Speaker	Mr Kevin Vinsen
Talk title	Are we alone in the universe?
Venue	Helvetica
Time	Tuesday 29 October 2019, 7.00pm

Simon Handford

Good Evening, Good Evening everybody!

I think we are going to make a start on time, or almost on time.

Thanks for joining us tonight, my name is Simon Handford and I am the Manager - Research Commercialisation Office at the University of Western Australia and I will be introducing the speaker very shortly.

But first, what I would like to do is acknowledge that we are meeting tonight on the Whadjuk Noongar land and that the Whadjuk Noongar people are the traditional owners of the lands and waters where we are meeting today and pay my respects to the elders, past, present and emerging.

Welcome to Raising the Bar. This is the second talk this evening. There are ten bars around Perth with researchers from the University of Western Australia talking about the research that they do and bringing it to the people. We have a beautiful campus down at Matilda Bay. We have got other areas around the city and regionally but it is really important that we let you guys know what we are doing and why we are doing it and it will let you know we are a university where we really value your input in any engagement.

We are excited to make education a part of our cities popular culture, through transforming local city bars into a place where you can enjoy a drink, whilst learning about the impact that our research has in the community at large.

If you are sharing Raising the Bar on social media, please tag us at @UWAresearch or #rtbperth19. That's getting a bit of Twitter action tonight and I also just wanted to let you know that tonight's talks are being recorded and will be published as podcasts on our social media channels, so if you haven't been able to get to some of the other talks, wait until you hear when the podcasts are uploaded and tune in to those at a later date.

Let me start by introducing our speaker Mr Kevin Vinsen.

Kevin's main research interests are computing for data-intensive astronomy developing methods for the automated classification of galaxies and gravitational waves, using multi-wavelength data, machine learning algorithms and modelling complex systems. Kevin considers himself one of the luckiest geeks on the planet, he is paid to do what he loves, astronomy and computing with some of

the biggest and "baddest" computers on the planet. The talk tonight is about, "Are we alone in the Universe?"

[clapping]

Mr Kevin Vinsen

Bask in the applause, some more?

Hi, my name is Kevin Vinsen and I am a Senior Research Fellow at ICRAR. ICRAR is the International Centre for Radio Astronomy Research.

You have probably never heard of us much, so I will give you a quick, what is ICRAR?

We are an interesting organisation where Curtin University, UWA and the State Government.

So, a quarter funded by each of the universities and half funded by the State Government. So half of my salary is paid by taxpayers. Thank you very much, I appreciate it, and as you will see, as you will find out tonight, we do some amazing stuff with your money!

ICRAR was formed ten years ago, this week is my tenth work anniversary at ICRAR.

We were formed to win the SKA. The SKA is the Square Kilometre Radio Telescope. I will tell you a bit more about that in a minute, but basically, it is the biggest radio telescope the planet has ever seen.

The first phase of ICRAR [inaudible 11:39] yep, did that! Half of its coming to Western Australia and half of it's going to South Africa.

The second phase was, design it! Well, we have just finished.

The third phase of ICRAR is just starting, build it! And this is going to be happening in our backyard up at the Murchison.

So, I am part of the Data-Intensive Astronomy Group. What we do, is build the computer systems that actually make the images and then the real astronomers then go and say, "Ooh, look, what's that, that shouldn't be there," which is actually how an awful lot of science works. "What's that, that shouldn't be there, I haven't seen that before?" There is none of this running around naked going, "Eureka, it's …"

We support the SKA work.

We are also having to develop and design new computer paradigms because what we have got at the moment just doesn't cut it and we are designing special, supercomputers.

We also do machine learning as well as part of our work. This involves really classifying the number of galaxies. Now, Gaia is up there at the moment classifying billions of stars. We expect to see millions if not billions of galaxies when the SKA comes online and we need to classify them but there

aren't enough eyeballs on the planet to go through and say, “Oh, that’s a spiral, that’s an elliptical or that’s a spiral with a bar,” so we need to get computers to do this to give us a hand.

We have been developing algorithms to do this but we also do things like hunting for gravitational waves. A gravitational wave, when two very massive bodies, like two black holes, dance around each other, [phewphewphew] like this and the mass maybe twenty, thirty times our Sun? Rotating fast, they walk space-time and they ripple it. Now, what we are looking for is a ripple about $1/10^{th}$ minus 21 metres so that is a thousandth the width of a proton and we can see these things and I have been developing machine learning algorithms to help do that.

