Is the weak force a force?

Abstract

In our previous paper, we explored the epistemological foundation of quantum chromodynamics: what concepts and models are we using, and what does Occam's Razor Principle has to say about that? In this paper we do the same for the weak force. We think the force concept should not be applied to the analysis of decay or disintegration processes. The idea of W and/or Z bosons *mediating* the weak force makes even less sense. W/Z bosons should be thought of as debris: transient or resonant matter. We suggest the whole idea of bosons mediating forces resembles 19th century *aether* theory: we don't need it. The implication is clear: if that's the case, then we also don't need gauge theory and/or quantum field theory.

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Is the weak force a force? A force holds stuff together – or keeps things apart. Something that makes things fall apart, cannot be a force, right? But if it is not some *force* that makes things fall apart, then what is it? What causes decay?

John Wheeler's concept of mass without mass implies that – ultimately – all matter is energy, and the mass of some particle is just the equivalent energy of the oscillation. But what is the oscillation? What is oscillating? Some *charge*. We do *not* think of an electron in free space as some dimensionless object: instead we think of a *naked* charge – just a charge with no inertia – spinning around at the velocity of light. We can then interpret the Compton radius of the electron as the effective diameter of the motion of the charge.

Let us recall the basics of that interpretation. We thought of the speed of light – the *c* in Einstein's mass-energy equivalence relation ($E = m \cdot c^2$) – as some tangential velocity. A tangential velocity will always equal the radius times the angular frequency of the rotational motion: $c = a \cdot \omega$. We then used the Planck-Einstein relation ($E = h \cdot f = \hbar \cdot \omega$) to substitute ω for $\omega = E/\hbar = m \cdot c^2/\hbar$) to find the Compton radius:

$$c = a \cdot \omega \Leftrightarrow a = \frac{c}{\omega} = \frac{c \cdot \hbar}{\mathrm{m} \cdot c^2} = \frac{\hbar}{\mathrm{m} \cdot c} = \frac{\lambda_C}{2\pi} \approx 0.386 \times 10^{-12}\ \mathrm{m}$$

The novel idea here is that one rotation – one *cycle* of the electron in its *Zitterbewegung* – packs the electron's energy ($E = m_e \cdot c^2$) as well as Planck's quantum of action ($S = h$). The idea of an oscillation packing some amount of physical action may not be very familiar but it is just the same as saying we have some angular momentum in the motion.

An electron is a spin-1/2 particle, however. How do we explain that? We introduced the concept of the *effective* mass of the pointlike charge: it acquires mass *because* of its velocity—because of its *kinetic* energy. We wrote that mass as m_γ, and we showed $m_\gamma = m/2$: the *effective* mass of the pointlike charge – as it whizzes around the center of the two-dimensional oscillation that makes up our electron – is half of the (rest) mass of the electron.[1] Where's the other half of the mass? That's in the potential energy of the oscillator. It's all quite deep and mysterious but we can't dwell on that here (we do so in our other papers).

The point to note here is that an electron – in free space or in an electron orbital – is stable. When we say the electron in an electron orbital is stable, we should be precise: it's the orbital – or the atom itself – that is stable. What makes it stable? The Planck-Einstein relation: $E = h \cdot f = \hbar \cdot \omega$, *exactly*.

[1] See: Jean Louis Van Belle, *The Electron as a Harmonic Electromagnetic Oscillator*, 31 May 2019 (http://vixra.org/pdf/1905.0521v3.pdf)

Indeed, the 2019 re-definition of SI units *defines* Planck's constant as being equal to h = $6.62607015 \times 10^{-34}$ J·s, *exactly*.[2] Hence, Planck's constant is an exact value, and we may think of a stable particle (think of an electron, a proton or a photon) as respecting the E = h·*f* = ħ·ω equation *exactly*.

