Anyone Out There? PowerPoint

Suggested Script

PRESENTATION NOTES

This presentation can take from 30 minutes up to an hour,
depending on how many *Optional Presentation Activities* are included.
Recommended for 7th grade to adult. (Use more activities with younger audiences)

Slide 1: **Opening Slide**
Show while the audience enters and during introductions.

Shown: Illustration of what we think the Milky Way galaxy looks like. Of course, we can't see it from this angle because we are within it.
The Sun is located just below the "D" in Drake in the last line.
Illustration Credit: R. Hurt (SSC), JPL-Caltech, NASA

Slide 2: **The Big Question**
To Say: From the earliest time, the night sky has evoked awe and contemplation about our origins.

Where do we come from? Are we alone?

Only in the last half a century is has science weighed in on the topic.
The science of Astrobiology is actually a combination of astronomy, biology, geology, meteorology, and many more disciplines.

Slide 3: **Frank Drake**
To Say: One of the founders of the science of Astrobiology is Frank Drake.

Drake began searching the skies with radio telescopes in 1960, before the idea of life elsewhere in the universe was considered a serious scientific pursuit.

The next year, he was preparing for a small meeting of about a dozen other scientists interested in the search for extraterrestrial intelligence. In putting together the agenda, he came up with seven factors that he thought would be relevant to determining the number of other intelligent civilizations in our Milky Way galaxy.

From this, we got the Drake Equation, really more of a thought experiment
Image credit: BBC.co.uk

Slide 4: **The Big Question**
To Say: The Drake Equation (shown here on the bottom of the slide) doesn't have any right answer that we know, it is simply a look at all of the factors we need to consider when speculating about the existence of intelligent ET.

We'll have to make many guesses to evaluate odds of finding ETs in our huge Galaxy
Don't worry about all of the letters! And those dots just mean we're going to multiply them all together.

N is what we're looking for. It's the number of civilizations in our galaxy right now that are able to communicate over interstellar distances. That's what we're going to estimate. We are thinking about whether there are any aliens out there to communicate with.

Let me give you an example of what we're going to do, but using one of my favorite foods.

Slide 5: **Stars in the Milky Way**
To Say:
You're in New York City. It's 10am on Sunday morning and I am craving a Hawaiian pizza with anchovies. Out of all of the restaurants in New York, you're looking for a restaurant that serves pizza. You find a lot!
Now you're looking for one that's open Sundays **<click>**
And that's open early **<click>**
And of course one that delivers **<click>**
Ahh, but do they deliver to your neighborhood? **<click>**
Now you want to make sure they serves pizza with anchovies…
So little by little you narrow down your search.
It's possible that a restaurant that will deliver pizza to your neighborhood at that hour with anchovies,
but then again **<click>** maybe not.
We're going to do the same thing but this time we're looking for aliens, not pizzas.

Slide 6: **N* Number of Stars in the Milky Way Galaxy**
To Say:
Let's take a look at the first factor, how many stars are in our Milky Way Galaxy. We know that there are hundreds of billions of stars in our galaxy.

Optional Activity:
Anyone Out There? Cards

To Do: If you are using the Anyone Out There? Activity, this is where you bring out the Presenter's Cue card and show the side with the 400 billion.

To Say: Let's see if we can work together to make an estimate. I'll get us started with the first factor, N* (*pronounced N star*). I will give us a generous estimate of 400 billion stars in the Milky Way. And now it's your turn. As we think about these factors, I'd like the whole group to help come up with an estimate. We will go through these together.

To Do: Split the audience into 6 groups then pass out the 6 cards. Give the groups a few moments before moving on with the presentation.

Image is an artist's impression of a star with many planets.
Image credit: NASA/Tim Pyle

Slide 7: **What Fraction of Stars Have at Least One Planet?**
So we start with all of the stars in our galaxy. But we're not going to find life on stars. For life, we need planets.

Studies of exoplanets (planets around other stars) are rapidly discovering how many stars have planets. The Kepler mission has expanded our exoplanet count considerably. The artist's conception of the Kepler Mission is seen bottom right. Future surveys promise to refine this estimate further.

Optional Activity:
Anyone Out There? Cards

To Say: So, I guessed 400 billion stars. Next, let's hear from Group #1. You are looking at the fp ("f sub p") factor. What is your estimate for the fraction of stars that have at least one planet around them? Don't worry; you can't get it wrong!

To Do: Follow the instructions on the Presenter's Cue Card to cross of the appropriate numbers for their guess.