Astronomy is a big area. Most people think about astronomy just as looking at the stars. Well, that is optical astronomy. I am a radio astronomer. What we look for is primarily hydrogen. H1. It emits a radio wave at 21 cm and this is the fundamental building blocks of the universe and there are tonnes of it out there and this is what we are looking at, because all you will see are pinpricks, but just the stars, what we see is tides of hydrogen flowing between galaxies and I am not kidding. Feel free to look any of this up in Google afterwards. Go and have a look at say, M81 and 82 in radio because you will see these galaxies are linked by clouds of hydrogen.

We also now do multi-messenger astronomy, so we don’t just look at one thing, we look at gamma rays, ultraviolet, infrared, optical because they all tell a different story and this is the story that we really want to tell which is, how did we get here and are we alone?

The SKA is coming to Australia. It has a budget of about AUS$1.2 billion for Phase 1.

Phase 1 is only going to be 10% of the telescope. The reason we are only doing 10% is, we can’t afford the rest.

Are there any eccentric billionaires in the audience tonight?

If you are and are keeping quiet, please come and see me discreetly afterwards, because I have got this really cool idea about a super new telescope here in WA, to make it bigger.

We will be building two of the biggest supercomputers, the world has seen here in Perth, to service this thing. One will be doing the telescope and one will be doing the regional centre work which will then federate the data around the world. Now, as part of this, you will notice that your internet speed going towards to Europe, suddenly is going to get better, because people are putting cables, because, hey! They have got a customer, us! Because we will be moving huge amounts of data.

Part of the work of the group is that we use really big computers. We actually managed to talk the Americans into lending the biggest supercomputer on the planet. Two hundred petaflops of computer power.

Now, just get your SI units, mega, Giga, terra, PETA. So, this is one “badass” machine and it took a little bit of work, but they lent it to us and we simulated data streaming from the SKA through the computer into imaging and produce a final image.

The downside of this thing is it uses 13 megawatts of power. Kwinana, our main power hub here in Perth, produces 240, so that once machine would use 3% of all of Perth's power and we need two of them. So, come 2024 and your air-conditioning starts to fade, sorry it is probably us, just turning our computers on the cooling and such like.

The data rates on this thing were pretty extreme. It was a bit like taking 16,000 YouTube videos and pumping them through every second. That start to make sense of the sheer scale of the numbers we do? This radio telescope will be so sensitive, we will be able to see an airport radar within ten light-years of us. Now, that sounds impressive but there are only actually two planets or planets or exoplanets within ten light-years of us, that we know of at the moment.

One around Proxima Centauri and one around Barnard's Star and for those of you who [inaudible 18.11] Hitchhikers Guide to the Galaxy fans, where did and Ford and Arthur hitch a lift with the Vogons too, Barnard's Star! You see, it's real. The Hitchhikers Guide to the Galaxy is real! For a little bit.

Some of the other things, if we took a day's recordings from this thing and you were listening to the playback, how many years do you think you will be listening. We are working in units of millions of years and my Mala students can't answer because they know the answer to this one.

How many millions of years? Just guess, stick your hands up, which won't work well on the podcasts.

Three million years at the back, lower than that.

How many millions of years to listen to this playback. We have three, it's lower than that. You know the answer anyway [laughing] you attended my Mala talks on it. Its two million years. Can you imagine two million years of listening to [crackling sound] and the other thing about this telescope is, the 130,000 antennas we are going to be putting out in the bush in Phase 1 and probably about 1 million on Phase 2, that will do about 100 times the current global internet traffic, flowing from those antennas into the main hub which is pretty good.

Now, the other part of my work and Andreas, if you are listening and this my Andreas not the other Andreas who we will get to in a minute, thank you for letting me do this part of the work. I do a lot of STEM Outreach. This involves me talking to my friends at ESA and saying, "Hey, dude, can I borrow your OPLINK at New Norcia?" "What do you want to do?" His name is Eade so I should put on a French accent and make it proper. But he says, "What do you want to do?" "Oh, I want to send messages to Proxima Centauri with some primary school kids." "Yeah, cool, when we are not using it for talking to the Mars Rover, you can do that."

So, $85 million worth of dish, they lent it to me and a bunch of primary school kids and we sent messages to Proxima Centauri.

See, STEM doesn't have to be boring, if you have got someone like me, who knows people who will lend you a damn great dish.

But I also go out to the bush schools as well. Perth schools get a lot of good traction with scientists but places like Lancelin, Hopetoun, Ravensthorpe, Dwellingup, Waroona, they don't, but I live down in Serpentine-Jarrahdale, so for me, that's no big deal.