We think *non*-stable particles do *not* respect this equation *exactly*. We like to think of them as *transients*: oscillations that die out. Of course, that triggers the obvious question: where does the energy go? The *metaphor* of a transient oscillation has its limits. In fact, it's seriously limited: the particle decay processes that are being studied in particle accelerators and colliders resemble car crashes: the term *disintegration* – as opposed to decay – is a more apt description.

Non-stable particles

Let us look at a few examples so we have a better feeling of what we are trying to talk about. Let's think of *pions*, for example. We should distinguish charged pions (the π^+ and π^- particles) from the neutral pion (π^0). They don't have a lot in common—except for their energy, which is of the same order of magnitude. However, the mean lifetime of the π^+ and π^- particles is much more measurable: about 26×10^{-9} seconds. In contrast, the mean lifetime of the π^0 particle is measured as something like 84×10^{-18} seconds. The difference between nanoseconds (10^{-9} seconds) and attoseconds (10^{-18} seconds) is 10 to the power 9, so that's a *billion*. The disintegration process is also *very* different:

1. The π^+ and π^- particles decay into a *muon* (positive or negative) and a *muon neutrino*.
2. The π^0 particle just leaves two photons.[3]

Muons are unstable as well, but their mean lifetime is measured in *micro*-seconds (10^{-6} seconds). Guess what? They decay into an electron or a positron (depending on their charge) and neutrinos. Let's write it down:

$$\pi^+ \rightarrow \mu^+ + \nu_\mu \rightarrow e^+ + \nu_e + \nu_\mu$$

Just change the signs for the π^- decay.[4] What about the energy equation? The energy of charged pions is about 139.57 MeV. That's a sizable chunk of money—at the nuclear level, that is. To put that number into perspective: it's about 15% of the energy of the proton.

What are pions anyway? According to the Standard Model of physics, the pion should be thought of as a particle that *mediates* the interaction between a pair of nucleons. In other words, they are supposed to mediate the strong force. I think that's nonsense.

Let me repeat that: I think the idea of some particle *mediating* a force is nonsense. It's like the 19th-century *aether* theory: we don't need it. Pions are just debris: it's part of the stuff that's flying around after the car crashed. To be precise, we get pions when protons – also known as hydrogen nuclei 😉 – crash into something else. That is illustrated below: they are part of the debris in cosmic rays. We can also create them artificially in colliders: the first artificial production of pions involved bombarding

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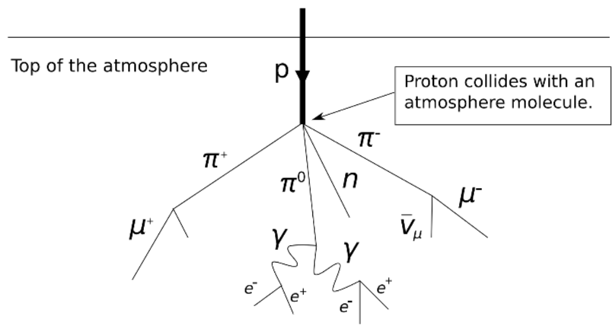
[2] The NIST defines the unit as J·Hz^{-1}, which confirms our interpretation of Planck's constant as a fundamental cycle. Note that the *reduced* Planck constant ($\hbar = h/2\pi = 1.054\,571\,817... \times 10^{-34}$ J·s) has an infinite number of digits but zero uncertainty. That is because π is an irrational number.

[3] We will quality this statement in a minute.

[4] The second step in the decay makes abstraction of the muon neutrino that was produced in the first step of the decay process.

carbon atoms with high-speed alpha particles. Don't think of them as virtual particles: they are real. Don't think of them as mediating some force. That's nonsense. They're just unstable: they fall apart. The weak force is not a force.

