Experts from email correspondence between artist Garvin Chinnia and scientist Carla Babcock

Musings and update

Sat, Feb 18, 2017 at 9:52 PM

Evening Carla, hope you are doing well. I just came back from an artist retreat on Mayne island. Got a lot of painting, thinking and beach combing done (they probably amount to much the same thing in the end). Also found a LOT of bones, some of them I suspect are from marine mammals. Terrestrial mammalian bones just aren't shaped the same.

I've been wondering about the nature of energy produced by matter and antimatter. I was watching a little interview with Neil degrasse Tyson, and he mentioned that antimatter reactions happen inside the sun, either on a small scale or that's kinda what causes the decaying reaction within (I have a question about decay but we'll come back to that). I can't remember which one for it was said in passing. But it got me thinking; would the energy being produced by a sun made of antimatter be different than that being pushed out by our Sol? I suspect not, from the tidbits I've been picking up from Skype conversations with other triumf scientists with our class, and of course youtube. I feel like it would be a good question to work with or at least deal with since I'm working with plants.

We spoke before at the seminar that I was thinking about using plants and fucking with spectrums over the summer. Right now I have been collecting moss from various sources and putting them all in a five gallon tank, just to see which ones would thrive. It's more playing than applying any actual method to it. I brought back a couple samples from my trip and added it to the collection. Even though I had saran wrapped the top they had dehydrated. The fresh samples were, ahem, fresh, and I added water to the whole thing. I'm thinking now that I'm going to keep adding moss to have that become the substrate and see if it can sustain itself that way. This leads to my question about decay, and thoughts about it. I made a connection between moss and decay, especially if it's on a tree. Suddenly I feel a misconception there though, as moss is a microecosystem in its own right. So then I guess the decay is actually warranted. But I digress. I wanted to know your opinion on the definitions of decay as used by physicists like you and the definition used by biologists. It's my understanding that physicists

use decay more in the way of change conversion or relaxation (there are a lot of linguistic implications and connections in THAT definition I do say), where biologists would see it more than breaking down (which when you think about is a sort of conversation or change of form). Practically the understandings between the fields must be different, but I feel like there are connections to be made. What're your thoughts on this?

This question comes up again in another piece I made involving a succulent growing on a cliffside I found. I'm basically attempting to recreate its environment in a jar, with the actual strata present in it. The succulent itself grows on dirt which is on top of a layer of more or less unbroken rock which is exfoliating (pretty sure that's the right term. I wish I had done better at my earth and atmospheric science class, as I had to look it up) at the bottom to another layer of dirt and so on. So there's the geological definition of decay to contend with. Another transformation.

So. These are what I've been thinking about lately (and the evolution of digital organisms by means of autocorrect fuckups, but I'll stew on that for another day and email!) and figured I'd get the ball rolling on our correspondence. Hope I've given you enough to muse on.

Until next time

Garvin

Tue, Feb 21, 2017 at 1:48 PM

Hey Garvin, The plants idea sounds super cool, and it seems like you've been doing a lot of ruminating on all this stuff... I also love collecting bones, but I think other people find it creepy. I think bones are so beautiful but I once brought a small bone back for my husband from a camping trip and he was totally weirded out. But, to answer your question about the sun:

The way the sun produces energy is through nuclear fusion reactions in its core. Different stars have different types of reactions, because the reactions depend on what elements are available inside the star (i.e. mostly H, or C, O and N?) and how big/how hot the star is. In our sun, we have mostly H and He, and it is big enough that the gravitational pressure of all that material is enough to raise the temperature in the core high enough to start H fusing together to make He.

So we get two H ions that get pushed together enough to fuse, and they make a deuterium + positron + neutrino. The positron is the antimatter part, the antimatter version of the electron. There are other reactions that occur in our sun that produce positrons as well. The deuterium then fuses with another proton to make 3He + energy, and the 3He fuses with another 3He to make 6Be, which quickly decays into 4He + H + H. Many of these reactions release energy in the form of photons, which makes their way to the surface of the sun, and that is the light we see. If the sun was made of antimatter (and everything around it was also make of antimatter) we would basically see the same thing, since similar reactions would proceed (as far as we know) and photons would be released just as they are with matter reactions. Since photons seem to interact the same way with matter and antimatter, we should see the same light from the anti-Sun. But experiments are still looking to make sure that antimatter really does produce the same type of light as regular matter. If the sun was not surrounded by other antimatter, but was just somehow transported to our regular solar system, then you would see an explosion of energy being made at the interface between the anti-Sun and the regular matter in space.