So that's what ICRAR is. Where are the Aliens?

Alright, so let's start by reinforcing the scientific method. We form a hypothesis, we test it and then we have a theory. Scientists use theory slightly different to the "lay public". To us, a theory is something that is well tested. So, evolution is just a theory and we go, "Yes, well done, it is, it's well tested, we have tested this thoroughly." So, we will try and stick to the facts. What do we know about our galaxy?

Between 200 & 400 billion stars in our galaxy alone. Gaia is currently cataloguing them and we think we will be looking at about one billion of the local stars, so that is ½ % of our own galaxies stars.

On a clear night, with no moon, out in the bush, you can probably see between eight and ten thousand stars, that's all. There's an awful lot more out there.

Of the stars that we know about, about 75% are what I call M Class, so these are smallish, coolish stars and our nearest neighbour Proxima Centauri is a Red Dwarf, type M and so is Barnard's Star, that's a Type M too.

These are everywhere and 75% as I said of all-stars for these small ones, 20% are like our old girl, the Sun, which is an F or a G or K type star, ones that have been around for a while and haven't got to big, haven't burned out, just right as the Goldilocks story goes.

What else do we know?

We know we can see organic molecules in space. Radio telescopes can see them because we are not looking at stars, we are looking for molecules. We can see things like amino acid or nitrile and glycolaldehyde. Now, glycolaldehyde is a carbohydrate, it is not saccharine but it is as simple as sugar that you can find in trees in New Zealand where they separate it from Gondwana and they have been around for a while. Amino acid or nitrile is a pre-cursor to amino acids.

We have detected Enceladus, the moon around Saturn, organic molecules in the water spray going up.

There is also lots of dust in space. Polycyclic aromatic hydrocarbons. Dust. Lots of bits of carbon. So, carbon is everywhere. An assumption that carbon-based life is probably if it evolved anywhere else, is going to be the dominant one, is probably sound, because of the sheer amount of carbon out there.

The other thing we know, there are lots of planets, it turns out and we have even detected water vapour in an Exoplanet, K218B has water in its atmosphere.

We have confirmed as of this morning. I spent the morning fact-checking, 4,113 Exoplanets within our local neighbourhood. There are another 2,420 potential Exoplanets from Kepler and 1,183 from TESS. Of all of the Exoplanets though, only 21 are likely to be rocky and hold surface water. The 34 that might, but they are sort of, borderline cases. Kepler only looks at $^{1}/_{400}{}^{th}$ of the sky though, so we can extrapolate that planets are really quite common out there. TESS is expecting to find about 20,000 plus Exoplanets.

The estimates for how many stars have rocky planets like us, vary wildly, from 1% to 100% depending on the paper you read. Some sort of people are saying, "No, rocky planets are not that common from this batch of data," whereas other people are saying, "Actually, yes they are from this batch of data." So we really don't know yet. There are about two trillion galaxies out there, so the numbers are stacking up here but we need to be in a galactic habitable zone for life to form. Now that means you are not near a Supermassive Black Hole because near the Supermassive Black Holes you have Accretion Disks which are whizzing around at near relativistic speeds. They are throwing plasma jets, high energy particles, gamma rays, X-rays. Not good for life to form. You don't really want to be near a Stella Mass Black Hole either, because if one came into our solar system, it would suck all of the gas out of Jupiter, first and then slowly start grabbing asteroids from the Oort Belt and throwing them at us. I didn't work well for the dinosaurs, did it?

So, we would be in a nasty situation if that happened and you don't want to be in the globular cluster either. The globular clusters, you will see these in the night sky. These are where we have between a hundred thousand and a million stars crammed into a space between 10 and 200 light-years. Just too busy! There would be far too many planetoids, asteroids whizzing around there and as we have already said, it didn't work well for the dinosaurs.

The ideal Goldilocks zone is we want liquid water, tends to be what we are, if we do meet aliens they will probably say to us, "Hello bag of water," because that is essentially all we are, a bag of water with a few other bits and pieces thrown in.

We need a habitable star. We don't want a James Dean type star that burns brightly and dies young, because it took us about four billion years to get here. So, a star going supernova wouldn't be a good thing.

We don't want too many neighbours because we really don't want them going supernova near us because that "bang" will wipe us out.

In the last four billion years, the estimates are around forty to fifty times we have had close encounters with other stars coming near us. You can imagine a star moving through our solar system would wreak havoc to our gravity. We would move a little bit too far in and we would all cook and too far out we would all freeze.