Slide 7 Continued

Background image is an artist's impression of a star with many planets.
Image credit: NASA/Tim Pyle
Artist concept of Kepler in space. Credit: NASA/JPL

Get the most up-to-date PowerPoint presentations about Kepler here:
http://kepler.nasa.gov/education/PowerpointFile/

***Slide 8:* How Many of These Worlds Have the "Right" Environment?**
To Say: But we're not just looking at any planets. We want a planet with the right environment for life. We call these "habitable planets." How many habitable planets do you think are around each of these stars with planets? Let's talk about what we mean by habitable.

Big gas giants are too violent, with no surface to speak of. Life that we could recognize would most likely develop on a small rocky world, like Earth, Mars, or Venus.

Also needs some heat source- What's Earth's heat source? (Sun!)
Right, we're in the Habitable Zone, or Goldilocks Zone- not too hot like the planet Mercury and not too cold like the dwarf planet Pluto

Mars is also in the Sun's habitable zone as well, but it lacks much of an atmosphere, so can't keep warm. We think it used to be much warmer and may have once had liquid water. What scientists are actually looking for are planets that might have…

Optional Activity:
Life in the Extreme (do this activity before clicking to the next slide)

Slide 9: **Liquid Water**
To Say: Liquid water! Let me explain.

Earth is the only place we know of that has life. To get some clues to what alien life might need to survive, scientists are studying organisms that survive in extreme environments right here on Earth to see all of the amazing ways life has adapted on our planet. There are organisms that can live without sunlight or oxygen. Others live under intense pressures or can survive in the vacuum of space. The possibilities seem endless. But the one thing that they all have in common is that they all need liquid water to survive, grow and reproduce.

It has some amazing properties, such as being able to coexist as a solid, liquid, and vapor, as in this picture.
It is also a common ingredient found throughout the galaxy, which is a good thing, if we're looking for planets with water.

Background:
Chemicals on Earth are common throughout the galaxy, so water is probably common on any planet that is warm enough to support it.

Slide 10: **Our Solar System**
To Say: Right here in our own Solar System, there are 6 worlds with some possibility of water: Earth, which we know is covered in water and also Mars may have had water in the past. There are also moons around gas giants that may have oceans of liquid water beneath their icy surfaces. Europa and Ganymede around Jupiter, Titan and Enceladus (shown here) around Saturn. Does that potentially make them habitable?
So the next factor asks: What's the average number of "habitable" worlds around a star with planets? This narrows down our search further. Now let's take a look at those worlds that have the right environment to support life.

Optional Activities:
Anyone Out There? Cards
If you are doing the activity, ask for group #2's guess and follow the directions on the Presenter's Cue Card.
Keys to the Rainbow Activity:
If you would like to show how scientists learn about planets around other stars using spectra, you can insert the slides 18-22 here or cover them at the end if there are questions.

Background:
This moon of Saturn (Enceladus) is spewing water from cracks in its surface. Scientists would like to know why!
Credit: NASA/JPL/SSI; Mosaic: Emily Lakdawalla

Slide 11: **f_ℓ How Many Habitable Planets Develop Any Life Forms?**
To Say: The next question is how many of those planets with hospitable environments actually go on to develop life of any kind, even basic single-celled organisms. We'll start with what we know: How many planets do we know of where life has developed? (Audience says 1)
<click>
Just one. Earth.
For this and many of the other factors we have only a SINGLE data point: our Earth
This makes it almost impossible to be accurate in our estimates, but guessing can be instructional too.

To Do:
Here you can bring out the Earth Timeline or illustrate some of the main points on the scale of your own body, facing the audience, as illustrated here.

To Say:
I'm going to make a simple timeline of life on Earth. The Earth formed with the rest of our Solar System 4 and a half billion years ago.
If the Earth formed at this (your right) fingertip, and this fingertip here (your left) is today, when do you guess life developed on Earth? *(Let them guess.*)

Just as soon as the Earth stopped getting bombarded by space rocks and the oceans formed, we have evidence for life, somewhere here in my first forearm. So life has been around for most of Earth's history. We don't know how life begins. That's one of the joys of science- we always have new questions to answer. But does knowing that life began so early in Earth's history gives us any clue about how easy it might be for life to begin given the right conditions? Or was it unique? That's what this factor looks at.

Okay, how many of you would be excited if we found some version of algae on another planet?
Well, it might not be as exciting as alien civilizations.
But how many planets do we think develop any kinds of life at all? (let audience guess)

Okay, now let's narrow down our search to aliens we might be able to talk to.

Optional Activity:
Anyone Out There? Cards
If you are doing the activity, ask for group #3's guess. The back of the Presenter's Card shows how many zeros to cross off for any answer.