Figure 1: Pions in cosmic rays



What about W^+, W^- and Z bosons? They're the same: they're unstable debris. In fact, there is no evidence for them whatsoever. Of course, the academics will cry wolf here: W^+, W^- and Z bosons are supposed to have been 'discovered' in the proton-antiproton collider at CERN.[5]

But where is the wolf? Do these experiments actually *confirm* quarks, gluons and W/Z bosons exist? They don't. These experiments only produce some *signal* that is 'consistent' with the hypothesis. A signal. Consistency. No proof. In fact, physicists owe an explanation to the general public: what does it mean when they say this or that particle *exists* if it can only travel as a quasi-free particle at a distance of the order of 10^{-15} *centi*meter. That's *a hundredth* of a femtometer (10^{-15} m). In case you don't know the femto-universe very well[6], you should probably remind yourself of the scattering radius of a proton, which is something tween 0.84 and 0.9 fm. Even when traveling at the speed of light, the equivalent *lifetime* of a particle traveling over a distance of, say, 3 fm is 10^{-23} seconds. That's smaller than anything we can measure. It then decays into other products.

That's not a particle: that's a resonance, or an excited state of something.[7] Whatever it is, it is surely *not* something you'd associate with the usual *definition* of a particle.

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[5] The first of these experiments go back to the late 1970s and the early 1980s and are associated with the PETRA accelerator in Hamburg, the Positron-Electron Project (PEP) at the Stanford National Accelerator Laboratory (SLAC), and the Super Proton-Antiproton Synchrotron at CERN. We encourage the reader to *google* and think about these experiments. What do these experiments try to find or measure? And how do they do it?

[6] I will readily admit that I don't, but I will also not hesitate to say that any of the physicists who write about it do. Why? Because you can't 'see' or 'measure' anything with precision in the femto-universe. Hence, your guess about what's going on there – as an amateur physicist – is as good as that of the academic physicist.

[7] A *resonance* in particle physics is effectively defined as a 'particle' whose lifetime is of the order of 10^{-23} seconds. Traveling at the speed of light, these 'particles' can, effectively, only travel about 10^{-15} m (which is about the diameter of a proton), before decaying. Distances of this magnitude cannot be measured in bubble chambers or in whatever other device for detecting subatomic particles, and the lifetime of a resonance is, effectively, analogous to the time an electron stays in an excited state, which is calculated using the Uncertainty Principle: $\Delta E \cdot \Delta T = h \Leftrightarrow \Delta T = \Delta E/h$. See: http://webhome.phy.duke.edu/~kolena/modern/dudley.html.

Transients versus resonances

So what can we say? Nothing much. All we can say is that, after some time, most stuff falls apart. Except protons and electrons—as far as we know, at least. And photons go on forever too. All other stuff falls apart: we're talking mesons and baryons, basically. Stuff that consists of two and three quarks respectively according to the quantum-mechanical canon. To be precise, baryons (think of neutrons, for example) consist of three colors (or three anti-colors), while mesons (think of pions) consist of a color and an anti-color.

What about flavors? Wikipedia defines a flavor as a *type* or a *species* of an elementary particle. That's useless: a different type of an elementary particle is a different elementary particle. That's just logic. If quarks change color all of the time, then they don't have a color charge. Full stop. Gluons are a superfluous concept, and particles that change another particle into some other particle – W^+, W^- and Z bosons – are canonical nonsense. No one has been able to prove they actually *exist*.

In reality, we have a very limited number of permanent fixtures (electrons, protons and photons), hundreds of *transients* (particles that fall apart) and thousands of resonances (excited states of the transient and non-transient stuff). What's the difference between them?

Stable particles respect the $E = h \cdot f = \hbar \cdot \omega$ relation—and they do so *exactly*. For non-stable particles – transients – that relation is slightly off, and so they die. They die by falling apart in more stable configurations, until we are left with stable particles only.

As for resonances, they are just that: some excited state of a stable or a non-stable particle.