To give you some idea, people know how far Alpha Centauri is? 4.2 light-years. If we wait (I had to look this one up) 26,000 years, it will only be 3.1 light-years away, because it is moving. It's moving, I mean we are all moving within space and the other thing we really need are gas giants outside us

because they act like asteroid absorbers. Their huge gravitational pull takes the asteroids and pulls them in towards them. Some get through, the Mau Mau, that one got through, we didn't actually see that one until it was leaving so that was a bit of a worry because that would have been a bit of a bang.

Now, the other problem we have is the sheer distance.

Our galaxy is somewhere between 150,000 and 200,000 light-years across and about 1,000 light-years of disk. We are around 26,000 light-years out from the centre and our nearest similar-sized galaxy is about 2.5 million light-years away.

We are quite isolated here. This is a nice quiet place where things don't happen much. Within our Virgo Super Cluster, that is 100 million light-years across.

So we have talked about Proxima Centauri, 4.2 light-years. We all watched Star Trek and Stargate, it doesn't sound far, it's only 4.2 light-years away. You know, Chekov would say, "Yes Captain we will be there in two minutes!" Well, let me put it into some context that's 40 trillion 130 billion 497 million 203 thousand 742.6 give or take, kilometres away! Now the fastest man-made craft at the moment is the Parker Solar Probe and that's cracking along 692 thousand kilometres an hour which sounds really fast apart from the fact that's .006 the speed of light. It's not actually that fast in galactic terms, I mean to us, wow, that makes Ferraris look slow and the Earth to give you some idea is about 40,000 kilometres round.

So, life on Earth started, we think, about 4.4 billion years ago. Evidence of life was fairly quickly after that. Photosynthesis around 3 billion years ago and that changed our atmosphere. It went from carbon dioxide to oxygen and we are doing our best to turn it back again.

Where are they?

Given all that information, in 1961 Frank Drake came up with an equation to try and work out where they are.

Nowadays it's more of a fun thing because the assumptions you have to make are just too weird. But if we put in some numbers its star formation rates, chances of intelligent life happening, chances of you actually having a planet where you can grow up. The chance of you actually getting a culture that gets to high tech.

When all said and done, we only just made it past the Cuban Missile crisis. Now the Russians have de-classified documents, we now discover they were going to launch and it was the second in command of a missile sub because the Russian protocol was three commanders had to say, "Yes, fire!" Two of them said "Fire!" and one of them said "No!" Praise be to him because he stopped a nuclear war. The Americans were just trying to move the sub away from Cuba but they didn't know that they just thought, you know. There are death charges, its war, push the button!

If we look at this number and we put in some pessimistic views, well in our galaxy, yes, we could be the only choice. That's it, we don't know what makes life actually start. It could be a really rare thing. Equally, we put in some slightly more optimistic numbers and there could be as many as 2,000 other civilisations in our galaxy but, its 150,000 to 200,000 light-years across, a thousand deep and that means if we divide the numbers up, our nearest neighbour would be two to three thousand light-years away. So the chances of actually seeing them or even hearing them could be remote. What were we doing 2,000 years ago? You can tell from my accent, I am from the UK originally and my ancestors they were living in houses where you took hazel, weaved it together and then went out into the field, picked up all the cow crap, peed on it, added some horse s**t and slapped it on the walls and called it plaster. Its wattle and daub! I mean, would you really want to visit people who lived like that?

I have a problem. The other thing is a quote from Jill Tarter she is the ex-head of the SETI Institute. If we take the oceans of the sea for as a metaphor for the universe, that's 1.639 zeta litres. A zeta litre is a tenth of twenty-one so it is twenty-one zeros after, so it is quite a big number.

Right, I want you to go and prove there are fish in the ocean, using that because that's about what we have looked at so far in that sheer scale of things. We have really only been looking for a little while. Radio has only been around for one hundred years, so it's not that far out, people don't know where they are and this is the Fermi Paradox. If aliens are out there, where are they? We have got a number of possible reasons.

One, there is some filter out there we go through to get to the next stage and other civilisations didn't do it. Is the discovery of nuclear weapons an inevitability. If it is, all you need is some idiot to push the button and you have no more civilisation. Maybe it's the invention of nanotechnology? Maybe it's the invention of artificial intelligence? We may have that great filter to come?

Steven Hawking, Elon Musk are all quite worried about this idea.

Well, Steven Hawking was, because it is the Late Steven Hawking.

