Plurality of Worlds: Christianity and the Possibility of Extraterrestrial Intelligent Life

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[0:00] Thank you, Harvey, for the introduction. So you can see my title, and let me just give you a quick outline of what I'm hoping to get through in this talk. I may have got too much material, but we'll see. So I'm going to give a quick introduction. I'm going to talk about pluralism, and I'll explain what that means soon in this period.

Then I'll give you what theological reflections have been on the scientific beliefs at the time. I'm going to talk about the work of William Huell and anti-pluralism, anti-extraterrestrial life in 1853, a sort of interesting key point in the development of the subject historically.
Okay, pluralism and retreat in this period, and then I'm going to talk about modern developments. So I'm going to give you, start the talk with two quotations. And the first is by a science writer named Phil Plait on the BBC website.
And he says, Even a few decades ago, hard-headed realists poo-pooed the idea of aliens. But times change, and so does science. We've accumulated enough data that makes the question less far-fetched than it once was.
And I'm starting to think that the question isn't, will we find life, but rather, which method will find it first? My second quotation is from Carl Sagan, a well-known astronomer and populariser of astronomy, in a talk in 1987, in which he described stages of what he calls the anti-Copernican conceit.
[1:36] One, we are the centre of the universe. All the planets and the stars and the sun and the moon go round us. Boy, we must be something really special. Two, but at least our sun is at the centre of the universe.

Three, well, at least the Milky Way galaxy is at the centre of the universe. Four, well, at least we humans are the pinnacle of creation. Five, at least we are the most intelligent creatures in the whole universe.
He does not explicitly say that this is a summary of intellectual history on this topic over the last 500 years, but he does definitely leave the reader with that impression.
He goes on to say that one to three have been overthrown by advances in astronomy. Four has been overthrown by Darwin. And that leaves five, which is the last illusion to go.
So I'm going to suggest a different view of this. The idea that there might be extraterrestrial aliens was historically called the idea of plurality of worlds. World can just mean a planet, but an older meaning, which is kind of lurking under the surface of modern usage, is planet or place filled with beings, plants, animals and rational beings.
[2:54] So in that usage, Earth is one world. And if there is a plurality of worlds, then that means there's more than one world. So in modern terms, the extraterrestrial aliens, intelligent beings on other worlds exist.

And the last 2,500 years in the West have actually seen the battle go back and forth between pluralists, and the pluralists, in other words, those who believe in plurality of worlds and aliens, and anti-pluralists who don't.
And I'm going to suggest that maybe we might use the categories from that book familiar to many of you, 1066 and all that, and it's an analysis of the English Civil War.
And you may remember that the royalists were described as wrong but romantic, and the roundheads, right but repulsive. And so my description, which is stretching things a bit, is pluralists, wrong but romantic, anti-pluralists, right but repulsive.

So in a bit more detail, pluralists have always anticipated that new worlds, i.e. aliens or extraterrestrial life, would be found, so to speak, over the next Dunning's unexplored hill.
[4:10] And they've been disappointed again and again, as we'll see. And though the score is decidedly uneven, the anti-pluralists have, I would say, on the whole, had a more sober and comprehensive view of the overall state of the evidence.

Now, a source for quite a bit of my book is that very fat book by M.D. Crowe on the extraterrestrial life debate. And I'm going to quote him from time to time.
So I want to start off in 1543, not because the story begins there, but because I've just got to do some selection. And in the period between 1543 and 1800, there was a revolution in astronomy due to Copernicus, Galileo, Kepler, and Newton.
At the beginning of the period, the accepted system was the Ptolemaic system. The Earth is in the centre, surrounded by the sun, moon, and planets, all going around the Earth.
And then the stars are on a sphere which is a long way, but not an immensely distant way from the Earth. In 1543, Copernicus died, and his book was published.
[5:30] And basically, he introduced, well, he introduced what's called the Copernican system with the sun at the centre, the Earth and the moon going around the sun, the other planets all going around the sun, and the stars are now no longer in a sphere outside the solar system.

