Civilizations we'll never know

There are an estimated seventy sextillion stars. That is seventy thousand million million million or 70,000,000,000,000,000,000,000 stars. That would be more than one star for each of the grains of sand on all the Earth's beaches.

The first generation of stars would most likely have formed in the absence of elements other than hydrogen. These first stars would have created helium from the fusion of hydrogen nuclei. It is the fusion of hydrogen nuclei to create helium nuclei which is the source of most energy released by stars. That energy keeps stars very hot. Most people are familiar with three states of matter: solid, liquid and gas. There is a fourth state in which electrons are in such a high energy state that they do not organize around nuclei to form the familiar atoms of solids, liquids or gases. This fourth state is called plasma and does not generally occur on Earth except briefly along the paths of the huge electrical discharges associated with thunderstorms. In contrast, stars like the sun are composed of plasma. Stars are much too hot for matter to exist in the solid, liquid, or gaseous states.

As the first generation of stars aged they would have created other heavier elements through fusion such as beryllium nuclei from helium nuclei. Some of the beryllium nuclei would have been bombarded by more helium nuclei creating carbon. Some of those carbon nuclei were in turn bombarded by even more helium nuclei. The result of the fusion of carbon nuclei and helium nuclei is oxygen nuclei. As these heavier nuclei collected in a star they would have been increasingly bombarded by other heavy nuclei – resulting in even heavier nuclei. As this process continued in a first generation star its thermonuclear core would became choked with heavier elements. Some really massive stars collapse into "black holes" when the energy pushing out is no longer great enough to overcome the gravity pushing inward. Other smaller stars explode creating a super nova. This disperses the heavy elements across space. Thus it may be generally assumed that all the heavier elements needed to form rocky planets were created deep within stars that died long ago.

Then there are the second or subsequent generations of stars such as our sun. First an eddy forms in giant clouds of gas and dust. As it condenses under the influence of gravity it spins in accordance with the laws of conservation of angular momentum. The outcome is frequently a new star with a ring. That ring may also have disturbances which condense into planets. There are different estimates regarding the percentage of those stars that are orbited by planets similar to the Earth. However, we do know that some stars other than the sun have orbiting planets.

There is an equation named for Dr. Frank Drake which basically takes that very large number of stars and begins dividing by factors which represent the likelihood of planets. Further divisions are done with factors representing the likelihood that those planets would be of such a size and distance from their stars that water would exist on their surfaces as a liquid. The object of this mathematical exercise is to make a guess as to how many other planets might sustain life as we know it. The interesting thing is that because the initial number is so large, one can make very pessimistic assumptions about the percentages having the various characteristics required to sustain life as we know it yet still arrive at a surprisingly large number of Earth-like planets.

Earth-like planets would need sufficient mass so that gravity would retain an atmosphere. That atmosphere would in turn prevent water from boiling away at the surface. We would also need to presume a hot core to sustain plate tectonics. Without that then there would be none of the wrinkles in the crust which form our familiar continents. A planet completely covered in water would surely be beautiful. But also likely inhospitable to life as we know it. Once everything settled out to the ocean bottom then there would be little to sustain life in the bright upper levels of the water column.

If one starts with an Earth-like planet then life and evolution are almost certain to follow a pattern such as is seen here. Self-copying replicators would get better and better at copying themselves within pools of primordial soup. Some of these replicators would wall themselves off with a membrane – resulting in the first bacteria and primitive algae. Some of these bacteria and primitive algae would join in symbiotic relationships – the first eukaryotic cells. Some of these eukaryotic cells would gain advantage by banding together – the first colonial life on our new Earth-like planet. Natural selection would continue according to the familiar pattern. Colonial animals would give rise to marine worms and creatures like sea cucumbers. Soon mollusk-like creatures and fish-like creatures would arise. Eventually something like mudskippers would venture out of the water and the familiar pattern would continue. This pattern would slowly but inexorably continue until it resulted in something like a primate. One of these primates would eventually gain advantage through a large brain capable of copying behavior and language.

Yes, there are people on other planets!

Too bad we'll never hear from any of them.

Many people believe space travel as portrayed in science fiction will be science fact someday. Speed limits imposed by the immutable laws of physics say otherwise.

