which is found in 0.5% of the eta decays.

Where the void trajectory lies close to the mid-plane normal to the two pairing axes, the two annihilations will occur essentially simultaneously. Thus, the system behaves as if there were only one center of shrinkage, and a e^+/e^- pair can be produced without an accompanying gamma. This mode has a frequency under 1/3000.

Two muons can result from *void-pair* trajectories which cause diagonally opposite *c-voids* to annihilate:

Fig. 6-11 nue Catalyzed Decay of eta to μ^+/μ^-

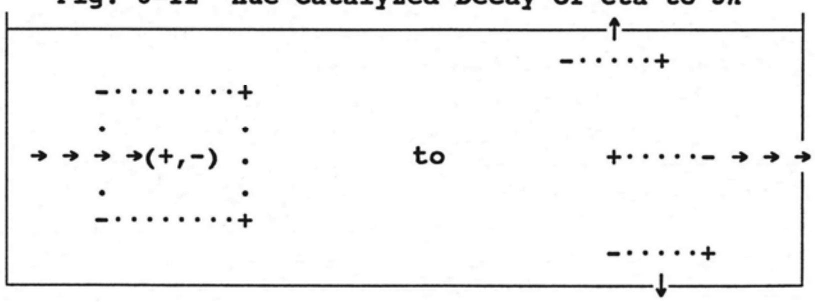


We should imagine, here, that the *void-pair* arrives normal to the plane of the eta, with its oscillating pattern diagonal to the eta. Thus, the two *c-voids* along the diagonal line can annihilate with the two *voids* of the *void-pair*, thereby releasing undedicated shrinkage at the center of the eta. This central undedicated shrinkage divides to supply separating momentum to the remaining two *c-voids*. But, because they were each centers of shrinkage of 549/4 = 137 MeV, there is enough local shrinkage to convert the separating unpaired *c-voids* to *excesses* (105 MeV required), so they leave as opposite-polarity muons. If the central undedicated shrinkage is precisely between the two muons, the decay will be μ^- / μ^+ (1/150,000). If it is off-center, the decay will be $\mu^- / \mu^+ / \gamma$ (1/3000).

Other less likely consequences can be imagined with the above *void-pair* trajectory. If the two *void-pair* components arrive such that they repel, rather than annihilate, the two defects most affected by the two opposite-polarity *voids* may be rotated into a cardinal orientation normal to the original eta plane, and pair, forming a π^0. This, again, would leave two dangling c-*voids*, which convert to *excesses*, leading to a $\pi^0 / \mu^- / \mu^+$ decay, or to a $\pi^0 / \mu^- / \mu^+ / \gamma$, if the *void* comes close enough to move all of the defects substantially away from the eta center of mass. The first is observed in 1/170,000 of the decays, the second in less than 1/200,000.

Now let us return to the second most frequent decay, $3\pi^\circ$ (31.9%). This result most plausibly derives, again, from the central passage of a *void-pair*, but when this result requires that the eta be in the 8ü/8ü state. When the higher mass-density of the bound LD oscillator cycle returns (normally leading to the 9ü/9ü state), the central *void-pair* is able to soak-up at least a third of the shrinkage by rearranging into a neutral defect-pair. This will destroy the particle's erstwhile symmetry, prevent charge-exchanges, and break the diagonal bond, thus, leaving the three defect-pairs to seek their free-space equilibrium spacing of 6ü, which releases central undedicated shrinkage, which divides to supply the separating momentum:

Fig. 6-12 nue Catalyzed Decay of eta to $3\pi^0$



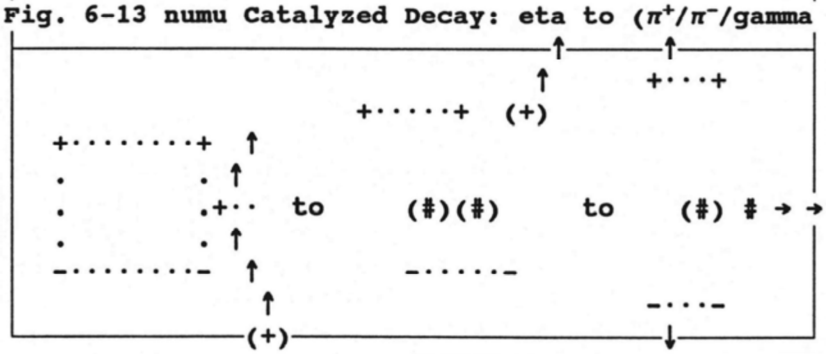
Eta(548) decays resulting in charged pions are somewhat less abundant than the neutral modes. Perhaps this is due to necessity for these decays to occur in the high-mass (9ü/9ü) state, where there is less central shrinkage density available to incoming *voids* and *void-pairs*, so they will not be able to tarry as long in the vicinity. The most abundant of these decays ($\pi^+ / \pi^- / \pi^\circ$, 23.6%) will have the same scenario as the $3\pi^\circ$ decay, the only change being the *void-pair* arrives during the eta's 9ü/9ü state.

Eta(548) Decays Yielding Charged, But No Neutral, Pions

Charged decays without an accompanying π° are less abundant ($\pi^+ / \pi^- / \gamma$, ≈ 4.9%; π^+ / π^-, ≈ 0.15%). You will see that these decays must occur when the eta(548) is in the 9ü/9ü state, and they must be initiated by a ±*void* (± numu) destabilizing agent, rather than a *void-pair* (nue). The visitation of a single *void* prevents the formation of a neutral pion, or the elimination of *c-voids* by charge-exchange annihilation, which would result by visitation by a *void-pair*. As I show in the next schematic, the most plausible trajectory for initiating the charged pion/gamma decay is one grazing the eta in roughly the diagonal bond direction. This will attract the negative defect-pair and repel the positive defect-pair, thereby severing the diagonal bond, which releases the bond shrinkage to provide separating momentum, which causes cardinal translations, releasing more shrinkage, which results in diminished defect spacings, which releases more momentum augmenting shrinkage and further spacing reduction as the two escaping pions reach their free-space equilibrium spacing of 5ü/7ü, and contribute to the last burst of momentum.