And if you look at this picture, and you look at those two stars, if things were actually as in the picture, then as the Earth goes around this picture here, we see the angle between those stars and the Earth would change.
We don't see that sort of thing, and that means, in fact, this picture is not to scale, the stars have to be immensely far away. So when the Copernican system came in, people realised that the stars were far, far more distant than they'd imagined them to be before.
And with that... OK, and let me just say also, in the Ptolemaic system, following Aristotle, it was believed that matter on Earth was one kind of matter, and the matter in the heavens was a different kind of matter.
So by the end of this period, by 1800, the Copernican system was almost universally accepted. Telescopes had shown mountains on the moon, and the stars, which were believed but not known for sure to be other suns, were known to be immensely far away.
[6:55] Newton's work gave a mathematical description of the laws of gravity, and the same laws applied both to matter in the heavens, the same laws applied to things like the moons of Jupiter and also matter on Earth.

So matter on the heavens and matter on Earth were no longer viewed as distinct things. And with this new knowledge, pluralist speculations began. One of the first was Giordano Bruno, and as many of you know, he was executed by the Inquisition in 1600, probably not so much because of his astronomical theories, but because he denied the divinity of Christ.
Though, you know, they threw the rule book at him, and one of teaching the plurality of worlds was one of the charges against him. One of the first pluralists in the UK was John Wilkins, an English clergyman and natural philosopher.
Here's a brief description of some of his... These people moved around quite a lot. He was warden of Worcester College in Oxford. He married one of Oliver Cromwell's sisters. He was master of Trinity College at Cambridge briefly, a founding member of the Royal Society, and became bishop of Chester.
So I don't quite know why he was from the Royalists and roundheads, but he seemed to get on well with lots of people. And in 1830... Sorry, in 1638, he wrote The Discovery of a World in the Moon.
[8:22] And I found it an interesting work which is kind of on the cusp of the transition from the old way of arguing by authority to the new natural philosophy based on observation.

In that book, he argues correctly that the moon has mountains and valleys and incorrectly that it has seas and an atmosphere. And his argument for inhabitants on the moon...
Oh, here is the front page of his work. And the argument for his inhabitants on the moon goes as follows. I have now sufficiently proved that there are hills in the moon, and hence it may seem likely that there is also a world.
In other words, inhabitants. For since providence has some special end in all its works, certainly then these mountains were not produced in vain. And what is more probable meaning can we conceive there should be than to make that place convenient for habitation.

So he gives here the first of the three main pluralist arguments. The argument from utility. To repeat the argument briefly, the mountains on the moon have some purpose.
[9:34] They obviously have no use to us, so they've got to have... be there for someone else's use, and the someone else, therefore, must be inhabitants on the moon. Similarly, a very popular argument, Jupiter's got four moons.

They're of no use to us, and we didn't even know about them until Galileo invented the telescope. God would not have created them without some purpose, and the most likely one is to give light to the inhabitants of Jupiter.
So that's the argument of from utility. The second pluralist argument Wilkins also uses. This is the argument from analogy.
Now, if our Earth were one of the planets, then why may not another of the planets be an Earth? More generally, the argument goes, if the planets share features such as mountains, seas, atmosphere with Earth, by analogy, we may also suppose that they are inhabited.
A third argument, which is used by the pluralists in this period, is what's called the principle of plenitude. I didn't find it in Wilkins' book, but here, from a bit later in the period, is Immanuel Kant, the well-known philosopher, arguing for plurality in an early work of his.
[10:52] And he says, now it would be senseless to set Godhead in motion with an infinitely small part of his creative ability. The argument takes a number of slightly different forms, but roughly speaking, it goes, just as life fills the Earth, so we should expect it to fill the heavens.

God, the creator, with infinite amount of creative capacity, should not restrict his creative capacity just to creating the beings that we see on Earth, but should fill the universe with all kinds of different beings.
People like Kant anticipated that there would be beings intermediate between men and angels. He says there's a big gap. That gap must be filled, so they've got to be out there somewhere.
So, historically, I've left a bit of a gap between Wilkins and Kant, and I'll go back and fill. So, this question attracted the attention of many of the notable philosophers, the philosophers, scientists, of the 17th and 18th centuries, including Newton and Huygens.
Huygens, a distinguished Dutch astronomer, wrote a book in 1722 called The Celestial Worlds. Nice title. Telescopes had improved enough to show the moon did not have an atmosphere, and Huygens therefore decided the moon was uninhabited.
[12:14] But he did think that the remaining planets were inhabited, advancing the usual three arguments, that is, utility, analogy, and plenitude. Sir William Herschel is best known for his discovery in 1781 of the planet Uranus.