The not-so-crazy kaons

Popular and not-so-popular textbooks on physics often explain the need for a quark-and-gluon theory to explain disintegration processes with a discussion of the weird behavior of kaons. We're thinking here not only of popular books such as, for example, Gerard 't Hooft's *In Search of the Ultimate Building Blocks*[8], but also of Feynman's discussion of them in his *Lectures on Quantum Mechanics*[9]. The latter was written in the early 1960s, but he already discusses the ideas of Gell-Mann and other 'like-minded physicists'' in it. We will use it here as a sort of benchmark argument to see what might and what might not make sense.

Feynman starts off by noting the usual conservation laws – conservation of charge, energy and (linear and/or angular) momentum conservation – cannot explain why, as kaons are disintegrating, certain interactions, events or *combinations* are possible, and others are not. He immediately starts off on the wrong foot: he treats all kaons as similar particles—conveniently forgetting their average lifetime is *very* different.

- The mean lifetime of charged kaons (K^+ and K^-) is about 1.238×10^{-8} s.
- In contrast, a K^0 particle disintegrates – on average – after about 9×10^{-11}.

[8] Cambridge University Press, 1997. See, more in particular, Chapter 7: *The Crazy Kaons.*

[9] *Feynman's Lectures*, Vol. III, Chapter 11, Section 5 (http://www.feynmanlectures.caltech.edu/III_11.html#Ch11-S5).

If you like quantum mysticism, you should note the mean lifetime of charged versus neutral differ by a factor that is equal to the (inverse of the) fine-structure constant $1/\alpha \approx 137$. 😉 What do charged and neutral kaons have in common? Their mass? Yes and no. Their energy is equal to 493.6 MeV/c^2 ($K^{\pm}$ particles) and 497.6 MeV/c^2 (K^0 particles) respectively. More or less, that is. The difference between the two point-estimates is 3.934 MeV/c^2. That's *huge* at these tiny scales: that's about *four* times the energy that's released when an electron and a positron annihilate each other.[10] So why would we treat them as similar particles? Their charge, their mass, their lifetime—it's all different!

The answer: $K^{\pm}$ and K^0 particles both disintegrate into pions—most of the time, at least. Even that's not true. Their *common* decay modes are quite different in terms of combinations and, importantly, in terms of decay times and probabilities. That's exactly the reason why physicists had to invent this strange property: *strangeness*, and introduce an even stranger conservation law: the conservation of strangeness.

Surely You're Joking, Mr. Feynman! But, no, he's not joking. That's what physicists do: they first arbitrarily lump a bunch of non-stable particles together – based on some random criterion such as *similar mass* (we don't care about 4 MeV more or less, right?) – and then they invent new quantum numbers to distinguish them again.

It gets even weird than that, because the quantum number magic doesn't quite do the trick with kaons. We need to distinguish long-lived and short-lived neutral kaons: K-short (K_S^0) and K-long particles (K_L^0). The decay time above was for K-shorts: the mean lifetime of K-longs is about 5.1×10^{-8} s, so that's about 4 times the lifetime of a $K^{\pm}$ particle. Why is that so? If you ask physicists, they will give you 20 pages of math to explain this. My explanation is simpler: because they're different particles. Full stop.

Of course, we also have the anti-particles, although no one ever bothers to precisely define what an anti-particle actually means in the context of QCD. In QED, we know: it's the same particle – all *properties* (mass, spin or momentum, magnetic moment, etcetera) are the same – except for the *electric* charge. In QCD, an anti-particle is a particle with… What? An anti-color, an anti-flavor, reverse spin? I invite you to check it: there is no unambiguous definition. An anti-quark will sometimes be defined as a quark with the opposite (anti) color, but then quarks are supposed to swap colors all the time through the exchange of virtual particles—those gluons that no one has ever seen! And when talking neutrinos, we suddenly don't know anymore, because neutrinos don't have color charge, so the antineutrino is perhaps the same as the neutrino but no one really wants to tackle that question: current thinking is that an antineutrino is a neutrino with opposite spin. *Really*?[11]

I feel quantum chromodynamics is a sector where physicists casually and routinely make *category mistakes*: they confuse particles with properties, define new properties (new quantum numbers)

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[10] In case you wonder, this is an easy calculation: an electron and its anti-particle (the positron) both have an equivalent energy that is equal to $E = m\cdot c^2 = 0.511$ MeV. When they annihilate each other, a gamma-ray photon will combine both energies: $2\cdot0.511$ MeV $\approx$ 1 MeV.