Algae Photo by Jay Janner/Austin American-Statesman

***Slide 12:* f_i How Often Does Simple Life Become Intelligent?**

To Say: The next factor looks at the likelihood that intelligent life will eventually form on a planet with simple life.
We each have our own definition of intelligence.
Dolphins certainly display complex thinking skills. And even crows seem to be capable of emotional intelligence.
Will these species ever look out into space and wonder about civilizations on other worlds?

To Do: Continue the timeline model as follows

To Say: Back to that timeline from before. All of the animals that we can imagine, even jellyfish and dinosaurs, developed here on the most recent hand, mostly in the last half a billion years. So there were simple organisms for most of the history of Earth, but complex organisms are a recent development.
Even more interesting, the entire history of humanity on Earth could be erased if I simply filed off the end of this nail. (Pretend to file a nail on your left hand.)

What does that tell us about this factor and how often intelligence arises?

Optional Activity:
Anyone Out There? Cards
If you are doing the activity, ask for group #4's guess. The back of the Presenter's Card shows how many zeros to cross off for any answer.

Photo credit: from the IMAX® film Jane Goodall's Wild Chimpanzees/Courtesy Science Museum of Minnesota

***Slide 13:* f_c How Many Intelligent Civilizations Communicate?**

To Say: But even if they're smart, can they talk to us?
Humans have actively sent out a handful of messages into space. It's expensive and we aren't sure where to direct our message. We are currently mostly listening.
(Our TV signals and such are too weak to show up as anything but noise across interstellar distances.)
Even if they have the technology, is it possible that alien civilizations might decide not to communicate? We don't know the answer to this and can only guess.

Optional Activity:
Anyone Out There? Cards
If you are doing the activity, ask for group #5's guess. The back of the Presenter's Card shows how many zeros to cross off for any answer.

Slide 13 Continued

Images:
Radio telescope RT-70 in the Ukraine that has sent a handful of interstellar messages
Top right: Aricebo message, written by Frank Drake and others, was broadcast only once in 1974. It was directed at globular cluster M13, which is 25,000 light years away.

Slide 14: **L Average Lifetime of a Communicating Civilization**
To Say: The last factor is perhaps our most difficult prediction.
Our technical civilization was just born. Will we be able to survive the many dangers that other species have encountered?
What are some ways that our species might not survive? Some of them are shown here.
Asteroid impact, droughts, natural disasters, wars (plus climate change, famine, pandemics, artificial intelligence, overpopulation…)
Some philosophers think that if a civilization becomes advanced enough, it could in theory continue forever. We don't know. Not only are we the only communicating civilization we know of, life on Earth is uncertain.

L is the average lifetime of a communicating civilization.
The Tg factor is the age of our galaxy but this is fairly well established at around 9 billion years
(for the bulk of the Milky Way).

Optional Activity:
Anyone Out There? Cards
If you are doing the activity, ask for group #6s guess. *** This guess has two numbers, lifetime and the fraction of the lifetime of the galaxy. Let them give you both answers but record the second one. The back of the Presenter's Card shows how many zeros to cross off for any answer.

Slide 15: **Range of Estimates**
To Say: So where does this leave us? Because almost all factors are wild speculations, the predicted number of civilizations in the Milky Way varies wildly.
We could be alone, or there may be an intelligent civilization fairly near us.
Again, these numbers are based on many estimates and so don't actually tell us the number of civilizations. But they do make us think.

Anyone Out There Activity:
If you have been making your own predictions with the activity, here is where you can compare your answers to these scenarios.

Slide 15 Continued

(If this number is 1 or less) ***To Say:*** You predict that we are alone in our galaxy! That would make us very special indeed. Unfortunately, the closest big galaxy is Andromeda and any signals we might receive from them would be 2 million years old. Plus, we would have no way to send back such a strong signal.

(If the number is less than 10)
To Say: With this few civilizations in our Milky Way, we will be very lucky indeed to find them. Right now, most of the planets we are monitoring are in our corner of the Milky Way.
To Do:
Draw a circle of about 1" radius around the Sun in the picture.
To Say:
It's unlikely that any of these few civilizations will be in there. Here's hoping they contact us first.

(If the number is greater than 10)
To Say: Wow, IF it turns out there really are that many intelligent civilizations in our galaxy, we can hope to hear from at least one of them. We may even detect their presence in sky surveys that are looking for planets around nearby stars.

Slide 16: In the Meantime
To Say:
So, we haven't detected any extraterrestrials yet, but we are looking, and listening.
It's important to note that we haven't found any credible evidence for life elsewhere.