He had strong pluralist convictions, and his personal notes show he believed not only that the moon and planets were inhabited, but also, surprisingly, even the sun. He thought that lunar craters might be the buildings of people he called the Lunarians, and Crow in this book speculates that Herschel may have confided to George III that with a bigger telescope he might be able to see the inhabitants on the moon.
And hence, George gave him the money for the telescope. And if that speculation of Crow is correct, this is just an early case of a pattern which has remained popular with astronomers up to the present day.
That is, to use pluralist hopes as a way of extracting funding. The pluralist book with most popular impact was by the Frenchman Bernard La Fontenelle, 1657 to 1757, who became the secretary of the Academy of Sciences in Paris.
He created a sensation with his 1686 work Conversations on the Plurality of Worlds. It's presented in the form of witty dialogues between a philosopher and a marquise, which takes place on five evenings on her country estate.
[13:43] They go out each evening and look at the moon and the stars and talk about the inhabitants. The book was almost immediately translated into English. His basic arguments are the same three arguments that I've shown you already, but he embellishes them with a certain amount of, well, a lot of witty dialogue, you know, lightly presented science, speculations on what the people or inhabitants of Mercury and Saturn are like and so on.

He also had inhabitants of comets, which he believed went from solar system to solar system, kind of like celestial tourists looking in at the systems on their forages. As a result of these and other works, the issue of plurality of worlds was very familiar to the intellectual classes in the second half

of the 18th century.
So one example is John Wesley. In 1758, wishing to improve the level of learning among the large number of converts to Methodism, he began to write a two-volume popular work on science.
One might wish that today's popular preachers had a similar concern. Reading Huygens' book in 1759, Wesley wrote in his journal, he surprised me.
I think he clearly proves the moon is not habitable. And perhaps because of this, his book cautiously advocated an anti-pluralist position. He got a lot of criticism for this in reviews and in his defence, Wesley made the comments as follows.
[15:12] So in his comment, he first gives a pluralist and then his response. So the pluralist, they who affirm that God created those bodies, the fixed stars, only to give us a small dim light, must have a very mean opinion of the divine wisdom.

So the pluralist is making the argument from utility. Wesley, I do not affirm this, neither can I tell for what other end he created them. He that created them knows.
But I have so high an opinion of the divine wisdom that I believe no child of man can fathom it. it is our wisdom to be very wary. I don't quite think of the misprint there.
How we pronounce concerning things we have not seen. And it's perhaps not surprising that the theologian should show better sense, more caution in describing God's purposes than astronomers.
I could go on giving quotations that show that pluralism had wide currency in the late 18th century.
But let me summarise by giving a quote from a book, Intelligent Life in the Universe, written in 1966.
[16:17] By 1800, this hypothesis, i.e. pluralism, had gained almost universal acceptance by scientists and intellectuals. An interesting thing is who are the authors of the book.

It's by Russian Klovsky and by Carl Sagan. Now I want to go on and talk about theological thought on pluralism.
Pluralism naturally raises theological questions. Of course, these were apparent from the beginning. And here is a quote from Wilkins talking about his inhabitants on the moon.
There are difficult questions raised. Whether they are the seed of Adam, whether they are there in a blessed estate, or else what means there may be for their salvation.
With many of our such uncertain inquiries, which I shall willingly admit, leaving it to their examination, who have more leisure and learning for the search of such particulars.
[17:13] So Wilkins is evading the question. So pluralism was used as an argument against Christianity. And the most striking quote is here from Thomas Paine, well known for the rights of man, in another book, Age of Reason, published in 1793.

And he says, to believe that God created a plurality of worlds, at least as numerous as what we call stars, renders the Christian system of faith at once little and ridiculous, and scatters it in the mind like feathers in the air.
The two beliefs cannot be held together in the same mind, and he who thinks that he believes both has thought but little of either. So the first point to note here is that Paine is using plurality as an argument against Christianity.
And it would be useless to use pluralism against Christianity unless people believe the evidence for pluralism to be strong. Then next, he gives one of the main challenges of pluralism to Christianity, and I think it's a challenge which still has faults with many people today.
So let's return to the question Wilkins asked about the theological state of these people if they exist.
One possible idea is that only man has fallen. This has been proposed by quite a number of people.
[18:39] A response to Paine was given by this popular Scottish evangelical preacher Thomas Chalmers, who lived from 1780 to 1847.

