

Astrobiology News January 2017: Reframing the Question, Are We Alone?

I've been thinking a lot lately about the impact the human space program had on my childhood. I recently saw the movie, *Hidden Figures*, which highlights the careers of three amazing African American women at NASA during the early 1960s¹. (I highly recommend seeing it and reading the book by Margot Lee Shetterly²!) Then, too, the passing of two iconic astronauts, John Glenn and Gene Cernan, within less than two months of each other, has reminded me of the emotional impact of seeing the Earth from space for the first time in human history. I recall standing in awe of the famous Earthrise photo taken from Apollo 8 on Christmas Eve of 1968, and the breathtaking "Blue Marble" captured by the Apollo 17 crew the last time human beings walked on the Moon³. Voyager 1's view of the Earth taken from beyond the orbit of Neptune in 1990⁴ and Cassini's view from Saturn in 2006⁵ transformed the stunning "Blue Marble" into the tiny "Pale Blue Dot", accentuating the vastness of space and reinvigorating the question, are there other worlds that harbor technological civilizations?

In 1961, astronomer Frank Drake identified several factors thought to be important in considering the number of technological civilizations with which we might be able to communicate, expressing these factors in what became known as the *Drake Equation*⁶. Over the past couple of decades, star formation studies and surveys for planets orbiting other stars have enabled us to place important constraints on two factors that were completely unknown in 1961 – the fraction of stars that form with planets and the average number of planets that orbit in the habitable zone of a star with planets. We now have good reason to think that most stars are accompanied by planets, and roughly one in five stars has a planet in the habitable zone. (Technically, we'd say that on average there are 0.2 potentially habitable planets per star, since some stars may have more than one planet in their habitable zone.)

Of course, how many of these planets develop life, intelligence, and technology, remains unknown. Also unknown is the typical lifetime of a technological civilization, which is important in thinking about whether we could actually communicate with an alien species, and also important in considering how sustainable our own high-technology future might be over the long term! A recent article in the journal *Astrobiology* puts a new spin on thinking about other civilizations by posing a somewhat different question: Has even one other technological species *ever* existed in the observable Universe?⁷ Framed in this manner, the lifetime of a technological species doesn't enter into the equation. The authors calculate that only if the fraction of planets that develop life, intelligence, and technology is lower than 0.0000000000000000000000025 are we likely to be the only technological civilization to have evolved in the entire history of the Universe!

The authors go on to consider how our present knowledge of potentially habitable

planets can inform SETI⁸ search strategies for other technological species in our Milky Way Galaxy *now*. *If all* habitable planets were to develop life, intelligence, and technology (a big “if”, I grant you), *and* the average lifetime of a technological civilization is about 50,000 years (another big “if”), one in every million stars (about 300,000 stars in our galaxy) could host a planet with a technological species. Since our Milky Way Galaxy is roughly 100,000 light-years in diameter, even detecting signs of alien technology would by no means guarantee we’d be able to conduct a two-way conversation, but this exercise does underscore why SETI searches should be viewed as long-term efforts that should not be expected to yield immediate results! Further studies of potentially habitable planets should help us identify the best targets for future SETI efforts. I prefer to remain optimistic. After all, prior to the 1990s, there was *no* observational evidence of planets orbiting other stars – as far as we knew, such worlds existed only in the imaginations of human beings.

Until next month,

Grace

¹ <http://www.foxmovies.com/movies/hidden-figures>

² <http://www.hiddenfigures.com/bio/>

³ <https://www.nasa.gov/content/blue-marble-image-of-the-earth-from-apollo-17>

⁴ <https://www.nasa.gov/jpl/voyager/pale-blue-dot-images-turn-25>

⁵ <https://www.nasa.gov/vision/universe/starsgalaxies/dotf-20061101.html>

⁶ <http://www.seti.org/drakeequation>

⁷ Frank, A. & Sullivan, W.T. III 2016, A New Empirical Constraint on the Prevalence of Technological Species in the Universe, *Astrobiology*, Vol. 16, No. 5, 359-362

⁸ <http://www.seti.org/>