Do we really want to be finding aliens, because, if they are a predatory species? …. I mean, one of the great things that would kids into science and excited about science would be if, we detect an airport radar and it's got dinosaurs on it! Space and Dinosaurs! You know, what a combination! Kids will be coming into science in their droves, no more lawyers and accountants and all these other blood-sucking industries, it will be SCIENTISTS that take over and rule the world. Hooray!!!

Yes, we are getting a few arms up, there are a few of my brothers in kind here.

But, other civilisations may realise, this is a bit iffy, let's have a look at this lot? Oooh, look the twelfth century, that guy called Genghis, he was a bit of a bad dude.

There are supposedly around 100 people here, so 75 of you, have got Mongol DNA, courtesy of Genghis and his hordes rampaging and doing what rampaging hordes do when they win.

Napoleon, oh yes, he walked all over the place.

Stalin, Heller, I mean, these are not good role models for anybody who is looking at us and our history. But my personal theory is just too far away. At the moment, the best we can do is .006 % of the speed of light. We are not going to find anybody because they just can't get here. Space is too big.

Thank you.

[clapping]

Simon Handford

Space is too big! [laughing]

I hope there are a few questions. I am not whether my first question should be, "Are there any eccentric billionaires in the audience?"

Oh there is a hand up, thank you, I will speak to you later on, or what was the message that you sent?

Mr Kevin Vinsen

These were messages from the kids. What I was trying to do was get them to critically think.

What would you send to aliens that is an update of what Carl Sagan and Co put on the Voyager mission?

And these were messages of:

"Hello from the children of Planet Earth!

"This is me playing the Cello."

"This is me doing Taekwondo, I can look after myself!"

One young lad put on:

"Please send help our parents are screwing up the planet" [laughing] It got sent, I wasn't going to filter what the kids sent at all.

It was their messages to what aliens might be.

They wanted to send it to TRAPPIST which is 40 light-years away because it's got lots of rocky planets but I had to point out to them, "you are 10 and 11-year-olds, 40 years, 40 back, you are going to be in your 90's if we get a reply. Shall we go somewhere a little bit nearer, 4.2 and 4.2 back, it's sort of only 8.5 years, you will just be finishing university by then, hopefully, if we get a reply."

Simon Handford

Nice one.

Any questions for our speaker this evening? There is one, right at the front.

Audience

First of all, thank you, it was very interesting, but you talked about distance but you haven't mentioned time.

So, the Universe has been going for 14 billion years ….

Mr Kevin Vinsen

13. 8 billion, you know, give or take …. [laughing]

Audience

just between friends …

So, could it have been that these civilisations have risen and fallen …

Mr Kevin Vinsen

Oh, absolutely!

Audience

Even before we were …...

Mr Kevin Vinsen

But even more exciting, because it took 4 billion years for us to evolve, our Sun had to be in just the right place, we needed a molecular cloud to have formed, so some big stars had to form, collapse, blow up.

You all do realise that you are made up of the remains of dead stars and any of you ladies who have got jewellery on, that's dead neutron stars and dead Supermassive Black Holes. So, you are all cruel to stars!

All of that had to happen first to get the carbon, the oxygen, the nitrogen, the iron and all the other elements that make us what we are. We could actually be the first. That's a scary thought, in some ways. We could be the first! It takes that long. We know evolution takes a long time to get things going, we know we had to go through a number of cycles to get to where we are, we had to see a number of stars give their lives for us, to be here and they did willingly. Well, they did mean when it is just physics, a bit of gravity, a bit of fusion [explosion sound]

That's a scarier thought, we are the first.

But yes, they could have risen, they could have fallen and this is this great filter thing. Do we get to a point where we invent nanotechnology? What's happening in the research labs? Somebody says, "What happens if I tweak that?" and suddenly all the little bots are out there starting to make "grey goop" and we are just feed, and they start dissembling us to make, whatever it is, this "grey goop" because we can't turn them off. That could be one of the filters.

Hopefully, we have passed through the, "You invent nuclear weapons and you DON'T use them."

China, Russia, the States and the UK and France are probably safe.

India, Pakistan, not so sure?

Israel, if they have got them, again, not so sure?

So we … so hopefully we are past this but there could other filters along the way.

The rise of Artificial Intelligence.

Oh, my Robot Overlords, I praise you!

Simon Handford

The eccentric billionaire was going to ask you questions, I might walk back this way.

Mr Kevin Vinsen

Sorry, he has to give them the mic because I am deaf as a post, I have to wear hearing aids and I won't be able to hear a word you are saying.

Audience

Sorry mate.

I am not a billionaire, I am very sorry to disappoint you.