In 1815, when he was rector of Tron Church in Glasgow, he preached a series of seven sermons on the relation of Christianity to plurality of worlds. He wasn't a liberal, nor an unimportant figure in the Scottish Church.
Later, in 1843, he was one of 471 ministers to withdraw from the Presbyterian Church of Scotland to form the Free Church of Scotland, and then he was chosen to be its first moderator.
These seven sermons were immensely popular, drew huge crowds, and his subsequent book went through many editions. He firmly embraced pluralism, and his main suggestion theologically was that perhaps only man has fallen.
You can look for justifications in the scripture like the parable of the lost sheep, earth standing for the one lost sheep, the other unfallen worlds for the 99 safe in the fold.

[19:43] So that's one idea, only man has fallen. A second idea is that Christ's death is effective not only for the redemption of man, but also all other fallen species.

So one proponent of this was the English bishop Beelby Porteus, 1731 to 1808, who drew support from the verses in Ephesians where Paul refers to Christ, reconciling all things to himself, whether they be things on earth or things in heaven.
So that's the second idea, Christ's sacrifice on earth, effective throughout the universe. But an obvious difficulty with this idea is how they can hear about Christ's life and death. A third idea of multiple incarnations was also considered by some.
And here, from a bit later in the period, is a poem, Christ in the Universe, by the American poet, no, I think, well, by the poet Alice Maynell, actually, I think she's British.
I'm only giving you a couple of verses. With this ambiguous earth, his dealings have been told us, these abide, the signal to a maid, the human birth, the lesson, and the young man crucified.
[20:54] She goes on to say that no one else in the universe knows our story, nor we theirs. However, But in the eternities, doubtless we shall compare together here a million alien gospels in what guise he trod the Pleiades, the lyre, the bear.

And the final verse, which I haven't got up on the screen, is, Oh, be prepared, my soul, to read the inconceivable to scan, the myriad forms of God those stars unroll, when, in our turn, we show to them a man.
So that's the idea of multiple incarnations, each one incarnation of the Son of God for each fallen world. And in general, I'd say, most theological thinking has been against this.
There's a sort of gut feeling that the incarnation of the Son of God as a human Jesus should be a unique event in the universe. But as far as I know, no first-rate theologian has really discussed this topic.
So I'm now going to jump forward in time to an essay, Religion and Rocketry, by C.S. Lewis, in which he engages with the pluralist objection to Christianity. As usual with Lewis, it's full of good sense as well as interesting speculations.
[22:08] Lewis begins by remarking that the discovery of vegetable life on other worlds would be of no theological importance, which is a point worth remembering now, since it's just possible that the next few years may see the discovery of bacterial life on Mars.

Lewis's essay shows no signs that he knew much of the early history of pluralism, but he discusses the possibilities that I've mentioned above and makes an interesting and I think new suggestion.
He asks if redemption by incarnation under passion is the only mode of redemption that is possible.
And he says it may be that redemption as on Earth is the only way a fallen race could be rescued, but we don't know.
At any rate, I don't know. Spiritual as well as physical conditions might differ widely on different worlds. And a bit later, summarizing his argument at the end of the essay, Lewis says, the mere existence of these creatures would not raise a problem.
After that, we still need to know that they are fallen, then that they have not been or will not be redeemed in the mode we know, and then that no other mode is possible. I think a Christian is sitting pretty if his faith never encounters more formidable difficulties than these conjectural phantoms.
[23:29] So here is a summary of the five theological possibilities that I've mentioned. One, only man fell, multiple incarnations, Christ's death effective other species, only man is redeemed, not very popular, and other modes of redemption as suggested by Lewis.

And so those are the only five basic sort of possibilities that I'm aware of. Now, I'm going to resume, that's my sort of theological part, now I'm going to resume my chronological account of scientific thinking on pluralism.
And the 19th century, first part of the 19th century saw little new on this topic as far as I see until the work of William Huell in 1853. And remember, 1853 is just six years before Darwin's origin of species.
So Huell studied in Cambridge, was elected a fellow of Trinity College in 1817, and in 1841 became Master of Trinity. His background was in geology, but his most significant work was in the philosophy of science, and in fact it was he who coined the word scientist.
He was a polymath known for his deep and wide knowledge. Earlier in his life, he advocated pluralist positions, but in the 1850s, possibly for theological reasons, he rethought these.

[24:58] Crow suggests that examining again the arguments for pluralism, Huell was surprised and pleased to find how weak they were. Let's recall again the three main arguments, those of utility, analogy, and plenitude.

His essay shows what I would call a strong mind, that is somebody who can pull together facts and evidence from very different eras of knowledge and apply them to the problem at hand. So his first contribution was to introduce the element of time into the debate.
In common with most geologists of that period, he accepted the great age of the Earth, though he would have said its age was a few million rather than a few billion years. Humans had clearly only been around for a much shorter period, maybe 10,000 years.
So for most of the history of the Earth, there had been no inhabitants. If therefore we see a planet, even one very much like the Earth, why should we conclude that it must have inhabitants now? Put another way, if we only had inhabitants of Earth for a small proportion of its existence in time, why not similarly should only a small proportion of space be filled with inhabitants?
[26:10] And one sees that this introduction of time greatly reduces the force of the argument from analogy. On the argument from utility, Huell points out the creator regularly uses means which appear very wasteful.

This is, remember, all pre-Darwin. Huge numbers of sperm or seeds are made, nearly all of which are wasted. So why should we suppose that every planet or moon has to be of use?
Having attacked on general grounds the positive arguments used by the pluralists, Huell then went on to look at the scientific evidence. He asked about the physical condition of the planets and whether they might be suitable for life, a point rather surprisingly very much neglected by most pluralists up to that point.
Huell argued that Mercury and Venus are too hot. He pointed out that Jupiter has a density roughly the same as water and he was one of the first people to suggest that it might not have a solid surface. Mars is more difficult for him but again he introduces the element of time and says even if it once had or may in future have inhabitants it may very well not have them now.
What about stars? Well he was able to argue quite cogently that double stars couldn't have inhabitant planets in their systems but there are still a lot of stars which aren't double stars and the weakest part of his essays where he argues that only the sun had inhabited planets.
[27:37] He suggests in the face of the evidence even of that time that the sun is the largest star in the universe and that most stars are perhaps rather small bodies incapable of supporting life on a planetary system.

His book attracted a lot of attention and one reviewer summarised his work as intending to prove that nowhere in all infinity is there a being as grand as the master of Trinity.
So now I'm going to go on to my next section which I'm going to call Pluralism in Retreat 1850 to 1940.
So the years after Huell saw somewhat of a retreat by pluralists. One of their three main arguments that of utility had already been dented by Huell and it was more or less finished off a few years later by Darwin.
Darwinism also eliminated the theological side of the argument from plenitude. That is the idea that the creator's power should show itself in producing all possible results.
[28:51] What remained of the arguments was analogy and combined with perhaps the remainder of the argument of principle of plenitude that gives a more modern argument which I'm going to call the argument from multiplicity.

With so many stars and planets surely some must have intelligent life. Well, in the later part of the 19th century as people learned more about the planets pluralists more or less abandoned the solar system at least as far as the possibility of intelligent life was concerned.
And pluralism fell further into disfavour in the first part of the 20th century. The modern theory of the formation of the solar system is that it condensed from a cloud of gas and that both the sun and planets were formed during this process.
This is called the nebular hypothesis and it goes back to Laplace in around 1800. However, as with most scientific theories there were difficulties and around 1910 Sir James Jeans suggested an alternative collision theory that a near collision between the sun and another star led to a cloud of gas being drawn off the sun and this then condensed into the planet.

So the two bodies collide, a spurt of gas comes off and that condenses to form the planets. Now, the distances between stars are huge and collisions are extremely rare.
[30:11] So if a collision is needed to produce planets then planets and so life would be extremely rare. So rare indeed that perhaps our solar system would be unique. This theory was widely accepted in the period say 1910 to 1935 but then ran into difficulties and it's now been completely demolished by the recent discoveries of planets around other stars.

