Earth 351- Forming a Habitable Planet
Problem Set #**9: The Great Silence**

Name:_____
Due: **Wed.**, May **24**, 2017

1. No compelling evidence exists that Earth or anywhere else in our solar system has ever been visited by intelligent beings from elsewhere. Currently, we "listen" with radio telescopes for a message, signal or indication of other intelligence, but nothing! It's 50+ years and counting. Why the complete silence?

Consider the attached compilation of David Brin (astrophysicist and science fiction writer) with his 23 possible explanations for the "Great Silence". (The entire article is under "SETI"on the class website.)

From material covered in Earth 351, *Forming a Habitable Planet*, give your opinion on the primary reason(s) for the "Great Silence", using Brin's numbering scheme to rank in your description.
(By email, send a distillation of your choices for compilation on the class website.)

2. Alternatively, in view of the thousands of exoplanets discovered in the intervening decades, can you independently craft another explanation for the "Great Silence"?

If the models presented by the TTAPS authors are correct even within orders of magnitude, one can only conclude that the arms race between the great powers is a pointless waste of time and money. Even a "limited" nuclear war will devastate the Northern Hemisphere and leave it barren of civilization, nearly devoid of life.

It would not be due to fearsome blasts, nor even lingering radiation. Some fragment of America or Russia might survive those effects. Rather, it would be the dust kicked into the sky by as few as a hundred nuclear ground bursts, or soot from airburst-ignited fires, that would plunge the world into a frigid night from which very little might survive.

At least that's the contention of TTAPS. In the years following, there have been numerous follow-up studies, but no one has successfully disputed the article's orverall conclusions, that nuclear war could severely affect Earth's climate.

Very interesting—and perhaps vital for us all to think about—but what has all this to do with extraterrestrials?

Well, there is reason to believe the nuclear winter scenario had its birth in a struggle to find excuses for absent star-faring aliens!

Consider the position in which Contact proponents like Sagan found themselves. Unable to convince themselves starships are impossible, they had to come up with some universal mechanism to explain how both the number of extraterrestrial species and their rate of expansion could be small enough to explain the Great Silence.

Sagan's answer was to propose the following:

Assume that two types of species achieve technology—peaceful and aggressive. Peaceful races presumably lack the greedy drives that caused humans to seize every opportunity to conquer and spread, here on Earth. These quiet civilizations will expand to neighboring star systems slowly, if at all. So slowly, we can excuse their absence. They just haven't arrived here yet.

Aggressive types would push ever outward, filling the Galaxy as fast as Jones and Tipler contend. But those species must first pass through a dangerous phase—that period between developing nuclear weapons and viable star travel. Sagan says warlike species either cure themselves of their aggressive tendencies, or die.

In other words, the "optimists" are now suggesting the Galaxy is sparsely occupied by long-lived pacifists—who drive their starshipss only on Sunday, presumably—and by the planetary tombs of all the rest . . . species who couldn't learn to control themselves.

But for this rationale to work, there had to be an easily triggered mechanism for destroying civilizations. It must be more powerful than even bomb blasts or radiation . . . so compelling that one could envision it happening again and again, to every warlike race that failed to make the transition to a calmer mode of life.

Nuclear winter appears to offer Sagan's brand of Contact aficionado just such a mechanism.

A MENU OF EXPLANATIONS FOR THE GREAT SILENCE

Why do we seem to be alone?

Each of the explanations offered so far suggests a way to suppress one or more of the factors in an expanded Drake Equation in order to make the overall contact number fit observations of actual extraterrestrials . . . so far zero. Let's summarize a list of popular (and not so popular) explanations.

Starting from the left side of the Drake Equation, we begin with some favorite explanations of Uniqueness proponents.

Category One: Solitude

1. Habitable planets may be rarer than astronomers now believe (Suppress factor n_e.)
2. Some unexpected "spark" may be needed to initiate life out of prebiotic compounds. (Suppress f_l.)
3. The final step to intelligence may require some "software miracle" that makes it far more improbable than currently expected. (Suppress f_i.)
4. Insatiable curiosity and manipulativeness, such as contemporary humans display, may be rare among intelligent species. (This effect would obviously suppress factor f_c.) As Author Poul Anderson put it: "The puzzle is why we're as bright as we are. Pithecanthropus was doing all right." He proposes that intraspecies selection, especially sexual, became fierce in protohumans, leading to a strange animal that is uniquely clever and capable of fitting itself to live in vacuum or the bottom of the sea.

If any combination of ideas 1–4 are right, we may simply be the first tool users ever to come along. We are the "Elder Race."