[11] It sounds as ridiculous as it is because – while neutrinos have very few properties (some tiny energy and spin, perhaps) – physicists don't hesitate to classify them as 'fermions' or – more specifically – leptons! Applying such generalizations to 'particles' – small energy packets with no electric or any other charge – makes me feel these general categories (fermions, or leptons) are totally useless in terms of providing some kind of understanding of what is actually going on in particle physics.

without bothering to use precise definitions (apart from noting it simplifies a bunch of matrices and *n*-dimensional mathematical spaces), work weird magic, and then – for some reason I don't quite understand – expect to be taken seriously somehow. *Surely You're Joking, Mr. Feynman!*

But let us go back to these kaons and see what physicists try to explain with their *flavor* quantum numbers (*strangeness*, *charm*, *bottomness*, etcetera), if anything at all. Am I joking? I am not. The table below shows how the Particle Data Group – a collaboration consisting of 227 authors from 159 institutions in 24 countries[12] – currently classifies the hundreds of mesons that have been 'discovered' after the second World War.[13] You can see that our pions are light unflavored mesons.

In contrast, our kaons all share the property of *strangeness*. According to mainstream theory, that means they must consist of a *strange* quark. The energy of the *s* quark is about 100 MeV, so that's about 20-40 times the energy of the 'first-generation' *u* and *d* quarks.[14] It's good to be somewhat more precise here—or *im*precise, I should say. The point estimate for the rest energy of an *s* quark – whatever the concept of rest mass or rest energy might mean in the context of QCD – is 96 MeV. The *u* and *d* quarks have energies of 2.2 and 4.7 MeV respectively. However, the standard error on these measurements is of the same order of magnitude as the point estimate![15] That's another reason why I don't like quark theory: such imprecision is not consistent with the concept or idea of a particle, is it?

Figure 2: PDG classification of mesons[16]

MESONS
All Mesons that appear in the Summary Table and/or Listings *
pi^{+-}, pi^{0}, eta, f_0, a_0, ... (Light unflavored)
K^{+-}, K^{0}, ..., K*, ... (Strange)
D^{+-}, D^{0}, D*, ... (Charmed)
D_s, D_s*, ... (Charmed, strange)
B^{+-}, B^{0}, ..., B* (Bottom)
B_s (Bottom, strange)
B_c (Bottom, charmed)
eta_c, J/psi, ... chi_c, ... (c cbar)
Upsilon, chi_b ... (b bbar)

However, I promised to get back to kaon physics. We can't observe the *strange* quark, so what can we observe? Decay products. The *intermediate* decay products when $K^{\pm}$ particles are pions and muons,

[12] http://pdg.lbl.gov/2019/html/about_pdg.html

[13] Carl Anderson not only found the positron in his analysis of cosmic rays but the muon too. It was the first meson to be discovered, in 1936. Fundamental research resumed after the second World War and, in 1947, a group of researchers found the first pion—also while analyzing photographic films of the *debris* of cosmic rays.

[14] The point estimate for the rest energy of an *s* quark – whatever that means – is 96 MeV. The *u* and *d* quarks have energies of 2.2 and 4.7 MeV respectively, but the standard error on these measurements is as large as the point estimate! That's another reason why I don't like quark theory: such imprecision is not consistent with the concept or idea of a particle, is it?

[15] You can *google* this yourself. The Wikipedia article on quarks, for example, is a reference that is not too bad (https://en.wikipedia.org/wiki/Quark#Mass).

[16] http://pdg.lbl.gov/2015/tables/contents_tables_mesons.html

which we discussed above. Pions are unstable mesons themselves, but they are no longer *strange*: according to the Standard Model of physics, they consist of a *u* and a *d* quark: the *strangeness* has gone.