There are serious scientific studies being conducted about the possibility of life beyond Earth. The NASA Astrobiology Institute is a group of researchers with a mission to study the origin, evolution, distribution, and future of life on Earth and in the Universe.
The SETI Institute is listening for signs of extraterrestrial life. (SETI stands for the "search for extraterrestrial intelligence")
Their SETI at Home project (top) lets anyone help with the effort from their home computer. If you're interestede, you can help the search!
NASA's Kepler mission (shown here) observes distant stars in search of Earth-sized planets.

Optional Activity:
How Do We Find Planets?
Show two of the ways that we are searching for planets around other stars

Optional video:
See how Kepler is looking for Habitable planets:
http://www.nasa.gov/mp4/315503main_ARC-KeplerOverview.mp4

Slide 17: Future Explorations
To Say:
It is possible that we are alone in our galaxy.
But if we are not, we very well may be able to detect alien life in the not-too-distant future. Our instruments are becoming more advanced and we are actively exploring the possibility of other life in our own Solar System.
How might it change humanity to discover another life form beyond Earth? What about another communicating civilization?

Photo of Allen Telescope Array (ATA) antennas (Dave Deboer)
The ATA is a "Large Number of Small Dishes" array designed to be highly effective for SETI (search for extraterrestrial intelligence) observations at radio wavelengths.

Slide 18: **Optional Slides for Keys to the Rainbow Activity**
To Say:
So, how do we search for planets around other stars that may harbor life? Even through our very biggest telescopes, all we see from a star is a point of light. The stars are so far away, we can't measure how wide one is or even see that they're round. And for the most part, we can’t see the tiny planets orbiting them.

But there’s a secret hidden in that starlight. Let me share it with you.
Have you ever seen what happens to white light when it goes through a prism? (rainbows)
<click>
Right! It makes a rainbow. When we send starlight through a similar process, we see a rainbow of colors.
<click>
Here’s an example of starlight spread out. What do you notice?
(There are lines)
Right, there are gaps in the spectrum. Those lines give us valuable information about the star. Let me show you.

Slide 19: **Star**
To Say:
Here is a simplified version of what we might see from a star.
Those lines happen because the white light coming from the star must first pass through the star's atmosphere. That's right, stars have atmosphere too! The ingredients in a star's atmosphere block very narrow areas of color in the rainbow. Each ingredient has its own unique set of lines. This tells us what's in the atmosphere of the star. So these lines represent a combination of many ingredients together.
Let’s see if we can figure out what’s in this star’s atmosphere.

Slide 20: **Star Ingredients**
To Say:
Here is the element Helium. Does it look like Helium is in the Star's atmosphere? Do its lines match the star's lines?
Let's see. **<click>**
Yes! It sure does. That means there's helium in the star's atmosphere! We've got part of the puzzle. But there's more too.
Let's see what else is in the star's atmosphere.
I'll cover up the Helium since those lines have been figured out. **<click>**
Now what about Oxygen? **<click>**
Do Oxygen's lines fit? (no)
Right. So that means the star's atmosphere doesn't have oxygen in it. Let's try again.
<click>
How about Hydrogen? Do the hydrogen lines fit? (Yes!) **<click>**
Great! So the star has hydrogen and helium in its atmosphere.
You all are ready for a more advanced mission.

Slide 21: **Planet A**
To Say:
Sometimes, a planet will pass in front of the star we're observing, dimming the light a little, as seen here.
<click>
If we spread out that light as the planet passes in front of it, we find something very interesting. The starlight also passes through the atmosphere of the planet, giving us valuable information. So, in this star, let's remove the lines from hydrogen and helium we already found and see what else is in the rainbow now.
<click>
Well, not much. Let's see if you all can figure out what is found in this planet's atmosphere.
<click>
We've put three components up here, so we can compare them all at once.
Is it Oxygen? (no)
How about Carbon Dioxide? (yes!)
And is there any water? (no)

Good job. This planet has a carbon dioxide atmosphere, something like Venus in our own Solar System. Unfortunately, we're looking for planets with environments that may contain life. That is, we want a planet with water in its atmosphere. Let's try again.

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Transit image of planet WASP-10b as it crosses the disk of its star. The brightness of the star decreases, allowing scientists to measure the precise size of the planet. Credit: Institute for Astronomy, University of Hawaii at Manoa

Slide 22: **Planet B**
To Say:
How about this planet? What ingredients does it have in its atmosphere? Which of the lines match?
(oxygen, water!)
Right! Now if we saw these lines as a planet passed in front of a star, it might be a good place to study further. Finding water in the atmosphere is very exciting. Gases like oxygen, ozone, and methane would be promising as well. These gasses disappear out of an atmosphere quickly unless something is constantly producing them.

And that's how we take the light from stars and learn about the atmospheres of planets.

Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov