The Deep Future: Crash Course Big History #10

Crash Course: Big History
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===== John =====

(00:00)
So what have we learned so far from Crash Course Big History? Well, the universe is big, it's really big, and it started from nothing. And now, a whole lot of nothing surrounds tiny pockets of something, and one day the entire universe will return to almost nothing.

(0:14)
Our universe may be one of many, just a tiny hole in a block of Swiss cheese that forms a multiverse with many other holes entirely beyond our sight, with constants and dimensions, and physical laws stretching away from the mental comprehension of humanity's most brilliant minds.

(0:30)
But in our tiny cosmic bubble forming as if by accident, the physical laws of the universe and the unequal distribution of energy arrange themselves in such a way that in the cosmic blink of 13.8 billion years, in a still fairly young cosmos, we have emerged.

(0:47)
Us! with all of our fighting, and reproduction, and consumption. We have been cobbled together from the ashes of dead stars. We have been forged on Earth, despite the chaos of a molten planet bombarded from above by every rock in the nearby solar system.

(1:03)
And we have survived and evolved by the slimmest of margins, our existence perpetually balanced on the edge of a knife. I mean, a couple times already we've almost gone extinct.

(1:13)
Some of our obstacles have been physical and some have been of our own making, but from here, many transformations still await us. Now I guess from our perspective, some of these transformations may be good. Some of them will definitely be bad, like, you know, ceasing to exist.

(1:26)
But really, it all depends on your perspective. I mean, no outcome is absolutely good or bad in the eyes of the universe, the universe is blind. The universe doesn't see, it just is.
Aaah- I forgot the into. Hi. I'm John Green. Welcome to Crash Course Big History. Today we're talking about the deep future of life, the universe, and everything.

(1:47)
Crash Course theme music plays

===== Hank =====

(1:55)
So today, we're talking about the future. Actually, we're talking about several potential futures falling on a spectrum.
First, there's the projected future. This is the business as usual, where variables on the Earth and the universe play out as our current knowledge of them suggests they will play out. I predict that the sun will rise tomorrow, and that I will skip breakfast and go to work.

(2:16)
Second, there's the probable future, where our current knowledge illuminates several possible futures that could happen, though variables may play out in a different way in the actual event.
For instance, it could happen that tomorrow morning I will find the time to eat breakfast, and I will discover that it energizes me and improves my productivity, and really is the most important meal of the day.
Unlikely, but it could happen according to our current knowledge of how things work, in this case, how things work in my kitchen.

(2:41)
Third is the possible future where we can no longer bank on our current knowledge, but rather must anticipate that future discoveries may alter how we currently think events are gonna play out. For instance, I may find a pill that provides me with all the calories and nutrients I need for the day, and I never have to think about eating more food again.

(2:57)
In terms of the universe, if we were to gain knowledge of, like, what dark energy is, and how it works, we may alter the current narrative of how it will continue to evolve.

(3:05)
Fourth, the preposterous future of outlandish predictions. 150 years ago the idea of flying to the moon would have seemed preposterous, but one way to test the limits of the possible is by going beyond them into the impossible.
A lot of preposterousness is possible in the next 1,000 years, or 10,000, or 10 million, or even 100 trillion years.

===== John =====

(3:24)
So, what might happen in the next 1,000 years? Well, last week we discussed how the next century might be pretty rough for us, but let's say that humanity gets through the 21st century bottleneck and our collective learning and complexity continues to grow.

(3:35)
Well then maybe there could be another great revolution, like another explosion of complexity as we saw with the dawn of agriculture, or the advent of industry.
In the next 1,000 years we could master hydrogen fusion, the same process that goes on in the Sun.
And that would provide us with a tremendous amount of energy, it would solve most of our energy problems.

(3:52)
Another possible great revolution is known as transhumanism, like your brain is sort of a computer so imagine if you could upload your consciousness to something plastic or metal like an actual computer.

(4:03)
You know, the thing about human brains is that they kind of rock, so never mind living seventy or eighty years, try millions of years.
Now, some say that both of these revolutions might be possible within our lifetimes - or at least within your lifetime - they're actively being pursued by scientists, but we've been promised a lot of things about the future over the years.