Mr Kevin Vinsen

Billionaire, millionaire?

Audience

Not at all!

Mr Kevin Vinsen

Damn!

Audience

I can buy you a beer!

Mr Kevin Vinsen

I 'm a celiac, damn! [laughing]

Audience

A question, I was told that there is a thing called RadioAstron which is like a radio telescope at Le Grange Point and it was launched some time ago and it makes a radio telescope of a massive aperture. Is it a thing?

Mr Kevin Vinsen

Radio … what you are talking about is what we call very long base-line interferometry. So, this is a technique that was invented in Australia in the 1940s by Joseph Pauley and [inaudible 42:49] and an Oxford Don whose name I forget. The downside the Oxford Don actually got the Nobel Prize and the two Aussies got forgotten. But, this was invented here, so what we do is we … one of the vagaries of physics is wavelength is a problem. So, aperture and the degree with the resolution we can see things is ratio over the diameter. You have got nanometres hitting your eye and the aperture of your iris in millimetres.

To get the same thing with a radio telescope which is 21 centimetres, we need a dish of 51 kilometres and we can't build that, so, what we do is maths tricks and this where data-intensive guys come in because we are good at the maths tricks and we sample the sky and for of all of you who saw the image of the Black Hole, that's how they did it.

They had telescopes all over the world, all sampling at exactly the same time, the same image.

The idea is to put one out on the Le Grange Point because then we don't have GPS going over us, we don't have cell phones, we don't have Wi-Fi, its clear space, we can see …

I mean, Elon Musk and his Starlink thing, is a terrible thing for radio astronomy because its … you know, we are looking for … I was told I am not allowed props, so we will do imagination.

Two feathers in my hand – I am going to drop them on the floor – flutter, flutter, flutter – [popping noise] well that was more energy than all the radio telescopes on the planet had recorded before 2014.

We don't want satellites up there because it is like them shouting at us and deafening us and we just have to switch off when they are going past, because it is just noise, we can't see it.

So, yes, the idea is to put one out there and point out …. It was proposed by the Russians but SKA … it is now thought the main threat is gone.

Fifteen countries involved because no one government is brave enough to put all the money on the table. It's over a billion dollars, so everybody puts … chips some money in and then we have a huge telescope to do this type of thing, but yes, the best place would be the far side of the moon. It is not the dark side like Pink Floyd said, it's the "far side" because it does get sunrise and if you actually

watch, you see a plasma form and the dust rise because the gravity is so low there. It is really quite weird to see. If you look carefully at some of the videos you can see that happening.

Any other questions?

Well not so much intelligent questions but more like smart ar*e comments.

So, as we only got half of the SKA and now called the HSKA [laughing] it became a battle.

Originally four countries pitched for it, China … well, guys, you are the wrong side of the equator to see the [inaudible 46:10] or you need to be in the southern hemisphere.

Argentina, well you actually a bit on the narrow side, we need long east-west lines.

South Africa and Australia.

So it dwindled down to South Africa v Australia and that was the pitch.

Both countries made their pitch and we actually lost. 50.1 to 49.9 – it was that close so they couldn't really call it.

Murchison is a great site for low frequency. So the low frequency came here.

The Karoo is actually slightly higher than us so that's a good place for mid-frequency, so build the mid-frequency there.

Curtin University are absolutely brilliant at doing low-frequency work. The MWA is the best low-frequency radio telescope on the planet.

The South Africans have built MeerKAT, I mean, that is a cute name for a telescope, isn't it, MeerKAT. Everybody has seen Meerkat things, they all look in the sky, well they not looking at stars they are looking for Eagles that come to eat them but they are still Meerkats being cute, looking at the sky.

We had the name ASKAP which is really quite dull but it is now online and it is doing its first set of work for us. [overtalk] It is all part of SKA.

Audience

Isn't it now a half kilometre or you have two x one square kilometre each?

Mr Kevin Vinsen

I will be the total collecting are which will still be a square kilometre when we finally finish it which is why I am looking for that eccentric billionaire because this is not a cheap toy!

Audience

The other thing in the kind of stuff I have read over the years, we had a hundred to two hundred billion stars and a hundred to two hundred billion galaxies, so now we are going up to two to four hundred and two or three trillion, is this just inflation or, or …

Mr Kevin Vinsen

No! It's because we are damn good at what we do. We invent better instruments and we say, "ooh, what's that?"

Audience

So, this is the current recognised figures, is what you are saying … gee I am right up to date on that now, I can impress all my friends.