Science fiction frequently portrays interstellar space travel as a casual undertaking. This is unlikely. For example NCC 1701 and other space vehicles have this unexplained ability to accelerate without losing mass. This would imply some mechanism by which the spacecraft could grasp the fabric of what ever it is that space is and pull itself along. No such characteristic of space has been observed. Physics would seem to limit us to Newton's third law of motion as a way of moving through space. In order to accelerate a spacecraft one must accelerate something else in the opposite direction – usually the combustion products of a rocket engine. The spaceship would need to carry huge fuel reserves because an equal amount of deceleration would be needed at the far end of the journey to avoid traveling past the destination – or crashing into it.

There is also another problem. According to Einstein's Theory of Relativity there is a speed limit. As one accelerates an object to near the speed of light the mass of the object is increased. Accelerating the object to the speed of light would theoretically increase its mass to infinity. This is apparently okay for light which seems to have no mass, but accelerating an object that last little bit to the speed of light would require infinite energy to push the object to infinite mass. Thus the kind of space travel portrayed in science fiction is highly unlikely. If interstellar space travel did occur then it would most likely involve multi-generation spacecraft and unimaginably huge investments to equip them.

Other people place a great deal of faith in the Search for Extra Terrestrial Intelligence – SETI. But we'll never hear from any extra terrestrial intelligence for exactly the same reasons no extra terrestrial intelligence will ever hear from us.

Popular culture says alien cultures on distant planets will soon be tuning in to watch "I Love Lucy" and "Gilligan's Island." The immutable laws of physics again say no.

First of all Gilligan and his pals were transmitted at not more than a few thousand watts. Radio waves spread out as they travel. This means that when one measures the power per square meter, there is a marked drop-off the further one ventures from the source. In fact, the power drops off in proportion to the inverse square of the distance. Gilligan's signal would be indistinguishable from the background noise well before it reached the nearest star – Proxima Centauri at a mere 4.2421 light years away.

There is another problem with the idea that "I Love Lucy" or "Gilligan's Island" will be our greeting to the universe. It is obvious that the sun generates a tremendous quantity of light and heat. We can see and feel those emissions directly. What is less obvious is that our sun generates a tremendous amount of power across the entire electromagnetic spectrum. This would be a problem even with a highly directional antenna. Let's do some math. The most favorable position for the receiver would be when the Sun and Earth appeared the greatest distance apart. That would make one side of the triangle roughly 93,000,000 miles long. Ninety-three million miles seems like enough separation so that one could aim an antenna at either one or the other - until one considers another side of the triangle. Let's assume an alien listener is on a planet circling Proxima Centauri. That side of the triangle is 23,462,784,000,000 miles long! With the ideal angle of nearly ninety degrees between these two sides then the apparent angle between the Sun and Earth when viewed from Proxima Centauri is a mere 0.00023 degrees. The angle would be even smaller from a more distant planet.

If you have ever lain awake at night concerned about the first impression which space aliens might get from "I Love Lucy" or "Gilligan's Island" then you may put your fears to rest. The noisy roar of our Sun is protecting you from any possible embarrassment.

And yes, we did place those plaques on each of the two Pioneer space probes. We also placed a sort of primitive time capsule on each of two Voyager space probes. If any of these four space probes were to make it out of the Oort Cloud and into another star system then the most likely result is burning up as the probe falls into a star. The odds of this happening are vanishingly small. If – against even greater odds – one of the probes encountered an Earth-like planet, then the probe would burn up in the Earth-like atmosphere. If that planet had a civilization then that civilization would require the collective wherewithal to first detect the approaching space probe and then reach out and grab it before the probe crashed into something. The probability of that happening is essentially zero – for reasons which will soon become very clear.

So just what would it take to signal our presence to another civilization? Or for another civilization to signal us?

The short answer is "quite a bit."

The first thing is to find a means of signaling which could not be mistaken for a natural emission. This simple requirement rules out much of the electromagnetic spectrum plus most periodic types of modulation. However there is one kind of light which would stand out from all the background light and noise. That kind of light is "coherent" light. Regular light is not coherent. Think of the waves on a choppy ocean. Waves are moving in multiple directions and there are longer period waves mixed in with shorter period waves. Now imagine organizing all those waves into perfectly parallel waves with exactly the same spacing and shape from one smooth wave to the next. The equivalent version of light is found in a laser.

There is another advantage to laser light. The collimated beam does not spread and dissipate as quickly as ordinary light.