It is rather unlikely that the shrinkage released by these three successive episodes will be precisely centered between the escaping charged pions. Hence, it is probably that the central undedicated shrinkage will spawn a gamma. We can infer that this precise centering necessary to produce a decay without a gamma occurs 0.15%/4.88% = 1/33 of the time. I show a schematic of the more probable gamma-releasing scenario below:

Fig. 6-13 numu Catalyzed Decay: eta to (π^+/π^-/gamma



You will see that I show the plus *void* rearranging momentarily near the center of its grazing trajectory. It is this rearranging which causes the released undedicated shrinkage to be off-center relative to the two separating pions, thereby spawning a gamma. The only way this off-center shrinkage can be avoided is for the *void* to pass through and collapse very close to the eta particle center.

There is one more possibility requiring the destabilizing agent to pass very close to the eta center, but this one requires the agent to be a *void-pair*. When a *void-pair* collapses near the center of undedicated shrinkage, it can turn into an *excess/void* pair, and annihilate, only to immediately reform into an electron/positron pair. This scenario can lead to a $\pi^+ / \pi^- / e^+ / e^-$ decay (0.13% of the decays).

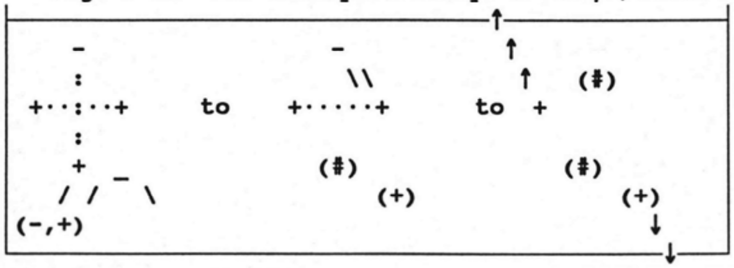
Interlude

For the preceding particles, I have attempted to devise plausible scenarios for most of the experimentally verified decay modes. Obviously, this practice need not be continued for all known particles, since only limited numbers of decay mechanisms are involved. What I shall do, instead, is to apply these mechanisms to a selected few particles of increasing complexity, and then round out the analysis by considering a few unusual decay modes which seem to require new modes of induction, or which appear to utilize different modes of interactions.

Charged Kaon Decays

With two orthogonal defect-pairs, the kaons are obviously susceptible to decay by induced defect-pair separation. However, because the *c-void* charges circulate by charge-exchanges with great rapidity, the kaon will be immune to any distant influence of a charged *void*, requiring, instead, *a very near miss,* properly synchronized with the charge-exchange cycle and correctly oriented with respect to the plane of the particle, to effect the separation into $\pi^{\circ} / \pi^{+/-}$ (21.2%). These requirements result in a much longer lifetime for the kaons, when compared to the two-defect-pair eta. These stringent requirements also suggest why the dominant decay mode, K^{+} to μ^{+}/numu (63.5%), results from an interaction with the much rarer neutral *void-pair*:

Fig. 6-14 nue Catalyzed Decay: K^{+} to μ^{+}/+numu



Here, the annihilation with the negative *void* releases the upper negative *c-void*, so that it immediately charge-exchange annihilates with the right-hand plus *c-void* of the remaining defect-pair. The result: two centers of undedicated shrinkage between a +*excess*, and a +*void*; hence, the shrinkage splits equally into separating momentum. In about one decay in 170, part of the undedicated shrinkage is off-center enough to spawn, in addition, a gamma.

Another possibility, requiring a nue trajectory more normal to the plane of the kaon, is for the unpaired upper negative *c-void* to charge-exchange with the left-hand plus *c-void*, yielding a horizontal π°. Then the unpaired plus *c-void* can transmute into a +*excess*, releasing additional undedicated shrinkage, both centers of which are assimilated as momentum by the π°, μ^{+}, and numu (3.2%):

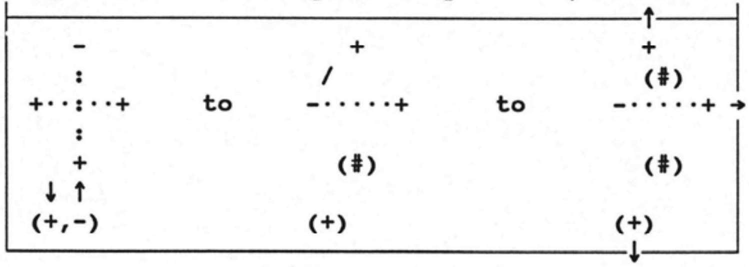


Fig. 6-15 nue Catalyzed Decay: K^+ to $\mu^+/\pi^0/$+numu

Somewhat similar to the latter decay is one yielding a π°, a positron, and an assumed nue (4.8%), although IPP would say the nue is the initiator of the decay, not the result of it:

