Drifters

by R Brent Smith

On closer inspection it is clear that this relic of a past apex civilization has been in space a long, long time. Its stained metallic surface is dented and perforated in a million places. Like a too thin tin roof in a hail storm, it has been bashed and penetrated by fast moving space rocks as it floated in space for untold eons. What used to be windows on the front of the craft are now gaping holes leading inside to utter darkness. Here sits an actual alien spacecraft; the first solid evidence that someone else has reached a stage where they can explore the universe. For days, as the craft is carefully positioned into its docking location, the engineers and scientists of the spaceport crowd at the few available windows to take in this historic spectacle. On Earth, media outlets provide a twenty-four-seven video feed of the space relic, illuminated by flood lights, doing nothing, just sitting in its dock. But that very stillness stirs the imagination. The very presence of this relic from an unfathomable distance into the past conjures thoughts that have never really been examined by most. The world is captivated. Like staring into a camp fire, people cannot look away. This relic fundamentally shifts the ground upon which all of our beliefs are based. It confirms that there can be, indeed there have been, alien worlds with technologically advanced civilizations. Who were these ancient beings? What did they look like? What has become of them? Are they still out there, perhaps watching us? What knowledge did they possess about the universe, of life, of death, of God? After so much speculation, this relic finally confirms that we are not alone, not so unique and not so special.

The above was the first paragraph to a lengthy story I wrote about finding alien relics. The story didn't work but I liked the idea behind it. So I turned the idea into the speculative science piece below.

The following is a fanciful thought experiment about finding evidence of alien civilizations. Please bear with me as I bring the various elements of this idea together.

Our civilization produces a lot of garbage. That garbage spreads out and accumulates in strange places. The most isolated desert islands have our plastic garbage washing up on their shores. In the Pacific Ocean we have garbage accumulating in large patches (The Great Pacific Garbage Patch). Ocean currents pick up garbage floating out to sea and direct it into locations where the ocean currents create gyres, trapping the garbage. The Great Pacific Garbage Patch is huge, 1.6 million square kilometers, containing over 80,000 tons of trash. In the geologic record, our civilization will be marked by a layer containing the residue of our trash.

We don't just leave our garbage on the land and in the sea. The space around our planet is filling with our space junk. As of March 2024 there were 9494 active satellites in orbit. Along with these working satellites, there is a lot of debris – over 25,000 objects greater than 10 cm in size, 500,000 between 1 cm and 10 cm.

Our space garbage is not just confined to our planet. On the moon there are 96 space probes totaling 208 metric tons. On Mars, we have dumped 7000 kg of equipment. There are five probes leaving the solar system; the discarded efforts to survey the outer solar system. In sixty years, we have done a pretty impressive job of creating space junk. How will these numbers grow in another hundred or a thousand or ten thousand years?

Our need for rare elements to support our technology will drive us to mine space. Our ecological footprint will reach out into the solar system. Our junk will move out there with us. Our junk, tossed into the cold emptiness of space will last eons. It will be slowly ablated by energetic cosmic rays but could last billions of years.

In 2009 a strange object passed through our solar system. It had a long, thin, cigar-like shape. It was unusually bright and appeared to accelerate as it left the solar system. This object, dubbed, Oumuamua, was from outside our solar system. Some have suggested that it was an alien spaceship, perhaps passing through and checking us out. This is unlikely, the thing was tumbling and the apparent acceleration as it left our solar system has been explained as a gravitational effect. But what if it was an alien spaceship – a relic from another civilization, far away and long extinguished? Such a relic may have been drifting through space for ages. The gravity of our solar system drew it in from interstellar space, setting it tumbling through our solar system. Maybe not an active spaceship but someone's space trash.

The Search for Extraterrestrial Intelligence (SETI) has been listening for radio signals from space for 60 years. The search has so far come up empty. But the search has an unreasonable constraint on it, one that probably ensures that no signals will ever be discovered. It requires that an alien civilization light-years away, broadcasts a strong enough signal for us to collect it now. The signal would have to be emitted at a time that allows it to propagate to us and be detected many years, decades or centuries after it was emitted. The coincidence of time is too constraining. We can only detect signals that arrive here now.

Space junk, on the other hand, has persistence. It can last for a billion years. In a billion years of life in the galaxy, how many civilizations may have come and gone? How much space junk has each of these left behind? No matter how long ago those civilizations existed, their space junk will still be floating around. The galaxy may be awash with space junk. You simply have to know where to look for it. You need to find those beaches where the junk washes ashore or an equivalent of the Pacific Ocean currents where the stuff collects.