If you are thinking of a giant laser pointer then you're on the right track. But it would need to be of unprecedented scale. Imagine covering the entire moon with solar collectors which could efficiently convert much of the solar radiation striking the moon to power a giant coherent laser. Even then the problem is massive. To begin to comprehend the problem, consider that you have a laser pointer and need to aim it carefully at every location in the sky. How long would it take to "paint" the entire sky? How long should you signal the same area? How long before you could signal the same area again?

Let us assume for a moment that there is a civilization out there which is watching for our signal all the time. They have a sophisticated array to monitor the entire sky except that portion obscured by the star around which their planet orbits. If they detected a blip of laser light then they would want to see it again to be sure it was not anomalous or caused by faulty equipment. So you would most likely want to signal the same area again allowing time for additional equipment to focus on a suddenly fascinating point in their sky.

But one can't devote too much time to "painting" one part of the sky over and over. Otherwise it might be centuries before one could get back to that same sector of the sky. So you send pulses from the laser to represent a few prime numbers - constantly moving the laser over a section of sky so that it might be seen several times over several Earth days. Then you move on and the now silent point in the alien's sky leaves them feeling lonelier than ever.

Of course, if one is serious about this signaling it would require more than just converting the moon to a giant signaling device. The ultimate goal would be a laser signal so strong that it could potentially be detected by an unaided eye on a distant planet. This would greatly improve the chances of our signaling being received. Consider that in human history we did not become aware of radio until after 1890. That represents but a tiny fraction of the time which we have been around gazing at the nighttime sky. Technological advancement accelerates exponentially. Not so our ethical advancements. Mankind would drop his first nuclear bombs on himself less than fifty-five years after the discovery of radio.

If we want our signal to be received then we must signal often or signal very brightly. Otherwise a civilization is likely to achieve the technological advancements required to receive and amplify weak signals and then self-destruct in the interval of time between our signals to them.

Coherently signaling our presence would obviously be no small undertaking. The engineering marvel would make things like the Great Wall of China or the

Great Pyramids of Giza insignificant in comparison. The people who created the Great Wall and the Pyramids devoted a significant portion of their resources to those projects – and did so as a sustained effort over decades. In order to coherently signal our presence a similar effort would be required, but on a vastly larger scale. We would need to divert all the resources currently arrayed against ourselves as various institutions of greed and religion compete for power. In reality, we cannot even cooperate enough to track so-called "Near Earth Objects" which might collide with our planet. These Near Earth Objects could pose a serious threat to our civilization. But we are not watching. Only a relative few of the very largest objects are tracked. Consequently, if some other civilization sent a probe in our direction millennia ago with a plaque attached then we would not detect it. And because we did not detect it before it burned up in our atmosphere we did not reach out and retrieve it. It is ironic to consider that another civilization may have launched a probe like ours – with its own little metallic greeting card. And that against all probability it passed near enough for Earth's gravity to be captured by it. It may have left a bright streak as it met its fiery end in our atmosphere. Noticed only by a few people who – in accordance with superstition – made a wish upon it.

To begin to comprehend the enormity of the engineering required, let's examine a much more modest undertaking. The United State's National Aeronautics and Space Administration (NASA) recently launched a special satellite named Kepler. Kepler will not orbit the Earth. It will orbit the sun – following the Earth at a discreet distance so as to avoid interference from our other activities. Kepler's purpose is to carefully watch roughly 100,000 stars for telltale signs of Earth-like planets. This is a tiny sampling of the estimated 70 sextillion stars which it could watch. In this case "tiny sampling" means something like .000000000000000014% of available stars. This sampling is meant to give scientists a better guess as to one of the factors in the Drake equation. The project is designed to watch for three and a half years and cost $600,000,000. This should begin to give some scale to the enormity of the task of simply watching the entire sky – a far less ambitious undertaking than signaling to the entire sky.

All the squabbling amongst ourselves over religion and resources guarantees that we will not cooperate to watch the entire sky, much less cooperate on the enormous project which would be required to signal our presence to others. Each year we manage to improve on the number and efficiency of the means by which we will destroy ourselves. At the same time religion makes us collectively more stupid with each generation. This same pattern will assert itself on every other Earth-like planet.

People on other planets are busy destroying themselves. Or have already done so. Which means there will be nothing for SETI to detect. So too, no reason for the inhabitants of other worlds to bother listening for us. If you don't like this conclusion then prove me wrong. Give up your religion and your greed and demand that your "leaders" do the same. And don't forget to start saving up your share of the down payment on that giant laser pointer.