Category Two: Graduation

5. Technological species may sooner or later discover advanced techniques that make radio and colonization irrelevant. (Still, it is hard to believe any race would abandon the electromagnetic spectrum—radio and light—completely.)
6. Space-faring sophonts might "graduate" to other realms or unimaginable endeavors, coming to look on planets and starships as mere toys. This would set a limit to the period of expansion, though not, perhaps, to exploration.

Either of these scenarios would lower our expected contact cross-section, *A*, with such a civilization. They might also tend to reduce *V*.

Category Three: Timidity

7. There might be reasons species develop an aversion to space-flight. For example, Carl Sagan has suggested that the achievement of immortality might make individuals reluctant to take even the slightest risk.
8. As discussed earlier, those species who don't destroy themselves may "cure" themselves of aggressiveness, and so become slow star-farers.
9. Intelligent species might develop a form of telepathy, through mind-computer links, which makes their lives far richer than existence as individuals. If this happened, they might grow reluctant to venture many light-days from the center of their civilization, in order to avoid, in effect, lobotomizing themselves.

Still, it's hard to imagine these notions applying in all cases, which is what we need from a convincing overall explanation for the Great Silence.

Category Four: Quarantine

10. Benevolent species may have a tradition of letting nursery worlds lie fallow for long periods, allowing new sentience to be nurtured there.
11. Observers might be awaiting mankind's social maturity, or may have quarantined us as dangerous. A galactic radio club might avoid too early contact, to let us develop our own unique culture, to contribute something new to the galactic melting pot.

12. No listing would be complete without including the far-fetched idea that aliens are already in covert contact with some on Earth. A charming Poul Anderson story depicts Earth's sole "member of the Federation" as an obscure tribe of southwest American Indians.
13. The *low rent* explanation suggests the Earth is simply too unattractive to be settled, or even visited by aliens. For example, Earth life forms rely almost totally on the left-handed isomers of complex organic proteins and amino acids. Other life forms could be right-handed.
14. Finally, it's possible Frank Tipler's imagined self-replicating robots, which should make star exploration cheap and easy for even the timid—might behave just a little differently than Tipler imagined. Perhaps there are hundreds of *friendly* probes, sitting around the solar system, patiently waiting for us. Perhaps we must prove our ability actually to go out there in person before they will deign to say hello.

There is a problem with the quarantine scenarios, unfortunately. All appear to call for cultural uniformity in the Milky Way . . . some way for the pattern to be enforced for billions of years in a galaxy of constantly shifting neighborhoods and star formations. Such a rigid pattern would seem difficult in a relativistic Universe governed by the speed of light.

Category Five: Interstellar Wanderers

Perhaps waves of interstellar wayfarers *have* passed this way. Travel in vast slowboat starships might select for the sorts of beings who *like* living in space, who even come to abandon planet-dwelling as a lifestyle. This could lead to different behaviors.

15. Truly space-borne sophonts might greedily fragment terrestroid planets for building materials and volatiles, having a terrible effect on factor n_e, the number of planets that can support life.
16. Alternatively, they might have a tradition of cherishing nursery worlds, protecting them without any desire to use high-gravity real estate.

But we have looked over our asteroid belts in recent years, and they appear to have been untouched since the beginning of the solar system. No

one seems to have disturbed them, yet these are the same small bodies such star-farers would covet—which our own grandchildren may be melting and reforming in a century or so.

Looking over our list so far, none of the explanations seems to explain the Great Silence in a convincing way. What's needed is a universal mechanism that acts impartially over long time scales, which would keep the numbers of extraterrestrial species small, or suppress their rates of expansion among the stars.

A few ideas have been proposed that seem to fit these criteria. The reader is warned that some may seem unsettling. If it's any consolation, I'll try to finish with an optimistic scenario ... one that satisfies all the preceding criteria without being nasty.

Category Six: Dangerous Natural Forces

We've already mentioned the possibility Earth might have fallen into a "Venus Trap" ... the runaway greenhouse effect that killed our sister world ... or the perpetual frozen tundra of the "Martian Trap." Here are some other "natural" hazards. Any of them could have disastrous effects on the last four factors of the Drake Equation.

17. In its 230-million-year orbit round the Galaxy, our solar system regularly crosses regions of shocked gas clouds and hot young stars. These can be dangerous events. Spiral arms are where interstellar clouds compress to form new stars, and where supergiants end their quick lives in titanic explosions.

    Proposed advanced cultures eventually tire of playing galactic roulette and leave the spiral arms for good—setting up in the Milky Way's "halo" of older stars that drift in long, lazy orbits out of harm's way. That could explain why we don't see anybody flying around this part of the Galaxy: Those who *can* leave, do.

18. Were the dinosaurs really killed off by meteorite or comet impacts, which triggered major changes in the Earth's ecology? If so, were these and other collisions random? It has been suggested that a small dark, companion of the Sun, called Nemesis, or Shiva, orbits far beyond the comet belt, dipping in every twenty-six million years or so to scatter icy and rocky debris into the inner solar system. Alternatively, interactions with the galactic plane, or spiral arms, might trigger such events.