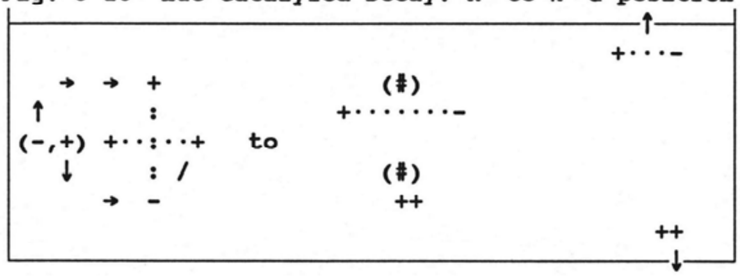


Fig. 6-16 nue Catalyzed Decay: K^+ to π^0 & positron

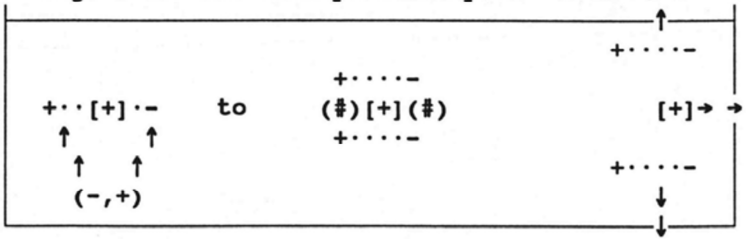
Here, the *void-pair* approaches more or less normal to the plane of the K^+, such that the -*void* can annihilate with the upper *c-void*, while the +*void* is attracted toward the lower negative *c-void*. We also must imagine that, by the time the +*void* arrives at the negative *c-void*, a charge-exchange has replaced it with a plus *c-void*. Hence, the +*void* merges with the +*c-void* (transmogrified to a plus *excess*), forming a positron.

Notice that static shrinkage is released both by the upper annihilation and by production of the positron, fueling the separation of the resulting π°/positron (4.8%). Occasionally, when the annihilation component is sufficiently off-center, a gamma is found among the decay products: $K^+ \rightarrow \pi^\circ / e^+ / \gamma$ (1/2700). Of course, in both of these decays, whether with, or without, a gamma, the nue is the initiator of the decay, rather than the result of it.

Three-Pion Decays of Charged Kaons

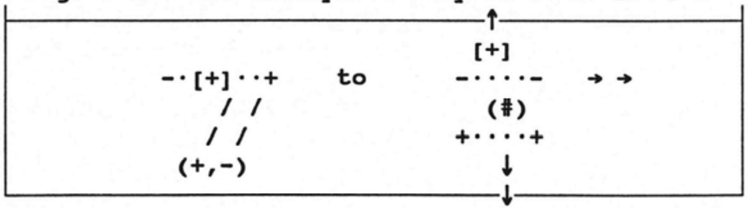
Three-pion decays of the charged kaons are also induced by interaction with a neutral *void-pair*, but they require that the *void-pair* have a rather special trajectory. The nue must arrive with a suitable polarization to repel or attract the neutral defect-pair of the kaon. This assures that kaon breakup will occur in such a way that all six defects are nearly equidistant from the particle center of mass, so that the *void* pair may acquire enough of the undedicated shrinkage to collapse into a pion. Notice that we are now looking at the K^+ *edgewise*, and the symbol [+] represents a plus defect-pair viewed endwise (i.e. its pairing axis is perpendicular to the plane of the paper):

Fig. 6-17 nue Catalyzed Decay: K^+ to $2\pi^0$ & π^+



There would perhaps be a similar result if the *void*- pair attracts the neutral defect-pair downward, and collapses by assimilating some of the undedicated shrinkage released by the kaon separation and cardinal translations of defect-spacings from 8ü to 6ü (neutral) and 9ü to 7ü/5ü (charged). Decays in which two neutral pions are produced are observed about 1.7% of the time. More frequently, an exchange occurs between the approaching *void-pair* and a plus *c-void* in the kaon, so that the disruption produces a $\pi^+ / \pi^+ / \pi^-$ decay (5.6%):

Fig. 6-18 nue Catalyzed Decay of K^+ to $2\pi^+$ & π^-



Besides these seven common decays, comprising almost 100%, there are 27 decay modes of low probability. All of these can be interpreted as resulting either from unlikely neutrino trajectories, or from unusual combinations of the various decay mechanisms we have already explained, namely:

1) Induced displacement breakups
2) *Void*/collapsed annihilation releasing *excess*
3) *Void*/collapsed fusion producing e^+ or e^-
4) Induced charge-exchange annihilations
5) Induced charge-exchange fusion
6) *Void-pair* collapse to pion
7) Void-pair collapse to excess/void

8) Undedicated shrinkage converting to gamma(s)

9) Undedicated shrinkage spawning e^{+}/e^{-} pair(s)

For example, an unlikely *void* trajectory parallel to the pairing axis of the neutral defect-pair of the K^{+} may displace the opposite-charge *c-voids* to opposite sides of the particle plane, breaking the pairing, and inducing reversion to opposite-charge *excesses*. This can lead to a $\pi^{+}/\mu^{+}/\mu^{-}$ decay (less than 1/400,000).

An example of mode 7) is decay into $\pi^{+}/\pi^{-}/\mu^{+}$/numu (1/70,000). Here, we may imagine a *void-pair* penetrating the kaon, the minus *void* being accelerated by the kaon charge, the plus *void* being retarded, so that as the two defect-pairs separate, the plus *void* finds itself in between them, close to the center of released undedicated shrinkage. Thus, it will convert from plus *void* to plus *excess* (μ^{+}), while the minus *void*, being further away, will remain a *void* (numu).

An exotic K^{+} decay to $\mu^{-}/e^{+}/e^{+}$/nue (less than 1/50,000,000), may be worth examining in some detail, since it utilizes an obscure decay mechanism, charge-exchange fusion. The decay can be initiated by interaction with a *void-pair* in two stages:

1) +*c-void*/+*void* fusion producing e^{+}

2) induced charge-exchange fusion by passage of the -"void" midway between two face-diagonally related plus *c-voids*:

Fig. 6-19 nue Induced Decay of K^{+} to $2e^{+}/\mu^{-}$/-numu

```
                                       ↑       ↑
                          \           (-)      ↑
      +                    \  +                ↑
      :                   (-)                 ++
  +···:···+              +·······-            (#)
     / : //                 (#)                (#)   -   →
    /  -                     ++                 ++
   / /                                           ↓
(-,+)                                            ↓
                                                 ↓
```

The first fusion (creating a positron) requires that the attractive minus *c-void* be replaced via charge-exchange by a plus *c-void*, just as the plus *void* arrives. The second fusion results from the -*void* following a trajectory midway between the two remaining plus *c-voids*, attracting both defects, but having sufficient velocity so that it is past the exchange point when the two plus defects arrive. Static shrinkage necessary to convert one of these defects to an *excess* is released by the first positron fusion; the other plus defect moves as a *void*. Thus, the two defects can fuse into a positron. Likewise, this second fusion releases shrinkage required to convert the right-hand minus *c-void* to a -*excess* (μ^{-}). The precision of trajectories required to produce this decay mode assures that it happens very rarely.