As for your question on decay, I think there are many similarities between the biological definition and the physics one. Normally we mean radioactive decay (physicists use the word decay in other contexts), and that implies the change of something into something else. There are many ways an atom can decay radioactively - sometimes it is really a transmutation, a changing from one element into a completely different element, which will have completely different properties. Sometimes the change is less obvious, like in the case of a de-excitation, whereby the atom releases some extra energy and settles into a more stable state, but it's still the same atom with the same properties. We would call both those things a decay. You can make some connections with the biological definition of breaking down organic material, in that many radioactive decays involve breaking a particle down. For instance uranium-238 decays by releasing an alpha particle (made up of 2 protons and 2 neutrons) and becomes a different element, thorium-234. Thorium-234 then decays into paladium-234 by releasing an electron, and the chain continues on to different elements. So both organic and nuclear decays involve things breaking down, though I guess in the biological case this break down needs something to do the breaking (bacteria I guess), but in nuclear decay, outside help is needed

only in certain situations (not very frequently). Anyway, when we say decay, really what we mean is that an atom is becoming less radioactive (the radioactivity is decaying away) - radioactive elements always decay in such a way that they move towards being more stable, and stable elements do not decay at all, they remain as they are forever, which is different than the biological cycle. I think it's interesting what you said about the moss - that the decay is part of the cycle of the ecosystem and so it's warranted. It's the same with nuclear decays, there are known chains by which different elements decay and it's just a part of how the universe works. Decay always seems to have a negative connotation, but I guess it is just the human fear of death...

Anyway, I guess this has been a bit rambling. If you want to meet sometime to discuss things, or you want me to show you some nuclear decay related stuff, just let me know. I'm super interested to see the project as it progresses!

Wed, Mar 8, 2017 at 7:38 AM

Hey Carla, hope things have been well. I would totally like to see some nuclear decay related stuff, either on paper or in a lab. Come to think of it, I guess we see that every day with the sun, but how many intuited that THAT'S what was happening with our star?

ANYway, I had a quick question about the matter/antimatter asymmetry. 2 I guess. The first one is this: can a random change happen in the processes of nuclear physics, like the random mutations that happen with the genetic code? Is there something that parallels that in physics? And if so, couldn't something like that have happened at the beginning?

My other thought/question is this: does matter/antimatter annihilation have to occur on a point by point basis? One molecule for molecule? Is it possible that a couple antimatter molecules could have hit one matter molecule at the same time at the beginning, and because of this chance occurrence left the matter that remains today?

Random thought: is there a chance that antimatter works super different on large scales than it

does in small quantities in the lab and also nature today, and that that could be the reason there's not much of it left these days?
I just realized that my understanding of nature is starting to include more than just the biosphere. ANYwho, I'll leave it at that for now, I just woke up with these questions. All the best Garvin

Tue, Mar 14, 2017 at 1:24 PM

Hey Garvin,
You are full of interesting questions these days... maybe one of these days you can come to the lab and I can show you some experimental stuff. Let's try to organize it during our collaboration time for this project.
In terms of something to parallel random genetic mutations, there isn't really anything in physics of that nature. We have lots of things which are random (we like to call them statistical...) for instance radioactive decay itself is a random process. If I am looking at a sample of 10 uranium atoms, I cannot tell you when each one will decay, only that after a certain time I expect a certain number of them to have decayed. When it happens for each atom is random. But since physics is all about describing our world in terms of known and measurable processes, we don't have anything that parallels a random, sporadic event which changes something in an unpredictable way. That's not to say that everything is deterministic - there are lots of things which are fundamentally unpredictable, the difference is that we know what the possible outcomes are and we can usually calculate the probability of each (if we understand the system well enough). So it seems pretty unlikely that a random event occurred to change the composition of the universe. Maybe something happened that we don't yet understand, but it should fit somewhere into our system for understanding the universe.
In terms of the possibility of multiple antimatter atoms annihilating with one matter atom, within our understanding on physics, this is forbidden. We have several pretty rigorous conservation laws that mean that certain quantities always have to be the same in any system. For instance, energy conservation means that in any interaction, the amount of energy in the

system stays the same. So if I roll a ball down a hill, the potential energy of the ball at the top is equal to the kinetic energy of the ball at the bottom. If I measure these two things and find a difference, it means that energy has been lost somewhere, maybe to friction between the ball and the hill, or to slight deformations of the ball. The same types of laws apply to things like charge (I think there was part of a presentation on this at the seminar), and particle type. So if I have two positrons (total charge +2) and one electron (total charge -1), I still have to end up with a net charge of +1 after the interaction because charge must be conserved. So not all three of the particles can annihilate.

How antimatter behaves on different scales is still a bit of an open question. You're right that when we study it in the lab, we are looking at individual atoms which may behave differently if there was say an antimatter galaxy. New experiments are aiming to see whether antimatter behaves the same in gravity as matter does. Normally in the lab, the electromagnetic fields we use to trap and manipulate atoms are much stronger than gravity, so we never see gravity's effects. It will be interesting to see if there is a difference - if so it could account for the matter antimatter asymmetry at the beginning of the universe. A complication to this is that the photon (and maybe the neutrino) are their own antiparticles, which means a photon and an antiphoton are the same thing. So if antimatter was somehow different on large scales, we would have to explain why photons behave in a regular way on large and small scales.

Maybe there is an antigalaxy out there somewhere, surrounded by a buffer of empty space from the normal matter universe and we just have to find it!

How is the moss growing going?