(4:22)
I still don't have a jet-pack, I find that the wi-fi in airplanes is very slow, and I'm not by nature a complainer, but my amazing virtual reality headset makes me feel nauseated.

(4:31)
But on the timescale of a thousand years, those revolutions and many others that we haven't thought of are perfectly possible if human complexity continues to rise.

(4:40)
Now, that's a big if, but let's get into bigger ifs, like what about the next 250,000 years?
Well on that timescale, the possibility of like, a supervolcano eruption like the one at Mount Toba that killed almost all humans on Earth becomes pretty likely.

(4:55)
Then when it comes to asteroids, so-called city-killers hit on average every 100 years, although most just land in the ocean, and ones big enough to wipe out most species on Earth like in the extinction of the dinosaurs can potentially land every few hundred million years.

(5:07)
Now it's possible that by this point we could've colonized some of the moons and planets of the Solar System.
It's also possible that we could have the technology to survive centuries long space flights out of our Solar System.

(5:17)
Especially if we can get some of that transhumanism because it would remove the need to bring along things like water and food, and also we wouldn't have to be afraid of the immense amounts of space radiation that destroy humans.

(5:28)
Quick question, Stan. How is there not a band called either 'Space Radiation' or 'The Transhumans'?

(5:33)
Okay, let's zoom out even further and talk about millions of years.
If Homo Sapiens hasn't been wiped out by some disaster within the next several million years, our species probably won't be around anyway because we'll have evolved into something else.

(5:46)
Like, seven million years is roughly the amount of time since our species split from our common ancestor with chimpanzees.
And while we do share 98,4% of our DNA with them, a lot of evolutionary change can happen in a few million years.

(5:59)
This is especially true when you consider that the human capacity for genetic engineering may have developed in a lot of scary and/or awesome ways, further increasing the pace of change.

(6:07)
And when it comes to moving outside of the Solar System, a few million years is actually a pretty long time, like, presuming that humanity never finds a way to move faster than the speed of light, physicists estimate that on the timescale of five to fifty million years, we could colonize almost every star system in our galaxy.

(6:22)
That shows you the precision of predictive science, by the way, five million years to fifty million years. It's only a 45 million year difference.
But here's a crazy thing to consider - if we can't move faster than the speed of light, we will never get outside of the Milky Way because the vast distances between star systems also mean that human populations would be separated by thousands of light years, and when a species is separated into, you know, different physical pockets of the universe, it stops being the same species pretty quickly.

(6:51)
I mean, you put turtles on different islands for a few thousand years and you get different species. I don't think that we're gonna, like, hold on to our shared humanity across hundreds of thousands of light years.

(7:00)
So imagine a distant future where, like, each star system is seeded by an ancestor and then a few million years later, those cousins look profoundly different from each other.

(7:10)
(to Stan)
Wait, like, as different as Americans look from Canadians or more different?
More different, apparently. How can you look more different than I do from a Canadian?

(7:16)
Another thing I'd like you to consider is humanity's increasing ability to harness energy. From the fire storm of the Big Bang to the first stars blinking into existence to life's active harvesting of energy to the massive increase of energy used in the industrial revolution, more energy means higher complexity and that's our overarching theme in Big History.

(7:37)
So life on Earth has gotten pretty good at harnessing the energy that's like, within Earth and that comes to Earth from the Sun, right?
But maybe a time could come when humanity or something else like us in the universe could harness the entire power of a different planet or a chain of several planets or a galaxy.
Then we could harness many orders of magnitude more energy than we can now and we know that is closely associated with rising complexity.

(8:02)
But perhaps I've speculated too much. The thing about futurism is that the further you look ahead, the more certain things become again. That's thanks to the beauty of physics, so let's look again at the projected future based on our current knowledge.

===== Hank =====

(8:15)
So, what will happen in the next billion years?
In about a billion years, the Sun will have begun to exhaust its fuel and will start to inflate.
Its luminosity will increase and this means plants on Earth over the following years will find it harder and harder to do most forms of photosynthesis and thus sustain complex life on Earth.