I Leave the Other Decay Scenarios to You!

Using these tools of analysis, the reader should be able to create plausible scenarios for all the other decay modes listed in the LBL Stable Particle Table for the K^+ meson. Indeed, these tools are nearly sufficient to understand the various decay modes of any meson resonance. However, we have not yet considered how the *structure* of a particle influences decay. This has particular significance to the neutral kaons, where the slant relationships of the associated defect-pairs influence both the probability of interactions, and the kinds of interactions which predominate. We shall now turn to these secondary considerations.

Neutral K Mesons – the Short & the Long

The unexpected decay behavior of the neutral kaons has puzzled physicists for a several decades. There have appeared to be two distinct particles of very similar mass, one with even parity (decaying rapidly into two pions), the other with odd parity (decaying more slowly into three pions, or into a charged pion and a lepton plus neutrino). The physicist's first question was: why should two particles with such distinctly different properties have so nearly the same mass? With more experimental evidence, it became clear that the two particles had almost precisely the same, if not identical, masses, and physicists began to wonder if the phenomenon were not better described as a single particle with a split personality. This notion has received some reinforcement as rare decay modes have been observed for the K_L^0 which mimic all the decay modes of the K_s^0. For example, the K_L^0 produces two pions about once in every 400 decays, while the K_s^0 decays to two pions about 98% of the time.

When Nature offers baffling experimental evidence, the bafflement occasionally can be credited to a deficiency in the theory by which the evidence must be interpreted. The current quark theory permits only one structure for the two varieties of neutral kaons, so one must remain puzzled by its bifurcation into two species. In IPP, on the other hand, the possibility of different slant relationships between two orthogonal defect-pairs leads naturally to two distinct species. Here, our problem is not why the two species exist, but merely which slant form to identify with which neutral kaon species. In Chapter 2, I identified the S-slant form as the K_L^0, and the A-slant form as the K_s^0. Let us now see if the neutral kaon decay processes are consistent with this choice. In Fig. 6-20, left, we see that the S-slant form (K_L^0) of the neutral kaon alternates between a high-mass state (9ü,9ü) and a low-mass state (7ü,7ü) as the particle undergoes sequential charge-exchanges. The A-slant form (K_s^0) (right) keeps the same, intermediate mass for both charge-exchange states (9ü,7ü to 7ü,9ü). Let's convert these structures to our simplified charge representation:

Fig. 6-20 Structural Differences – Neutral Kaons

```
     K0L (S-slant)                  K0S (A-slant)

#1   +        state #2         #1 +        state #2
     :            -               :            -
     :            :               :            :
-···:···-    +··:··+         -··:··-     +····:····+
     :            :               :            :
     :            -               :            -
     +                            +
```

A significant difference between S-slant and A-slant forms lies in their charge-distributions. Notice that the S-slant (K_L^0) retains charge symmetry while its size alternately contracts and expands. On the other hand, the A-slant (K_s^0) maintains a larger spacing of the positive charges, and smaller spacing of the negative charges in both charge-exchange states. There are also effects on charge dominance as the two particles move through the space lattice. Cardinal translations of the K_s^0 will invert the charge dominance, while diagonal translations will preserve it. The charge symmetry of the K_L^0 remains unaffected by either type of translation.

These geometric differences between the two neutral kaons will obviously affect their susceptibility to decay by a passing *void*. The radial charge asymmetry of the K_s^0, particularly if preserved by diagonal translations, will make it easier for a passing charged *void* to induce differential movement of the plus and minus *c-voids*, an effect which may lead to desynchronization of the charge-exchanges, with the consequence that the particle may dissociate into two pions. If the *void* approaches somewhat normal to the plane of the K_s^0 (the most probable geometry), we should expect a separation into two charged pions. This is found for 69% of the decays. An approach parallel to the particle plane, on the other hand, will induce charge separation more strongly in the two closest defects, disrupting only one of the two normally synchronized charge-exchanges. The unaffected charge-exchange will convert the two odd defect-pairs to even, causing the particle to split into two neutral pions. This occurs in 31% of the decays.

In contrast to the substantial dipole moment of the neutral pion, the K_s^0 has only a subtle radial charge asymmetry, as a lever for a passing charged *void* to work upon. Thus, the K_s^0 requires a much closer approach by a charged *void* to effect its dissociation. Since closer approaches are rarer, the lifetime of the K_s^0 will be substantially longer than that of the neutral pion, (the experimental value is about six orders of magnitude longer). And we should expect the K_L^0, with nearly perfect charge symmetry, to require even closer approach by a *void* before dissociation occurs. This expectation is confirmed by experiment: the half-life of the two pion decay mode is about five orders of magnitude longer in the K_L^0 than in the K_s^0.

The interaction of neutral kaons with a *void-pair* is much more likely for a K_L^0, than for a K_s^0. This difference in behavior is again a result of charge-exchanges, but is related not to charge asymmetry, but to the mass changes in the K_L^0 charge-exchange cycle. Each time the lower mass state occurs (7ü,7ü), about 250 MeV of local undedicated shrinkage is produced. This means that any *void* in the vicinity will momentarily collapse to accept whatever portion of this shrinkage is accessible to the *void*'s center. Lone *voids* and *void-pairs* will react differently, however:

A lone *void* can accept this undedicated shrinkage momentarily, but cannot form a stable structure, so it must return the borrowed undedicated shrinkage to the high mass state of the K_L^0 (the next charge-exchange state).