Mr Kevin Vinsen

You know, Gaia is the latest ESA mission that is up there counting stars.

Hubble has been up doing some amazing work, we will see James Webb coming up soon.

But, every time we get a new instrument, we find things that … we go, "Oh, what's that?"

[overtalk]

Is that what I really think, "Good Lord, look, there's even more of them!" "Oh well, right, scrunch, scrunch, scrunch, throw that one out, a new piece of paper!"

Audience

So, if you are 200 million, 200 billion and whatever ….

Mr Kevin Vinsen

Two trillion galaxies, 200 – 400 million stars …

Audience

So, you are out of date, if you don't know those new figures yet and just finally, I think as humans we have a perception based on our environment, of course, which limits our thinking and anything more than a few million we start to get bamboozled by the numbers that don't make any sense to us. But you see, the chances of winning the national lottery are a few hundred million to one …

Mr Kevin Vinsen

No, I mean [overtalk] Oz Lotto is 1 in 45 million …

Audience

But someone actually wins it ….

Mr Kevin Vinsen

Oh yes!

Audience

Which is something we mustn't forget?

Mr Kevin Vinsen

Oh yeah!

Audience

There is actually a winner?

Mr Kevin Vinsen

But equally if you cancel out the odds of when the next asteroid is going to come, yes, it's going to happen but it's not going to be … you know the chances are, you are going to be not the winner, most of the time and then, in that case, we want to be not the winner. We don't want that asteroid coming here.

Simon Handford

Question just down here.

Audience

Thank you for the talk, in 2017, there was an international consortium in California on the Origin of Life Anthropology Research. The question earlier about, you know … and you answered that we could be the first, so there-in a very negative – pessimistic context, they were like, "Look, we are the most thorium rich, potassium-rich planet that the whole anthropic principle as you know about … some people call it the "fine-tuning" arguments, the Goldilocks stuff you were talking about earlier, so if it takes as you know, the [inaudible 50:17] on paradox, it takes us three billion years up until you have the Homosapien species, sentient life forms that can then send radio signals, is it possible then that you can look at a sort of, clone of our solar system or local part of our galaxy, somewhere out there in the past, so to speak? As you know it takes time [inaudible 50:45] of four-plus billion years of the periodic table.

Mr Kevin Vinsen

One of the exciting things about the new telescope is, that we are so much more sensitive because, tyranny of distance, any signal is Inverse Square Law so 1 over R-squared. The further away you get, you are squaring it. So, a metre away is 1, two meters away it's 4, three meters away it's 9, 5 meters away it's 16. So, it falls off rapidly. We might be able to see but we are always looking into the past with the telescope.

We look at Andromeda tonight in the night sky, that's two and half million years ago. That light left there, we can only now see it. So, within our own solar system, we would only be looking back a hundred, one hundred and fifty thousand years, if we could see through all that dust and that's a problem but, again, radio telescopes can see through certain amount of that. It's also interesting because it emits infrared light and that gives us an idea of what's happening within the infrastructure of our galaxy but, it would be lovely to … distance is a killer and when I did the calculations for the signal I sent to Proxima Centauri, so this was using the New Norcia dish, using the same power they use to talk to the Mars Rover.

It would arrive at the other end at 10 x 34 watts per square metre. So that's "zero.thirty-four zeros and then a number". That's very, very, very faint.

And, that's always going to be one of our problems with listening and looking.

Now, we can look for absorption lines and say, "Well, hey, look there's oxygen." Oxygen naturally doesn't form like that, it is all these lovely plants causing photosynthesis that gives us that. We can see hydro-fluoro carbide, anything that is pollution, that would be a marker. We could see that but not by looking for it, but the fact that it has absorbed something and we see the missing bit.

Yes, it would be lovely to do that but the distance is such a problem.

Audience

So, basically, to use a kitchen analogy for everyone in the room, there hasn't been enough time for the "meal" to be fully cooked. We are like the first to come on the scene where now, the "meal" is ready, so to speak, from a periodic table of context then.

Mr Kevin Vinsen

Yes, well I mean, stars burn. They burn hydrogen and produce helium and once they start to get the older parts of their lives they start burning the helium to produce the carbon, the oxygen and the nitrogen which is sort of, kind of, useful because that's mostly what we are. H20, carbon, plenty of nitrogen in the atmosphere, we have got a bit of manganese, magnesium, a bit of calcium, all these extra bits and these just come out of stars blowing up.

