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In this TEDxOldham talk Tim discusses the latest science behind the search for alien life.

Tim O'Brien - TEDx Talk Transcript

Thanks very much.

I'm going to ask you a sort of interesting question, which is: where are all the aliens?

I'm a scientist, not crazy, but I actually think maybe there are aliens around, and I want to convince you that this is a worthwhile scientific question to ask.

But I think, first of all, we need to appreciate how big space is. The best answer that I ever heard was in the Hitchhiker's Guide to the Galaxy, Douglas Adams that space was big, very big, extremely big. We really don't know how big it is.

Let's get a little chance to understand that. This is the sun, even occasionally spotted from here in Manchester. But the sun is about 150 million kilometers away, which is a bit hard to imagine. The earth is about 12,000 kilometers across.

So, 150 million kilometers is a large distance. One of the things we tend to do is, we think about how long would it take to get to somewhere if we

traveled at a certain speed. So in this case, the fastest we can travel is the speed of light. So, that's about 300,000 kilometers every second and at that speed, you'd get to the sun in about eight minutes.

So in fact, when you look at the sun, that light has taken eight minutes to reach you, which is, you know, the sort of length of time - you're here listening to a part of all of these talks - is not too long.

But space is obviously bigger than that. If you go out into our Milky Way galaxy, our Milky Way galaxy has many suns, many stars, hundreds of billions of stars. So, if we shared all the stars out between all the people on the earth, we'd all get about 50 each, basically, is that sort of number of stars in our Milky Way galaxy, and the nearest another star to the sun, that light that took eight minutes to reach us from the sun.

It's on its way now, when I started talking, some lights set off from the sun and then it'll get here about halfway through this talk. And, if that light sort of passed by the earth, we'd waited for that light to get to the nearest another star, we'll be sitting here listening to my talk for about four years.

So probably, not the best thing to be doing. So huge, vast distances between the stars. And, across the whole of our Milky Way galaxy, that light would take 100,000 years to cross it with those hundreds of millions of stars within it.

Actually, that picture is a galaxy. It's not our galaxy. It's the nearest big spiral galaxy to our own. It's called the **Andromeda galaxy**. So, it's the nearest other big, large galaxy like the Milky Way. The light from those stars that you see in that picture, you can actually see this if you know where to look, you can actually see the center of this galaxy just with an unaided eye, you don't need a telescope. A little fuzzy blob.

That light you can see from the center of that galaxy takes 2.5 million

years to reach us. So, you see back in time 2.5 million years when you look at a galaxy like this. So space is big and this is just the nearest another galaxy.

If we're talking about life, we're asking the question about where are the Aliens? We need to probably ask where are the planets? We only know of one example of life so far, life here on this planet.

So, we know that there are many stars. We can see them shining in the night sky but it's very hard to see the planets.

So, do these hundreds of millions of stars have planets orbiting them?

They do. And we're living in a very special time at the moment, actually, where 20 years or so ago, we found the first planet orbiting another star like the sun. And I looked up what the number was yesterday, and the number now is 1,642 confirmed planets orbiting another stars. So, that's just the ones we've found.

By extrapolating that to all the stars in our Milky Way... we know that there are billions and billions of planets in our Milky Way. Virtually, every star that you see in the night sky will be orbited by planets.

Of course, you could ask the question: Do those planets have life on them? And one of the key things there is, whether they're too close to their star. Would they be too hot? So, for example, liquid water is something we think is key to life here on earth, the only example of life we have.

So, if you're too close to your sun, it'd be too hot; that water would evaporate. If you were too far from your star, from your sun, then you would actually find that that water would freeze. You wouldn't have the liquid water, we think it would be essential for all the biochemistry to go on that keep us, allows us to be alive, allows us to have life on earth.

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Again, looking at what we've found in our Milky Way alone with these, 1.5 thousand confirmed planets so far, we know there must be billions of so-called habitable planets, just in our Milky Way galaxy. Not in the Andromeda galaxy the one I've shown you this another galaxy. And not in the hundred billion other galaxies that we can see in the observable universe.

Just in our own, there must be billions of habitable planets, potentially habitable planets. In other words, ones that are not too close to their star, not too hot; not too far away, not too cold so they've got liquid water.

Now, have aliens visited earth?

Who thinks aliens have visited the earth? Oh, nobody's daring to put their hands up. OK, there's quite a lot of people around the planet who do believe aliens visit the earth and visit the earth all the time and indeed claim to have met them.

But I don't think there's actually much good evidence for that. But, it's sort of an interesting question, might they've done - you know, we've only been around for... Well, modern humans have not been around for that long at all, in terms of the history of the planet, just a few hundred thousand years.

So, might aliens have visited the earth at some point? Well, here's an interesting sort of thing to think about. And it's something we might do in the future, which is to send out a fleet of what are called **von Neumann Probes**. They're space probes that you send off and they go out to search around other stars to see what they can find around other stars.

We've just discussed the fact that these stars are very far away, even light

takes four years to reach just the nearest another star. We can't make things travel at the speed of light, the fastest spacecraft travels at something like 60,000 km an hour or that sort of speed, a small fraction of the speed of light.

So, imagine sending out one of these space probes traveling at... that's a fraction of the speed of light. That's the sort of speed we can send things out at the moment. It would take it, you know, maybe 50,000 - 100,000 years to reach the nearest another star.

But when it gets there, what it does is it self-replicates. So, it gets there, and maybe along the way it gathers material from the stuff between the stars maybe, when it gets to a planet around one of those stars, it gathers more material and it builds a copy of itself.

And then, actually, those spacecrafts set off again and they head off in different directions and they go to the next another stars. And when they get there, each of those self-replicates and sets off again. This sounds a bit like science fiction, but, in fact, it's possible to imagine that we'll be able to do this in the not-too-distant future.