The *void-pair* interaction yields several scenarios:

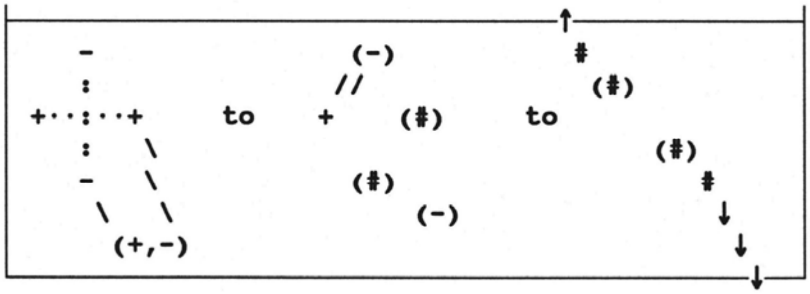
1) **Three neutral-pion decay:** The paired voids may move into a *c-void* defect-pair relationship, by stealing local shrinkage momentarily released in the transition from high mass state to low mass in the K_L^0 charge-exchange cycle. If the *void-pair* is close enough to acquire enough shrinkage to form a neutral pion (135 MeV), its formation will prevent the high mass charge-exchange state of the K_L^0 from recurring; this will make the kaon structure unstable so that it breaks apart into two pions. This scenario leads to a three neutral pion decay.

2) **Two charged-pion/one neutral pion decay:** Whether the K_L^0 dissociation occurs as charged or neutral pions will obviously depend upon the angle and timing of the *void-pair's* approach. If the disruption results in a single last charge-exchange, two neutral defect-pairs will result; if the last charge-exchanges are dual, the resulting pions will be charged. These three pion decays constitute about a third of the K_L^0 decays.

3) **Charged-pion/lepton/neutrino decays:** The remaining two thirds of the K_L^0 decays are predominantly charged-pion/lepton/neutrino decays, with pion/electron decays somewhat more likely than pion/muon decays (39% vs. 27%). These decays are analogous to the π^o/lepton/neutrino decays of the charged kaons, as described on page 6-12. Notice that the ratio of muon/electron decays is very nearly the same for charged kaons (3.20%/4.82% = .66) and for neutral kaons (27.1%/38.7% = .70), which suggests that these pion/lepton decays have similar modes of initiation. We should see, also, that the inability of the neutral kaon to decay into mu/numu can account both for the longer lifetime of the K_L^0 compared with the charged kaons (4.2 times longer), and for the order of magnitude larger percentages of pion/lepton/neutrino decays.

4) **Why there are no mu/numu decays:** We should not ignore the apparent inability of the neutral kaons to decay into mu/numu, because this decay could conserve both charge and momentum in IPP. Let us find out why the neutral kaon decays, instead, into 2 gamma:

Fig. 6-21 nue Catalyzed decay of K_L^0 to 2 gamma



Here both components of the nue annihilate simultaneously with their opposite-polarity *c-voids*, which leaves the remaining *c-void* defects without pairing partners, so they undergo charge-exchange annihilation. So instead of mu/numu, the system ends up with undedicated shrinkage only, which divides in the usual way into two gamma. These represent about 0.06% of K_L^0 decays, and about 0.0002% of K_s^0. This substantial difference in abundance with the two varieties of neutral kaons can possibly be attributed to the greater ease of simultaneous nue annihilation when the opposite-polarity defect-pairs can both be in their low-mass state together, rather than alternately.

DECAY OF TAU LEPTON QUA MESON

Why IPP Considers the Tau to be a Meson

Why should we consider a tau lepton to be a meson? Here are three reasons:

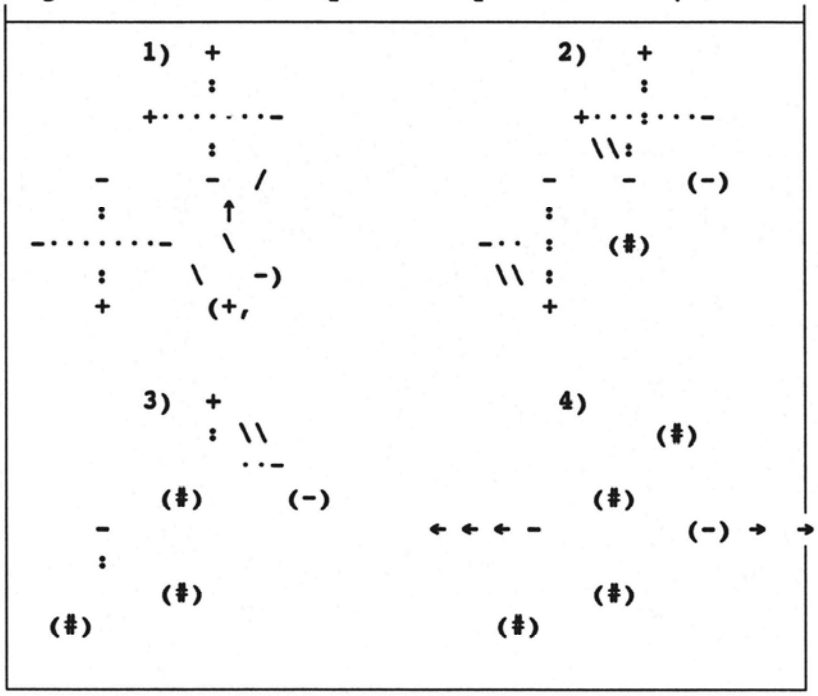
1) The fact that the tau particle decays about 65% of the time into hadrons clearly opens the possibility that the tau, itself, is a hadron, albeit a strange one, in that in all hadron decay modes, a portion of the center of mass energy is not accounted for in the observed decay products. This missing mass-energy is currently attributed to the formation of an unobservable tau neutrino.

2) In IPP, the electron and muon are identified with simple defects in the space lattice, and there is no other simple defect possibility to associate with a heavier lepton.

3) There is an elegant meson structure, stabilized exclusively by charge-exchanges (no paraxial, nor diagonal bonds), whose calculated mass is almost precisely the measured tau mass, whose defect charges sum to plus or minus one, and whose charge-exchange sequences should generate a spin of one-half. (See Figs. 2-16 & 2-17, and the discussions on pages 2-14,15).

Our first challenge is to show how this meson structure decays into lepton/neutrinos. This is rather easily seen, if we notice that the central four defects have a charged kaon configuration, and undergo charge exchanges of the offset kaon type, albeit the central defects are slightly skewed, have their defect planes rotated 90 degrees to the normal kaon configuration, and pair with the four outer defects, rather than with each other. Thus, these central four defects will interact with a *void-pair* which invades the central region in a manner analogous to the charged kaon decay described in Fig. 6-14, producing a μ⁻/@numu, and the inducing charge-exchange annihilation of the outer defects by depriving them of their pairing partners. Notice that I have assumed that the minus *void* of the *void-pair* displaces the lower minus *c-void* of the top vertical defect-pair, causing it to charge-exchange annihilate with the diagonally adjacent plus *c-void*; this in turn causes the charge-exchange annihilation of the upper outrigger defects. And, because the undedicated shrinkage produced in these annihilations sums to the particle center, the μ⁻ and @numu can assimilate all of the released shrinkage as particle momentum. As in the kaon decay, the electron antineutrino is the initiator of the decay, and is half annihilated in the interaction, the remaining half emerging as a muon neutrino in the decay products. This tau decay has an amplitude (probability) of 17.6%.

Fig. 6-22 mue Catalyzed Decay of Tau⁻ to μ⁻/-numu



Although this decay is similar to the charged kaon, the tau differs from the kaon in having an almost equal amplitude of decay into e⁻/@nue/nutau (17.9%). Here we must infer that the nue arrives when the tau has a different pattern of charges, such as to induce both an annihilation, and a *void/excess* fusion to produce a *replacement* defect. Let us imagine a timing of the *void-pair's* arrival, such that the approached side of the tau⁻ particle is as shown in (1). This charge configuration will tend to separate the *void-pair*, so that both *voids* are configured to annihilate with the adjacent central defects; but the right-hand annihilation will be denied by a central charge-exchange, so that a replacement defect forms instead:

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Fig. 6-23  nue Induced Decay of Tau⁻ to e⁻/nue

      (1)   +          (2)  +       (3)
            :                 \\        \       (#)
        -······-         +······-     \   +)
      -     :            -  (#)        (-,  (#)
      :     +            :(#)  --          (#) --
  +······-    \      -   :                       \
      :     \   -)    \\ :               (#)       \
      -      (+,         +
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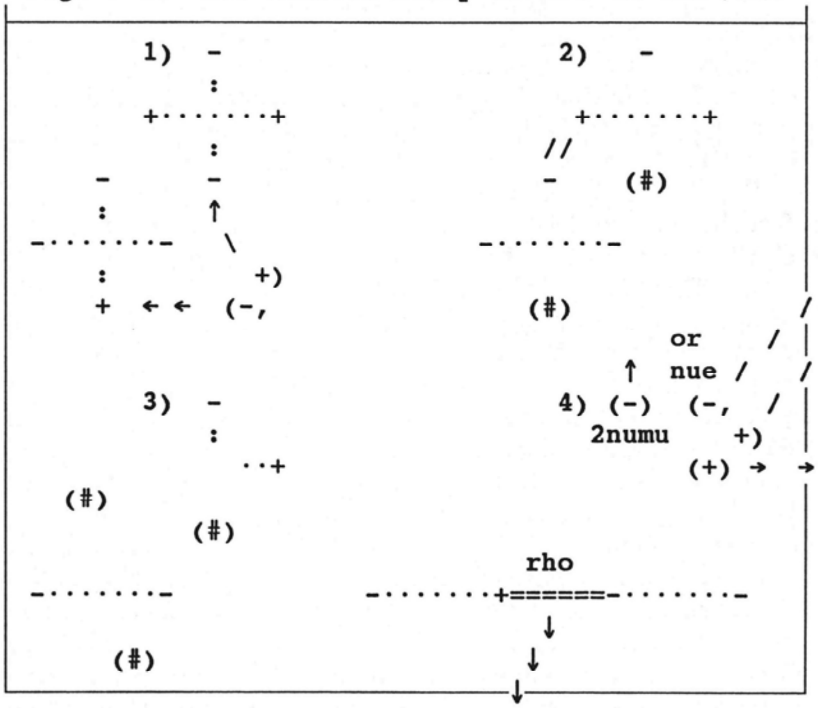
You will see, above, that the upper central *c-void* defects, after the first annihilation and electron-producing charge-exchange, are still components of defect-pairs, and will be unable to annihilate until the both outrigger pairs have undergone charge-exchange annihilations. Thus, it seems credible that they will be ejected before they can annihilate, revert to joined opposite-polarity voids, and leave the scene as a *void-pair*, or nue.

Explaining the Missing Mass Component in All Tau Meson Decays

These two lepton decays of the tau, of course, are not persuasive evidence that the tau, itself, is a lepton; many mesons decay into leptons, with accompanying neutrinos. What has seemed compelling evidence to physicists is the fact that *all* the *hadron decays* of the tau show evidence of missing mass and momentum. In all computer analyses of tau decays, some undetectable fragment must always be inferred to account for the angular disposition and energy of the decay products. Our challenge, then, is to discover why our particular chosen structure for the tau meson invariably generates an unobservable neutrino in its hadron decays.

Let us begin with the most common tau decay into a rho⁻/nutau (QCD name for the undetectable fragment). (In 1994 LBL, this is more conservatively listed as simply π^-/π^0 /nutau, 25.2%) For this hadron decay, we infer that the impinging *void-pair* interacts with "inner" and "outer" defects along one side of the particle, when these defects have a suitable polarization for mutual annihilation with the impinging *void-pair*. Let us assume that these annihilations lead to the charge-exchange annihilation shown in 2), which leaves a single negative defect-pair in the lower area, and two unpaired *c-voids* in the upper area, as shown in 3). This configuration, with undedicated shrinkage on both sides of the negative defect-pair, leads it to expand rapidly by cardinal translations, until it creates an internal pair of defects to become a paraxial bound duo, or rho particle, as in 4). The unpaired defects leave simultaneously as 2 opposite-charge numu, or alternatively as a nue, and, of course, the rho breaks up immediately into π^0 / π^-. :

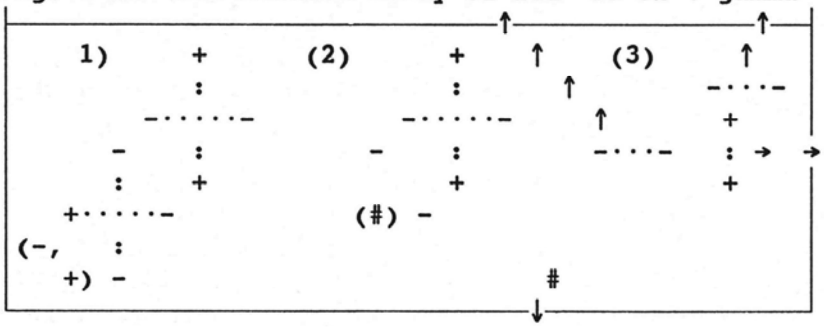
Fig. 6-24 nue Induced Decay of Tau⁻ to rho⁻/nue



With slightly different trajectories of the *void-pair* and tau, or variations in the charge-exchange timing, the above scenario could yield π^-/nutau (11.7%). This decay requires that the undedicated shrinkage contribute more toward momentum, leaving an inadequate amount internal to the π^- to spawn a *void-excess* pair; thus, the rho⁻ does not form.

The decay of a tau meson into three charged pions/nutau, or these plus a gamma, is fairly common. The gamma producing decay is most likely to result from an endwise approach of the *void-pair* (1), since annihilation with the two end defects would generate an offset zone of undedicated shrinkage (2) which could not be entirely assimilated by the remaining defects; thus, the shrinkage would divide between a gamma and momentum separating the remaining defects. The two unpaired defects released by the annihilation could be expected to pair with each other (3) in the jumble of departing particles, through electrostatic influences of adjacent defects:

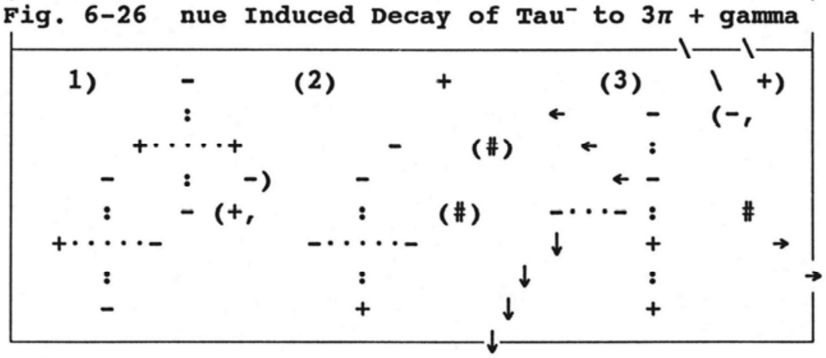
Fig. 6-25 nue Induced Decay of Tau⁻ to 3π + gamma



This particular scenario should not have appreciable "missing" mass-energy; the only component unaccounted for in the decay products would be the momentum of the incoming *void-pair*. A scenario yielding an nue in addition to a gamma could be an attack by the *void-pair* upon either side of the upper K^0 group:

The annihilation of the two defects adjacent to the *void-pair* (1) leads to an off-center zone of undedicated shrinkage, opposite charge unpaired *c-voids*, "expanded" K^- (2). As this latter cluster moves away from the particle center by the assimilated momentum, it can convert either to a K^- (1.7%), a rho^0 π^- (5.4%), or π^- π^- π^+ (7%). These will be accompanied by an *excess*-pair (nutau)/ γ.

Fig. 6-26 nue Induced Decay of Tau⁻ to 3π + gamma



These few decay examples of the tau qua meson should lend an aura of plausibility to my speculation that physicists may have erred in their assumption that this particle is a lepton. Obviously many more decay scenarios can be imagined for these particular decay products, as well as for other decay modes (LBL 1994 lists 45 allowed modes in their ambiguous "h" designations (where h is any hadron), and 46 lepton violating modes). To develop scenarios for all of these modes, we would need to consider all the possible approach angles, and energies, of the *void-pair* for all the charge-exchange states, and consider, as well, modes in which only the plus *void* of the *void-pair* undergoes annihilation; one might even need to consider particle disruption by a near-miss of lone *voids* of either polarity. This wealth of decay geometries lends confidence that we could discover plausible scenarios for all hundred or so of known tau decay modes. Fortunately we can avoid this tedium, since the reader should now have enough insight to explore these possibilities on his own.

What Determines a Particle's Lifetime?

What we must still explore is the effect of defect cluster geometry upon the mean life of particles. Why should a similar decay mechanism, such as interaction with a *void-pair*, result in such different lifetimes for different classes of particles? A clear example is in the decay of K^- and tau^- into μ^-/numu(s): there is a similar mode of decay for both, but the K^- has a mean life 25,000 times longer.

This time difference might correlate with differences in the average defect-pair spacings of the two particles (8ü vs. 10.75ü), but how do we explain the *void-pair* interactions which produce the 15 minute mean life of the neutron beta decay to a proton, as well as the billion year mean life of the beta decay of potassium 40 into calcium 40? In these later two interactions the defect-pair spacings of the affected neutrons are virtually the same, yet their lifetimes differ by thirteen orders of magnitude!

To span these vast time differences we clearly need to complicate our concept of particle/*void-pair* interactions (in current parlance, "weak-force interactions"). The fundamentals are clear: in beta decay, a minus *excess* somehow merges with a minus *void*, a process which obviously requires the conspiratorial participation of close-by positive and negative *voids* (numu's) to subvert the pairs' mutual repulsion. Except for the muon decay, this fusion process necessitates, also, a prior conversion of a *c-void* into an *excess* (or a *void*). Let us begin this analysis by reviewing what we have learned about neutrino-induced decay.

When we view particle decay as the destabilization of a defect cluster by the electrostatic influence of visiting defects, we see that the probability of decay (the inverse of lifetime) depends upon how close an encounter is needed to effect some change. We have found for example, that:

1) All the shortest lifetime resonances (full width 10-500 MeV) have one or more "expanded" defect-pairs *unstabilized* by charge-exchanges, which constitute "hair-trigger" reservoirs of energy ready to be released by relatively distant destabilizing agents creating only subtle electrostatic influences.

2) Intermediate lifetime resonances (full width 30-300 KeV), such as the psi and upsilon particles, have expanded kaon subgroups whose defect-pairs are stabilized by charge-exchanges. However, these sub-groups are vulnerable to collapse, because their defect-pair spacings are larger than the equilibrium spacings of isolated kaons. However, since these expanded kaon subgroups in the longer-lifetime psi's are neutral, with two odd-ü defect spacings, they have dual charge-exchanges that don't exhibit a dipole moment. Because of this balanced charge-exchange mode, they are immune to distant electrostatic effects, and require a much closer approach by a visiting *void* to effect disruption. Since closer *void* approaches are much less probable, these neutral clusters have considerably longer lifetimes.

3) By contrast, even the shortest lifetime "stable" particle, the eta meson (full width 1200 eV), has defect-pair spacings closer to the free-space equilibrium value for

pions (8.5ü vs. 6ü), is small and compact, and is bound by strong dual diagonal bonds in addition to charge-exchanges, and thus requires a very strong electrostatic influence to separate the bonded pairs (a direct hit, or a near miss, by the approaching *void*).

4) The π^0 meson, probably the longest lifetime particle still susceptible to decay by a passing lone *void* (full width 8 eV), is at its equilibrium spacing (6ü), is a lone defect-pair, and so must suffer severe enough displacements by the approaching *void* to "uncouple" the paired defects and rob enough of the pair's undedicated shrinkage to cause one *c-void* to revert to a *void*, one to an *excess* so they can mutually annihilate. This decoupling requires not only a close approach, but also one whose trajectory is very precisely positioned relative to the paired defects. Obviously, such precision of void trajectory is rare; hence, the neutral pion's long life relative to other resonances susceptible to *void* destabilization.

Some Other Particles Immune to Lone-Void Destabilization

As we examine the decay scenarios for the other "stable" particles, we see that they are not affected by a lone *void*, either because they have only one polarity of defect, like the $\pi^{+/-}$, or because their defect-pairs are protected by geometrical symmetries (two or three axes of defect-pairs) as well as by charge-exchanges involving all the particles' defects (or, at least, all of their defect-pairs). Thus, their decay probabilities are limited to the close approach of the much rarer *void-pair*.

The Evidence for Two Types of Decay Agents

One fact which lends credence to this division of the fast decays into two groups induced by different agents is that the range of decay times in each category is about the same, seven orders of magnitude (for decays induced by the *void*, mean lives of 10^{-23} to 10^{-16} sec; for decays induced by the *void-pair*, 10^{-13} to 10^{-6} sec).

Long Half-Life Decays Require Multiple Decay Agents

When we try to extend the above arguments to the decays of neutrons and nuclei, of the type we studied in Chapter 4, we have obviously run out of categories of agents in the lattice for a slower class of decays. What remains as latent possibilities are simultaneous multiple defect approaches, such as a *void-pair* in combination with a *void*, or *voids*. If we assume a fortuitous disposition of charges around a "reluctant" nucleon *c-void*, we can imagine a sort of push-pull effect, an opposing negative *void* persuading a negative *c-void* of a neutron to undergo charge-exchange fusion with the negative *void* of an approaching *void-pair*, and attracting the plus *void* of the *void-pair* to fill its place in the nucleon. Thus we end up with neutron turned proton, an electron, and a -*void*, with all three products assimilating the released undedicated shrinkage as momentum. Incidentally, this scenario, which results in a muon neutrino being accelerated away from the beta decay site, rather than the currently assumed neutral electron neutrino, can clear away some of the mystery of the missing solar neutrinos, since a charged neutrino flux would be deflected away from the earth by the earth's magnetic field.

The requirement of a synergistic "electrostatic ambience" around a susceptible nucleon embedded in a nucleus can reduce the probability of decay to almost any extent. Perhaps multiple *voids*, precisely positioned relative to an approaching *void-pair*, are necessary to induce the beta decay scenario in an embedded neutron (or proton). Obviously a decay scenario requiring three roving particles of suitable polarity to be in a precise geometrical arrangement relative to a nucleus is many orders of magnitude less probable than a scenario requiring only two, which, in turn, is many orders of magnitude less probable than those requiring one.

Endless Things Left to Explore!

Well, there is the bare bones of the case for induced, rather than spontaneous, decay! I'm sure you would be more persuaded, if you could be shown some concrete examples of charge distributions in and around embedded neutrons favorable to charge-exchange fusion with an approaching *void-pair*. Unfortunately, my understanding of nuclear structures is still too rudimentary to warrant pursuing these matters further.