Everything, The Universe...And Life: Crash Course Astronomy #46

Crash Course: Astronomy
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Hey everyone. Phil Plait here with Crash Course Astronomy... for one last time. We've come a long way together, you and I, from the banging beginning of the Universe to its far, far, future; from subatomic scales to superclusters of galaxies. We've watched the sky, mapped how it looks to us from the ground, and then sailed out into the black to investigate its denizens up close. And - one of my favorite parts - we've seen how human beings, people like you and me, have worked over the centuries to figure all this stuff out. We're pretty clever for a bunch of apes who only recently figured out how to walk upright.

But after all the topics we've covered here, all the space we've explored, there's still one more thing I want to talk about that didn't quite fit anywhere else in the series. It's yet another fascination of mine, and judging from talking to so many people over the years, it's something important to a lot of us. Which doesn't surprise me. I think asking this question is a deeply human thing to do, perhaps ironically part of what makes us who we are. And it's simply put, too. Are we alone?

(Intro)

When people ask me what field of astronomy is the most exciting right now, I don't even hesitate: Exoplanets. I talked about these back in Episode 27; alien worlds, planets orbiting other stars. The first were discovered in 1992, and now we know of THOUSANDS, with many thousands more awaiting confirmation.

Most of these exoplanets are giants, far more massive than Earth and likely to have very thick atmospheres like Neptune or Jupiter. They also orbit so close to their host stars that they're hotter than Venus. But as our techniques got better, we started finding smaller planets farther out, and now we have a short list of planets that could very well be Earth-like in many ways. Close to our size, density, temperature, surface gravity... but that's all we know.

With our current abilities, these planets are on the thin bleeding edge of what we can observe. Do they have atmospheres? If they do, do they have a copious amount of oxygen in their atmospheres? That would be a critical observation: In Earth-like atmospheres, oxygen molecules are extremely reactive chemically, and won't last long without being replenished. The easiest way we know to do that is biology. It's not the only way, so it's no guarantee - there are some other processes that can produce and maintain oxygen in a planet's atmosphere - but seeing it would be a good sign, and there are other fragile molecules that, if detected, would strengthen the idea of biological activity.

Detecting the presence of O_2 in an exoplanet's atmosphere is just tantalizingly out of reach right now. We can almost do it. We may not have to wait too much longer, though. The James Webb Space Telescope, the successor to Hubble, is a gigantic infrared space telescope currently scheduled to launch in late 2018. It should be able to tease apart the light from some of the nearer and brighter of these distant worlds and look for the signature of oxygen, as well as other biologically produced gases.

Still, finding them in an Earth-sized planet may be beyond James Webb, too. NASA has studies looking into space telescopes specifically designed to look for alien Earths, but that's a ways off yet. But think of it. When I was a kid there were nine planets - OK, eight. Now we have thousands, and they're not at all what we expected. The diversity of worlds is stunning, with some hot, some cold, some big, some little, some in solar systems so compact they can fit five planets inside the orbit of Mercury, and some with planets far-flung.

Nature is more clever than we are. Sometimes, I think that if something's possible to do, Nature's done it somewhere. But what's more amazing to me is that we now think that most - MOST - stars in the galaxy have planets. Given that multiple planets orbiting each star is common, that means there are likely more planets than stars in our galaxy. And there are over 200 billion stars in our galaxy. I also want to point out that we see traces of life on Earth going back nearly 4 billion years. There was certainly life before that, but didn't leave evidence we can find so many eons later.

That timing is interesting: This means life existed on Earth not too long after it cooled enough to have liquid water on its surface. That in turn strongly implies getting life started on planets is easy. The ancient Earth was a tough place to live, yet life took hold within a few hundred million years after it formed. Put this all together, and what do you get? If the galaxy is filled with planets and life gets its start so easily, the galaxy may be filled with life! We need more evidence, more observations, but that
s the way the numbers lean.

Mind you, I'm not talking about intelligent life - just life itself. But still, that's just about the coolest thing I can imagine. So, are they out there? This is a question I am always asked when I give public talks. "Do you believe in UFOs and aliens?" My answer is always the same: No, and yes. Given what I just said, it seems inevitable that life exists out there in the Universe. The conditions for life to arise are easy to make, and there are a lot of chances for it out there. On the other hand, for most of Earth's history the most advanced life was basically algae.

Complex life, life capable of intelligent thought, is a relatively recent development. So alien life, sure. But aliens sophisticated enough that they can come here to pose for blurry photos, abduct people, and slice up cows? I'm not buying it. The evidence just isn't there, and now that so many people walk around with cameras, we see even fewer reports of mysterious lights in the sky than we used to – or, at least, most of these lights seen are explainable. Wedding lanterns, balloons, Venus, meteors, the Moon, satellites, and so on. I'll note astronomers are watching the skies literally all the time. If UFOs were real WE'D be reporting the vast majority of them!