And again, if you look at how long this takes — you can calculate how long this process would take. You can actually explore the whole galaxy in less than a hundred million years.

Now, to an astronomer that sounds quite quick, because the earth is about 4.5 billion years old, 4.5 thousand million years. This was less than a hundred million years and you can speed it up by making multiple copies or making them travel a bit faster. So, this is actually short on the lifetime of a planet like the earth or on the lifetime of the stars that are in the galaxy.

So if you imagine that there might be life on one of these planets doing

this, one interesting question is, where are the aliens? If there had been a civilization before us, that was able to do this, might they've done this, might we've actually been visited by these fleets probably robot spacecraft self-replicating and spreading through the galaxy. We haven't seen any evidence for that, but it's an interesting question.

We've not been here for very long in the history of earth, this is something we'd be looking for. It's called the **Fermi paradox**: if Aliens exist where are they? because, really, this is actually not too long to populate the galaxy.

How are we going to look for life on other planets? Well, one of the ways to look for intelligent life, and I'm only going to talk about intelligent life here, and that's because we know that on the history of life on earth most of that time life was bacterial life. So, it's basically microbes for billions of years before it evolved into anything complicated like plants or animals or even intelligent life like us.

So it may well be that bacterial life is common but if we're interested in intelligent life, if we wanted a conversation with some of these aliens, one of the ways we might do it is by using a radio telescope. This is the one at Jodrell Bank where I work, the Lovell Telescope and this is just a recording of the sort of signal we pick up with that telescope.

(Radio signal sounds)

But, you may get a little bit bored. It just sounds like hiss. It's just noise. It's actually radio waves. In that case, it's radio waves that came from a star that exploded in about the year 1670, as it happens. You know, you can't really hear much. It just sounds like noise.

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If you were expecting to pick up a signal from aliens, you'd probably expect something a bit more complicated in that signal than just that noise.

And here is an example of something that was picked up not long after we started to think about using radio telescopes. Big ones like the Lovell Telescope there at Jodrell was built in 1957. So, in the 1960s we started to use these telescopes to look out for messages, maybe 'Morse code' type messages buried in that noise.

And just a few years after that in 1967 one of these signals was picked up and here again is a recording made with our telescope pointed at a particular direction in the sky.

[1967 - An unusual signal from space]

So, this is a bit of a surprise. We had been used to hearing the noise, the hiss... to hear, to see the regular radio flashing of an object in the invisible sky would be quite a surprise and actually, that first object was discovered by Jocelyn Bell at Cambridge University in 1967.

That first thing was called little green man 1: LGM1. They called it because they thought, this is possible for an alien signal. We actually now know that they're remnants of exploded stars. The things called pulsars, very exotic objects that we use to test our understanding of physics and Einstein's theories of gravity.

So, not aliens, perhaps sadly but exciting for physics all the same. What do we do with other telescopes? Well, we use telescopes like this one; this is the Arecibo telescope. This is a massive radio telescope, the world's biggest radio telescope. It's in a valley in Puerto Rico. It's 300 meters in diameter. That makes it four times the size in diameter of the Lovell telescope at Jodrell Bank, a huge telescope. That's used for lots of different things.

But one of the things it does is a project called SERENDIP which some of you might know as SETI at home. You can download a screensaver for your computer and it'll basically process data looking for these sort of extraterrestrial signals being picked up with a radio telescope like that one.

Another radio telescope around the world has been doing this sort of work is the Green Bank telescope. This is in West Virginia. This telescope is about 100 meters in diameter. These large telescopes collect lots of radio waves. They see, or if you like, they hear very faint things coming from the distant universe.

So, these are the sort of things we might be interested in using to pick up extraterrestrial signals. And this one's been used to search out those... look in the direction of those planets that we know of.

The Parkes telescope here is in Australia. Again, this telescope and the Green Bank telescope were involved in a new project looking for these extraterrestrial signals called the Breakthrough Listen Project. Our own telescopes, here in the UK, we started a project with these telescopes a network of telescopes spread across the country between Jodrell Bank and all the way out to Cambridge.

Seven radio telescopes all connected by optical fibres linked together to act as one giant telescope. And again amongst all the other things we do we're starting to look through those signals; looking for potential extraterrestrial signals.

What's coming in the future is an amazing telescope we're designing at the moment called The Square Kilometre Array. It's going to be built in Southern Africa and Australia. It's going to be made up of hundreds of dishes connected together, and other types of aerials connected together, that would make a giant telescope whose size is equivalent to 220 times

the size of the Lovell telescope at Jodrell Bank. It'd be able to see incredibly faint things in the universe, pick up incredibly weak signals.

And in terms of looking for aliens, in just one minute, that telescope will be able to look at every star in the direction. It's pointing out to about 300 light years away from us. So, the nearest another star was four light-years. It'll be able to get 300 light-years away searching every star in just a minute for the sorts of strong signals that come from the radar systems that we use in our big telescopes.

So, if there are aliens out there with this sort of technology and if there are signals coming our way this telescope is going to be an amazing facility for us to be able to detect those signals.

What I can't do is give you the answer to my question at the beginning, which is where are all the aliens? We don't know. We haven't detected aliens anywhere. We do know there're potentially habitable planets. That's a fact that wasn't — we didn't know that twenty years ago. We know that now.

We have got the technology. We will have the technology that is allowing us to search ever greater bits of our galaxy. Searching for the sorts of signals from the technology we produce, the radar systems that we use in airports and so on.

Looking out for these signals that might be coming from aliens and I do hope that at some point, in the not-too-distant future we will be able to answer this question, 'Are we alone in the Universe?'

Thanks very much.

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