So after 1940 when Gene's theory fell out of favour again pluralist thought naturally returned but with different vocabulary.
The term plurality of worlds which I've been using fell out of use and people began to talk about search for extraterrestrial life or extraterrestrial aliens instead. But I'll continue to talk about pluralists since it's a convenient shorthand for believers in the existence of intelligent life on other worlds.
Even for the solar system some pluralists continued to hope. Here is a quote from the 1966 book of Shlowski and Sargon which I've already referred to at the end of their chapter on Mars.
They're proposing a Mars explorer like the one in fact that we now have. Perhaps the pictures will be unspectacular rocks, lava flows and sand dunes. An occasional scraggly plant would not be unexpected but there are other possibilities, fossils, footprints, minarets.
[31:38] We will only know when we drop our instruments on the surface of Mars. Well, now we have such pictures, not surprisingly they show none of those things and even a scraggly plant would be a cause of immense excitement and we haven't seen any.

Before the space program even the best views of the planets were very poor. But we've now sent probes to most of the planets and I will now review very quickly what's been found. Mercury and Venus are far too hot for life.
Mars is now barren but the photos from Curiosity show that it once did have running water. Was there ever life on Mars? If so, the most likely form would be bacteria which are relatively simple as life goes and extremely adaptable.
If we find life or its remains on Mars, which is still a big if, the next question is whether it had an independent origin from life on Earth. And this is a surprise perhaps to many people.
A meteorite hitting Mars could project rocks on Mars containing life into space. Some of these would then arrive on Earth and it's thought that bacteria on the rock could survive the journey and so grow on Earth.
[32:54] So it's just possible that all life on Earth actually came from Mars or conceivably the other way around that life on Earth then some of it got transferred to Mars.

The outer planets Jupiter, Saturn and beyond are not thought to be suitable for life. But a big surprise has been Jupiter's moons. Of these the most promising is Europa, one of the four Galilean satellites.
Its surface consists of ice at a temperature of about minus 200 degrees Celsius. There are good reasons to suspect that under that surface maybe about 50 kilometers down there are liquid water oceans and these oceans are kept warm by heating due to tidal forces.
So there might be bacteria there maybe similar to the bacteria which live deep in Earth's oceans close to volcanic vents. If this life exists finding it will be quite a challenge and though immensely exciting from a scientific viewpoint in my view following Lewis the discovery would have little or no theological significance.
So if we are looking for intelligent life then we must look to the stars. The first question is whether planetary systems are common and we now know the answer is yes. Astronomers use the word exoplanet to describe a planet outside the solar system.
[34:14] No exoplanets have yet been observed directly. They are too faint and too close to their stars. But their existence has been shown by various indirect means.

One is that the exoplanet perturbs the motion of the star slightly. Another is that if an exoplanet passes between us and its star then it cuts off a little of the light of the star for a period of a few hours.
The satellite Kepler launched in 2009 is observing 140 and 145,000 stars regularly measuring their brightness every half hour or something. And based on its observation Kepler has now located 114 definite planets and about 2,700 candidate planets and most of the candidate planets will in fact turn out to be true planets.

And the total number of known exoplanets by all means is now about 900. So we can say with certainty what we couldn't say 50 years ago that planetary systems are common in the universe.
What about planets with life? By habitable planet astronomers mean a planet of more or less the right size circling its star inside what is called its habitable zone i.e. the zone where the planet is neither too hot nor too cold for liquid water to exist.
[35:31] And so far among the 900 planets only a handful of habitable planets have been found. one of these is a planet three times the mass of the earth around an obscure star called Gliese 581.

The tentative discovery of this exoplanet was announced in 2010 and at a press conference the same day one of the authors of the paper, Stephen Vogt, said the chances of life on this planet are almost 100%.
This is about a planet which you haven't seen and existence is actually only obtained by very indirect means and it's not even actually a certain planet at this point still just a candidate.
So given this recent data we can estimate the number of habitable planets in our galaxy to be about a billion with a rather wide margin of error. Remember that habitable planet doesn't mean that it has life.
just that one of the conditions of life, that is water, could exist on its surface. And that's as far as observations can take us at present. In the next few years we'll see what Curiosity finds on Mars and maybe in the next two decades we'll learn more about Europa.
[36:49] It takes a while to travel out there. Space-based telescopes may also give us our first direct visual observations of exoplanets and just possibly spectroscopic observations of those will detect oxygen.