This brings me to Lagrange points. Lagrange points are regions of space around an orbiting planet where the combined gravitational pull of the sun, the planet and the centripetal force caused by the motion of orbiting create a balance of forces. In terms of space time, the Lagrange regions are flat areas next to the gravity wells created by the planet and the sun. Here, objects can settle into a stable orbit, undisturbed by the pull of the planet or the sun. These objects revolve around the sun in lock-step with their planet. There is a Lagrange point ahead and behind each planet, just inside its orbit and another in line with the planet but outside its orbit. A fifth is on the opposite side of the sun. The James Webb telescope sits in Earth's second Lagrange point. Several other satellites are positioned in other of Earth's Lagrange points. Once there, the satellite needs to expend minimal energy to maintain its orbit.

The giant planets have proportionally larger Lagrange points. Jupiter's Lagrange regions are several hundred million kilometers long and contain millions of trapped asteroids – the so-called Trojan asteroids. The giant planets have been collecting objects into their Lagrange regions for billions of years.

If space were indeed awash with junk, one would think that some of it would be collected into the Lagrange points of the giant planets. These may be the space equivalent of the Pacific Ocean currents. Several billion years of space junk, alien technology, could have settled into these Lagrange regions. This junk, if it exists, could tell us about past civilizations, some, billions of years old.

So here is my idea. Perhaps, rather than searching for impossibly coincidental radio signals, we should be looking for alien junk. The galaxy could be awash in it. Gravity will collect it, space will preserve it. We just have to know where to look.

An interesting space mission is currently underway. The Lucy probe is part way through its voyage to the Lagrange regions of Jupiter to study the Trojan asteroids. It will sweep through the two Lagrange regions ahead of and behind Jupiter over the next several years, passing eight specifically identified Trojan asteroids. Maybe this probe will find more than just asteroids. Perhaps it will find space junk left behind by ancient, far off civilizations; stuff that has drifted through space for eons and settled in Jupiter's Lagrange regions.

The following is a more mathematical treatment of this idea that space junk may be drifting through the galaxy.

Further to my speculation that space could be polluted with alien space junk, I played around with the Drake equation. The Drake Equation is a formulation designed to estimate the number of technological alien civilizations that may be transmitting radio signals. It consists of a multiplication of probabilities or maybe more accurately, possibilities. I wondered if I could modify this equation to estimate how much space junk might be around. First let's look at the original equation. The number of technologic civilizations, n is given by the relationship:

$$\mathbf{n = r \times f_p \times n_e \times f_l \times f_i \times f_c \times L,}$$

where

r is the rate of formation of stars suitable for the development of intelligent life

f_p is the fraction of those stars with planetary systems

n_e is the number of planets per solar system with an environment suitable for life to develop

f_l is the fraction of suitable planets upon which life actually emerges

f_i is the fraction of life bearing planets on which intelligent life emerges

f_c is the fraction of civilizations that develop technology that produces detectable emissions

L is the average length of time such civilizations produce such signals, in years.

Depending on the values assumed for each parameter the result of this calculation can range from the possibility of there being other advanced civilizations being very unlikely to the possibly being a small number.

Parameter	Drake (values used in 1961)
R	10
f_p	0.5
n_e	2
f_l	1
f_i	0.01
f_c	0.01
L	10,000
n (Drake)	10

Clearly one could debate the values chosen for the various variables. These could have a wide range of values. Take f_l, the fraction of suitable planets that harbor life. Drake assumes all such planets develop life. But our searches for life have so far found nothing, suggesting that maybe the miracle of life is indeed a miracle and very rare.

I modified this equation to calculate the number of bits of space junk in the galaxy. Using some of the values in the equation that were used above, I calculate that the galaxy could indeed be polluted with astronomical amounts of space junk from past civilizations. Below is my modified equation with the parameters and values I used to estimate the amount of junk, the density of alien technology drifting through interstellar space.

$$\mathbf{n_h = n_{sun} \ x \ n_e \ x \ f_l \ x \ f_i \ x \ f_c \ x \ n_{obj} \ x \ n_{interstellar} \ / \ V_{galaxy}}$$

where

n_h is the density space relics in our galaxy

n_{sun} is the number of sun-like stars in our galaxy – estimated to be 7% of the total number of stars which is around 100 billion. Sun-like stars burn for 5 to 15 billion years and the galaxy is about 13 billion years old. I assume that only sun-like stars are stable enough for intelligent life to evolve. This probably results in a large under estimate of how many stars may support life. I estimate that there are 7 billion sun-like stars.

n_e is the number of planets in the goldilocks zone – capable of having liquid water, a presumed requirement for life to develop. In a 2020 article by Mike Wall on Space.com, he references a study that suggests that as many as half the sun-like stars in the galaxy may have earth-like planets. The work was led by Steve Bryson of NASA’s Ames Research Center. Drake, working long before any exo-planets were discovered, used a value of 2 for this – the planets don’t have to be earth-like, they just have to have liquid water. I will use the same value as Drake; 2.