Where did it go? *It's energy, stupid!*[17] The extra energy went into some heavy lepton (a muon) – no colors or flavors here – or, to provide for some *change* (coins instead of notes), into neutrinos.

And where do the muons and pions go? They decay into *permanent fixtures of the Universe*: the charged electrons or positrons[18] and the electrically neutral photons and neutrinos. The former provide the bank notes of the universal currency. The latter provide the coins. What universal currency? Energy.

[…]

Is that it? Is that my alternative theory of physics?

I'd say: yes, and no. I am *not* saying I have an alternative theory for kaon physics. I am just saying the current one doesn't make much sense to me. Look at the decay modes of kaons. The reference is this: http://pdg.lbl.gov/2015/tables/rpp2015-tab-mesons-strange.pdf. It's the *authoritative* reference: the reference of the Particle Data Group. We have a *zillion* decay modes – OK, I'm exaggerating here – but they all result in the same: high-energy collisions (the production of cosmic rays in the atmosphere or the high-velocity car accidents we engineer in high-energy particle colliders) produce weird intermediate particles—such as kaons, which then disintegrate into charged electrons or positrons[19] and the electrically neutral photons and neutrinos, and… Well… That's it.

We should be able to analyze this in terms of the *classical* energy, momentum and charge conservation laws, and then some add-ons, probably. But those add-ons shouldn't be all those *ad hoc* quantum-chromodynamical quantum numbers. :-/ They make no sense whatsoever to me—but, of course, I am just a philosopher. An amateur physicist.

Kinetic, potential, directional and non-directional energy

You may wonder: those conservation laws – and Newton's Force Law – can't possibly explain all of the diversity in physics. I think it can – especially when combined with the force of Maxwell's Laws. More importantly, we haven't even started to explore the power of the concept of a *color* charge.

Let me only make a remark on the energy concept here. It is a very *rich* and, therefore, very *powerful* concept from an epistemological point of view.

Is the concept of energy rich enough to do so? I think it is. Energy is supposed to be some *scalar* variable, just like mass. But look at the richness of the concept: we distinguish between kinetic and potential energy. Kinetic energy is related to an object's *motion*. Motion implies direction – linear or angular. Potential energy is related to an object's *position* and, as such, it's got no direction.

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[17] We don't want to be impolite here. The reference is to President Clinton's successful 1992 campaign slogan.

[18] Positrons are unstable only because we live in the Matter-Universe. Hence, they're bound to be annihilated. We can *think* of an Anti-Matter Universe, but we surely do *not* want to find and meet with it. ☺

[19] Positrons are unstable only because we live in the Matter-Universe. Hence, they're bound to be annihilated. We can *think* of an Anti-Matter Universe, but we surely do *not* want to find and meet with it. ☺

There are enough degrees of freedom here. The brightest minds should stop wasting their time on mindless brain games: they should start to try to explain reality.

This sounds like a *very* bold statement, but we are not shy—because the discontent within the scientific community itself has grown a lot lately—and I mean *an awful lot*.[20]

Conclusions

In our previous paper, we explored the epistemological foundation of quantum chromodynamics: what concepts and models are we using, and what does Occam's Razor Principle has to say about that? In this paper we do the same for the weak force. We think the force concept should not be applied to the analysis of decay or disintegration processes. The idea of W and/or Z bosons *mediating* the weak force makes even less sense. W/Z bosons should be thought of as debris: transient or resonant matter. We suggest the whole idea of bosons mediating forces resembles 19th century *aether* theory: we don't need it. The implication is clear: if that's the case, then we also don't need gauge theory and/or quantum field theory.

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[20] See, for example: https://www.forbes.com/sites/startswithabang/2018/06/12/is-theoretical-physics-wasting-our-best-living-minds-on-nonsense. I would like to thank Luc Hellinckx for providing this reference.