In any case, other solar systems might be in even worse shape than we are, so often smashed by cosmic debris that we're the first to climb up far enough to look around.

19. Our Milky Way may contain objects far more dangerous than mere shock fronts or falling rocks. Radio astronomy shows that many galaxies contain powerful, dangerous jets of relativistic particles, perhaps caused by huge black holes at the galaxies' cores. It's still unclear whether we share this galaxy with a compact version of such terrors, but already there is strong evidence for a black hole, of a few hundred solar masses, near the center of the Milky Way.

Category Seven: Dangerous "Unnatural" Forces

Nature can be malignant, as we have seen. But there are other dangers, as well, dangers that might arise from life itself.

20. Migrational holocausts. This idea was discussed earlier. What happens to planets that are colonized by an expanding interstellar civilization? Unless the settlers leave large parts of their worlds fallow in wilderness preserves, or engage in "uplift" bioenginering of local higher animals, their mere presence is likely to do harm. A world probably cannot serve as a useful nursery of intelligence so long as it's occupied by a space-faring race. When the interstellar tenants finally vacate or die off, it may be a long time before a local species of tool users evolves.

    So Earth might be the first nursery world to have recovered sufficiently—since the last wave of "civilization" passed this way.

21. Inevitable self-destruction is another cheery theme mentioned earlier, suggesting that many alien races found themselves where we now stand, on the teetering precipice between self-ruin and self-control; perhaps only a very few make it.

22. From physics and science fiction comes the dreadful notion of "deadly probes," which devastate life among the stars. A particularly paranoid advanced species might not want any potential competition to rise up elsewhere and so might send forth machines like Tipler's self-reproducing probes, but with a nasty edge. Whenever radio traffic indicates that new sentients (like us) have arisen, these robots would home in to destroy the

infection before it spreads. This need only happen once for it to become the status quo, keeping the Galaxy silent and empty for billions of years.

Category Eight: A Grasp at Optimism

Is there any friendly explanation for the Great Silence? Isn't there any way the Universe could look the way it does and still let both sides in the debate get their dream—a galaxy with other minds to talk to, and yet still wide open for our great-grandchildren to have adventures in?

I have managed to come up with one.

23. The "Water Worlds" scenario. We've spoken of the Venus Trap and of a Mars Trap, which might yank Earth-like worlds toward conditions where life can't exist. This leaves us with the impression that Terra miraculously found itself straddling a narrow fence between two death sentences, and that might be true.

On the other hand, it might not. Recently, Professors Kasting and Pollack have published persuasive arguments that there is a deep valley, a cusp, between the Mars and Venus catastrophes. Within this valley there is another "trap," pulling toward it all planets within its reach. This is the pleasant trap of the Water World.

The existence of life on Earth has had powerful repercussions. It has taken most of the carbon out of the atmosphere and regulated the planet's temperature so that it varies less than the heat output of the Sun itself. One result: the preservation of vast oceans.

If this turned out to be a common phenomenon, let's consider the possibility that the Earth is unusually *dry* for a water world. In other words, what if the vast majority of this kind of planet has far *less* dry land than ours?

Geneticists say that species diversity and rates of evolution depend on the size of the environment involved. It is unlikely that land creatures would develop to the complexity they have on Earth on a world with only island archipelagoes and tiny continents.

That doesn't necessarily mean *intelligence*, per se, is impossible on such planets. After all, dolphins and whales are pretty bright. But it does imply there'd be few places where "hands and fire" beings would develop the technology and basic outlook necessary to take to the stars.

There might be millions of intelligent species out there, ignorant and uncaring about starships, preoccupied with their own oceanic adventures. The result? Envision our descendants setting forth, as Jones and others anticipate. They find no other star-farers, and at first it seems they are all alone. At last, though, they discover other minds . . . minds that pose no threat, no danger.

Intelligent whales, or squid, or octopus . . . why should they refuse the roving humans' request to make use of local asteroids to build their cities and factories? If the strange-looking bipeds are willing to bring down exciting toys and machines, why not invite them to come take their vacations on the shores of the "useless" little islands, to splash and play and exchange philosophy lazily under the balmy sunshine?

Humans could be the voyageurs—the transporteers—carrying mail and slow philosophical discussion among the water sapients who will only be grateful for the service, of course, never jealous. Our great-to-the-*n*th grandchildren will have their adventures, and serve to tie the Galaxy together.

It sounds like a way to give both sides in our great debate what they want, without having to have a dangerous, malignant Universe, one that's out to get us.

I promised to end on a note of optimism, and I cannot do any better than that.

Now, if only if were true.