f_l is the fraction of suitable planets upon which life actually emerges. Drake assumed a value of 1 – that is, life always emerges when conditions are right. Our explorations of Mars have so far found no proof of life there. Maybe Drake was being too optimistic? For lack of any evidence for or against, I will use Drake’s value of 1. After all, I want to compare my results to Drake’s.

f_i is the fraction of life bearing planets on which intelligent life emerges. Drake assumed 1%. I have no reason to change this. Although Earth was teaming with life for billions of years before we appeared on the scene.

f_c is the fraction of civilizations that develop technology that allows them to build spaceships. Drake assumed that 1% of intelligent species will develop the technology capable of sending radio signals out. I assume this value also holds for civilizations that send objects into space.

n_{obj} is the average number of space relics left behind by each civilization. In 60 years, we have put millions of bits of our technology into space. Granted, most is trapped in orbit around our planet and will eventually fall back into our atmosphere but if our civilization is to last even a thousand more years, our space junk will spread across the solar system as we exploit its resources. Many more probes can be expected to be sent out of our solar system for scientific or exploration purposes. In sixty years, we have sent some 5000 satellites into space. Five probes are going into interstellar space and we have sent out 100 probes to objects in our solar system. Let's say our civilization lasts 10,000 years, a value used by Drake. I suggest that the numbers of spacecraft would reach billions. Consider that in the 150 years since the automobile was first invented, we have built a billion of them. By comparison, 10,000 years is a hundred times this. A billion spacecraft in ten thousand years is not unreasonable. All it needs is for us to start mining asteroids, living on other bodies in the solar system and have supply and trade voyages. The defense of the Earth from near-earth asteroids may be another intensive use of space and spacecraft. We may need thousands of spacecraft to detect and deflect incoming asteroids.

$n_{interstellar}$ is the fraction of these spacecraft that escape their home system and reach interstellar space. This could happen either by intent or by ships being ejected through collisions or orbital interactions. Let's say 0.1%. We have five probes heading out of our solar system now – approximately 0.1% of all satellites that we have launched.

V_{galaxy} is the volume of our galaxy. I looked this up on the internet. There are various ways to calculate this. I liked the calculation that treats the galaxy as a flat cylinder 100,000 light years across and 1,000 light years thick. This gives a value of 8 x 10^{51} cubic km.

Combining all of these inputs in the table below, I calculate that the galaxy could have 1.4 x 10^{12} bits of alien technology floating through interstellar space. This is an unimaginable number of relics drifting about in our galaxy. But the galaxy is huge. The density of these objects works out to a very small number (see below).

Parameter	**Modified Drake**
n_s	7,000,000,000
n_e	2
f_l	1
f_i	0.01
f_c	0.01
n_{obj}	1,000,000,000
$f_{interstellar}$	0.001
Number of interstellar relics	1.4 x 10^{12}
Volume of Galaxy	8 x 10^{51} cubic km
Average density of alien relics in the galaxy	2 x 10^{-40} relics/ cubic km

So this calculation doesn't give me what I had hoped for; that space junk would be so common that we couldn't miss it. There may be massive numbers of relics drifting about, but the galaxy is so large that the numbers are diluted to such a miniscule level. Disappointing. I thought I might be onto something, but I am not giving up yet.

I have an average density of objects in interstellar space. Now what? I tried several approaches but I settled on calculating how much volume is swept out by our solar system as it moves through space. Assuming that this volume contains the density of objects that I estimated above, I can calculate how many objects our solar system encounters in say a billion years. This calculation is summarized in the table below.

Parameter	**Value**
Density of interstellar artifacts	2 x 10^{-40} relics/cubic km
Cross section of our solar system	1.5 x 10^{13} km (using Oort cloud as the diameter)
Speed at which our solar system moves through	240 km/s

space	
Volume of space swept out by our solar system in 1 second	4.2 x 10^{28} cubic km/s
Volume swept out by our solar system in 1 billion years	1.3 x 10^{45} cubic km
In one billion years, our solar system will encounter	260,000 relics
If Jupiter captures 0.1% of these relics, there will be this many relics in the Trojans	260 relics

So, according to these estimates, in a billion years a quarter of a million alien space relics could drift through our solar system. If my guess that Jupiter might capture 0.1% of these into its Lagrange regions, there could be a sizeable number of relics floating in among the Trojan asteroids. If these relics are colliding with the asteroids there, we could get a similar situation as around our planet – a 50-fold multiplication of junk as the relics are broken to pieces. This could result in 13,000 bits of alien junk in among the Trojans.