That doesn't mean aliens aren't out there, though. Space is big – remember, folks, that's why we call it "space" – and getting here is a huge pain in the butt... or whatever aliens use to excrete waste matter. It takes a vast amount of energy to accelerate a spaceship to the speeds needed to travel to other planets. Even then, that's slow compared to the speed of light. Not only that, light is easy to make. You don't need a lot of super sophisticated tech to make radio waves, and it's easy to embed a lot of information in them. After all, that's how radios and Wi-Fi work.

So why go to all the trouble of meeting other life forms in person when you can chat via radio? This is the premise behind SETI. The Search for Extraterrestrial Intelligence, that is. This is based on a simple idea: If aliens are out there, it's easier to stay home and talk via radio than through the interstellar version of the Pony Express. There are a lot of assumptions built into this idea, of course. One is that, well, aliens exist. The next is that they're much more technologically advanced than we are. But that makes sense. Any aliens that don't have tech can't communicate with us, so they don't play into this. And we know how quickly our technology advances; we're just starting out and already have some pretty cool gizmos. Give us a hundred years, a thousand, and where will we be?

The Earth is over 4.5 billion years old, but we've detected exoplanets far older than that. Life there might be that much more advanced than we are. They might communicate with each other using neutrinos, or ripples in spacetime, or quantum entanglement, or some method we can't even imagine. But if they're interested in finding life in the galaxy that's just starting to get their technological legs under them, radio waves are the way to go.

Even primitive societies like ours use radio waves, and they can travel for thousands of light years. Aliens could broadcast radio waves across the galaxy, or target likely stars, or wait for us to make enough noise - and for those waves to travel outward at the speed of light long enough to reach a listening post - and then aim a transmitter at us. So the folks at SETI scan the skies at various radio wavelengths, hoping to hear a signal. So far, nothing yet.

But they don't despair. My friend, the astronomer Seth Shostak, is a SETI scientist. He's been doing this for years, and recently made a bold, but logical claim. SETI tech is advancing rapidly, and they're getting so good at listening that they'll be able to scan billions of stars. He predicts that, if anyone out there is broadcasting, we'll pick up the signal in the next 20 years. If we don't, then, given the statistics, it may very well mean that we're alone in the galaxy. Or aliens might exist, but they're not broadcasting. Or, of course, that perhaps there's another flaw in the chain in of logic that we've missed. Either way – if they detect a signal, or they don't – the resulting conclusion is at least interesting, and at most terribly profound. And it's only our first, logical step in attempting to look for life Out There.

I love astronomy. Maybe you've figured that out over these past 46 episodes. I love it for so many reasons: The beauty, the grand nature of it, the incredible vistas, the depth of the wonder and science of it. When I was little, the subtle profundity of the questions related to astronomy were perhaps beyond me. But even then, the questions themselves provoked a sense of wonder, of awe, so much so that even as a little kid, I could be stirred by them.

And now, as an adult, I grasp these questions better. How did we come to be? What was it like in those first few fractions of a second after the Big Bang? Is ours the only cosmos out there, or are we part of a much larger multiverse, riding along with other Universes like bubbles in a sea of multidimensional foam? What is the nature of stars? How do planets form? Are there other Earths? Are we alone?

These are some of the grandest questions we can ask, and in one shape or another have been asked by humans for thousands of years. These are also questions that were once only in the purview of religion and philosophy, but now we have observations to pursue them, evidence to back up our conditional answers. Because of astronomy, because of SCIENCE, we now stand on the edge of understanding, our cleverness and brilliance having taken us to the point where these questions, finally, have an answer we can almost touch.

And the best part? As we investigate, as we peek around the next corner, as we climb over the next hill, we find those answers... and they reveal a host of more questions. The exploration never ends. There's always something else to discover. And that, THAT, is why I love astronomy. And so, it is not out of arrogance, not out of false smugness, but out of pride and understanding hard-won by a legion of scientists who came before me, who came before all of us, that I can now say: Let's go explore the Universe.

Thank you for watching. And, if I may indulge myself: my personal thanks to Derek Muller of Veritasium for his hand in getting me set up with this dream gig, and course to Hank Green, who wants to make the world a better place, and is doing a fine job at it. And to all of you who have watched Crash Course Astronomy: Don't forget to be awesome.

Crash Course Astronomy is produced in association with PBS Digital Studios. Head over to their YouTube channel to catch even more awesome videos. This episode was written by me, Phil Plait. The script was edited by Blake de Pastino, and our consultant is Dr. Michelle Thaller. It was directed by Nicholas Jenkins, edited by Nicole Sweeney, the sound designer is Michael Aranda, and the graphics team is Thought Café.