Supernova builds the building blocks, so we have got to find the right conditions and like I said, we have only found twenty-one planets so far that were in the right type of zone where we should see rocky and could have liquid water but they may not have all the other elements that we have to make us what we are.

As they came up within this astrobiology thing, we don't know what makes life happen. We thought we did in 1953, "Hey look, take some sludge, zap it with electricity, that might do it," well we have been trying for another sixty-odd years since, to figure out what actually makes that last little connection and we still haven't done it yet. We don't know what makes life, life?

Somehow, all these organic molecules erase themselves into a sort of a little cell-like structure and then keep on doing that and then replicate and then pass other information on.

Anybody who is looking for a good PhD, there is a great topic.

Audience

Just one quick … So, are you familiar with the fossils on the moon augmentation and the astrobiology circle, to try and answer this original life question?

Mr Kevin Vinsen

Well, we don't know, because we haven't had a huge amount of rock come back from the Moon. Apollo 11-17 bought back a couple of kilos – tens of kilos of it and that's all.

There could be, we don't know.

Audience

That was the hypothesis.

Mr Kevin Vinsen

The useless scientific method is the hypothesis, is that it has not been tested, it's an idea but we have not tested it yet, we don't have a theory, like evolution, where have tested it again and again and again.

If any of you want Kevin's handy-dandy way of winning a Nobel Prize, prove Einstein wrong.

I will guarantee you a handshake from the King of Sweden and 8 million Corona because that one, if we could prove that, then, you know, faster than light travel, maybe? But we are limited by this equation, the square root of 1 over V squared over C squared.

Where V squared is your velocity and C squared is the speed of light.

Any number divided by zero is – Infinity!

So, as you get closer to the speed of light, you need more energy, your mass increases, you need more energy, your mass increases. So, ultimately you use all the energy of the Universe to get you as close to the speed of light as you can but you can never get there because you have used all the energy.

Simon Handford

I am tempted to wrap it up there on that note. [laughing] Seriously, are there any more questions before we thank Kevin for his talk this evening?

Oh, there is a question there, hang on.

Audience

Just following on from that, if I was the Treasurer of the Australian purse, would I be able to say you are wasting my money? [laughing]

Mr Kevin Vinsen

No! Because we had, we had … were audited by Price Waterhouse Coopers [thingia-bob doo-da and whatsit] a big accountancy firm came in and audited ICRAR because we are funded by the State Government and they made a rather interesting discovery which again won't work on the podcast but [blowing on my nails haah] we bring back into the economy five times what the Government spend on us.

[clapping]

So, no, I don't think so. We are giving a better return than Freo Football Club probably, who I am a supporter of but, I am originally from Norwich city in the UK and so I like lost causes, they are second from bottom in the premier league. No, we do that and other things that you have got out of us, how does one say this, a venerable lady, you have probably had an MRI or a CAT scan. All that imaging technology, it's amazing how they slice you through and use indirect imaging, well thank Joseph and Ruby for the maths, that was us.

Radio astronomers did that.

Anybody hooked into the Wi-Fi that's in here?

Australian invention CSIRO Radio Astronomy Group, that's us too!

So, we give back pretty well and of course all your internet speed going over to Europe is about to improve significantly with the new cables that are going in to feed data to Europe from the SKA.

Simon Handford

Okay, any final questions for Kevin?

Before we say thank you properly, I gather there is a gift from someone in the audience? I don't know whether this is a ….

Mr Kevin Vinsen

There is?

Simon Handford

There is!

Mr Kevin Vinsen

Hang on, I've been set up here cause this is … he sits beside me at work [laughing]

Simon Handford

Yes, I have all these [inaudible 59:14] before, Kevin.

On behalf of the audience, thank you very much for talk.

[clapping]

Very thought-provoking and as a remembrance of this day, one of my fellow Master's students from Swinburne who figures himself to be a bit of an artist has produced a little memory for you to keep.

Mr Kevin Vinsen

Thank you!

Are we alone in the Universe?

Thank you.

[clapping]

And that was me about thirty years ago when I actually had a decent amount of hair and was nowhere near as fat as I am now [laughing]

Simon Handford

Thank you Kevin and I would just like to finish by thanking all of you for coming out tonight to Raising the Bar and the University of Western Australia's event.

Mr Kevin Vinsen

One more thing, I forgot on my way through the talk, I borrow a lot of computers from a lot of people and a very tall gentleman over there, owns a supercomputer in Singapore that he lent me. Thank you, Andreas!

[clapping]

Simon Handford

I think that's it, thanks, folks.

Look out for Raising the Bar 2020.

Thank you.