(8:32)
The beginning of the end. What will happen in the next three to five billion years? Now the story is starting to get even more tragic.
The Sun will get larger and larger until it boils the surface of the Earth dry.
Once we get to a surface temperature greater than 100 degrees Celsius, we can be pretty sure that that's it for life on Earth.

(8:50)
So if anyone human or human-like is still around, we'll have to leave our childhood home and move into a dorm room somewhere else in the galaxy.

We won't even be able to come back home for our moms to do our laundry.

(8:59)
How about in the next 200 billion years?
As dark energy continues to accelerate the expansion of the universe past the speed of light, we will no longer get to see light from other galaxies.
If we were to lose the knowledge of the Big Bang cosmology that we were taught at the beginning of this series, our galaxy would be all we'd see or be aware of.
We'd revert to the idea that the universe had no start date, is static and eternal.

(9:22)
The Milky Way would be our entire universe. That's why a number of scientists refer to the current age where we can see the evidence for the Big Bang and see other galaxies as 'the golden age of astronomy'.

(9:32)
But you know, a golden age that lasts hundreds of billions of years is not so bad.

(9:36)
What will happen in the next 100 trillion years?
The last, tiny, slow-burning star will have flickered out and new ones will have ceased to form.
No new heavy elements will form, all that will be left is the residue of heavy elements from long since dead stars, a cosmic graveyard with the remains of dead stars and planets wander in the darkness.

(9:56)
But let's not stop there, what about in the next trillion trillion trillion years?
More accurately 10^{40} years. That's a one with 40 zeroes after it.
This is an even more incomprehensible stretch of time than a hundred trillion years and even more incomprehensible things will happen.
The most likely scenario is this.

(10:14)
Matter will grow feeble and decay into energy and remember, matter is loosely speaking just a more congealed form of energy.
Eventually, the universe will be an empty orb of weak cosmic radiation, with the energy spread out like too little butter spread over too much bread.

(10:30)
This, as far as we can tell, is the end of complexity as we know it.
And then, in the next trillion trillion trillion trillion trillion trillion trillion trillion years or $10^{100.}$ even black holes will evaporate and the universe's grand narrative will have more or less come to an end.
After all those transformations into a great amount of variety and networks of intricate complexity, all will pass away.
All that will remain is a universe that is very old and very tired.
It is the spectre of heat death.

===== John =====

(10:59)
Okay, so for me, one of the most comforting thoughts about all existence comes from science - the idea from the first law of thermodynamics that matter and energy are neither created nor destroyed.

(11:10)
The building blocks that make up our bodies have been around since the beginning of the universe, we have merely changed form and after we die, or bodies will return to that inanimate cosmos from which they sprang.

(11:12)
And in that sense, all life is connected and also, all life is kind of eternal.
Now of course, there's still the fear of losing your particular consciousness depending on your worldview, like, I will cease to be John Green.

(11:36)
And from my perspective, that's not ideal, but we're programmed to have that fear. If we weren't afraid of ceasing to exist, we wouldn't be a very good species. We would have gone extinct ages ago and none of us ever would have gotten to be.

(11:47)
I don't think that's either good or bad, it keeps our species going and the universe looks on, free from any mandate or obligations or programming - completely free.

(11:57)
And what a lot of us overlook is that we are not just observers of the universe, we **are** the universe. We don't exist outside of the universe, we are indivisible from it, we are made of the same stuff, and in all of our transformations over billions of years from star stuff to single cells to students, to one degree or another, at every stage we've shared in that freedom of transformation to flow endlessly from one form to another.

(12:22)
And maybe we won't survive as individuals, maybe we won't survive as a species, but we **will** continue into the deep future.
We are a tiny part of the universe, but we are part of it, and from so simple a beginning in ways most beautiful and most wonderful, we the universe have been and are being evolved.

(12:41)
That ability, in fact necessity to change is your birthright acquired at your original birth 13,8 billion years ago and it can never be taken away, it can never be destroyed.

(12:53)
Thanks for watching Crash Course Big History and as we say in my hometown: don't forget to be awesome.