And one explanation of oxygen in a planet's atmosphere though not the only one is life. That's as far as we're likely to see progress in our lifetimes I would say.
What about intelligent aliens? Well here we have one thing going for us. They're not just passive objects like bacteria or lichens waiting to be discovered but are potentially active agents.
The galaxy is about 13 billion years old and our sun is only about 4 billion years old 4.6 billion years old. And as far as we can tell conditions in our galaxy have been suitable life to arise for maybe 7 to 8 billion years.
So if intelligent life is common some species might be very much older billions of years older than us. That is plenty of time for them to explore the galaxy. So we have the question asked by the physicist Fermi in the 1940s.
[38:01] If they exist why aren't they here? This is often called the Fermi paradox but it's only a paradox if one starts from pluralist assumptions.

And here are four broad approaches to the answer to Fermi's question. First is advanced species destroy themselves.
souls as we may. Second, space is too big and interstellar travel is too slow. Third is what's called the zoo hypothesis. They are here, they are watching us but they are not communicating with us so Earth is a kind of zoo under which we're on observation.
And four is they have not visited us because they do not exist. So the first argument does not convince me.
Maybe we will destroy ourselves but I don't think it's certain we will and even if we do there may be a bit more luck or wisdom in a key person or two would have averted that outcome.
[39:07] So I find it very improbable that all intelligent species end up by destroying themselves.
What about the second? Space is too big. Well, space certainly is big and certainly we could not send a probe to the stars now.

However, consider the following ingenious argument by the physicist Frank Tipler. In the next few hundred years we are quite likely to see the development of two technologies which we don't at present have.
The first is a propulsion system which can send probes to the stars at say 1% of the speed of light.
And the second is machines which can make copiers of themselves.
Now, the germs of both those technologies exist today. NASA has looked at plans for what is called the Orion Drive which could propel us probe to the stars using a series of small nuclear explosions.
And you may have heard of 3D printers. This is a RIT-RAP machine from the internet and it's capable of making about 60% of the parts for a new RIT-RAP machine.

[40:17] So, we're not there with machines which can make copies of themselves yet but we're perhaps, you know, further along than you might expect.

So, here's Tipler's idea. You combine the two technologies and we send a few of these machines to nearby stars. Using the materials in the planetary systems of those stars, those probes build new ones, send them out to other stars and so on.
And in a few million years, those probes can explore the galaxy for a fairly small initial cost of just sending the probes to the nearby stars. Now, if we can do that, so could others.
And if they haven't, why? Well, Tipler said it was because they don't exist. His paper drew some criticisms, but they can be answered and last year I wrote a short paper dealing with some of them.
As I finished that paper, I found my own thinking on the question of pluralism changing. I had been a pluralist, but as I consider Tipler's arguments, and also what can be accomplished using technologies only slightly ahead of ours, plus billions of years of time, I found myself veering towards anti-pluralism.
[41:30] If technological alien civilizations billions of years old exist, even outside our galaxy, we should see evidence of them, but we don't. So maybe, after all, intelligent life is extremely rare in the universe.

A final question is why this is so. Well, as you've seen, astronomers are often uncritically optimistic about the possibility of extraterrestrial aliens, but evolutionary biologists are much more pessimistic. They argue that evolution does not favour intelligence, and that even if there are many planets with life, our own intelligence is so unusual that it may only have evolved once.
So that's a possible explanation for why such things might be rare. Another is that life might actually be rare. At this point, we don't know.
So I'd like a bit provocatively to close with what I would call the pluralist conceit, which is stage one, the moon, the sun, comets, and planets, and stars all have inhabitants.
[42:40] Two, well, at least the planets around the sun and other stars have inhabitants. Stage three, well, at least the planets around some nearby stars in our galaxy have inhabitants. Well, four, well, at least somewhere in the galaxy there are other civilizations.

And five, well, at least somewhere in the observable universe there are other civilizations. We've disproved one and two, and evidence is, in my view, very much tending against three. More speculatively, Tipler's arguments go against four, and the very speculative arguments I've hinted out in the last part of the talk are against five.
So, there we are. APPLAUSE Thank you.