There could be four hostile civilizations in the Milky Way, researcher speculates

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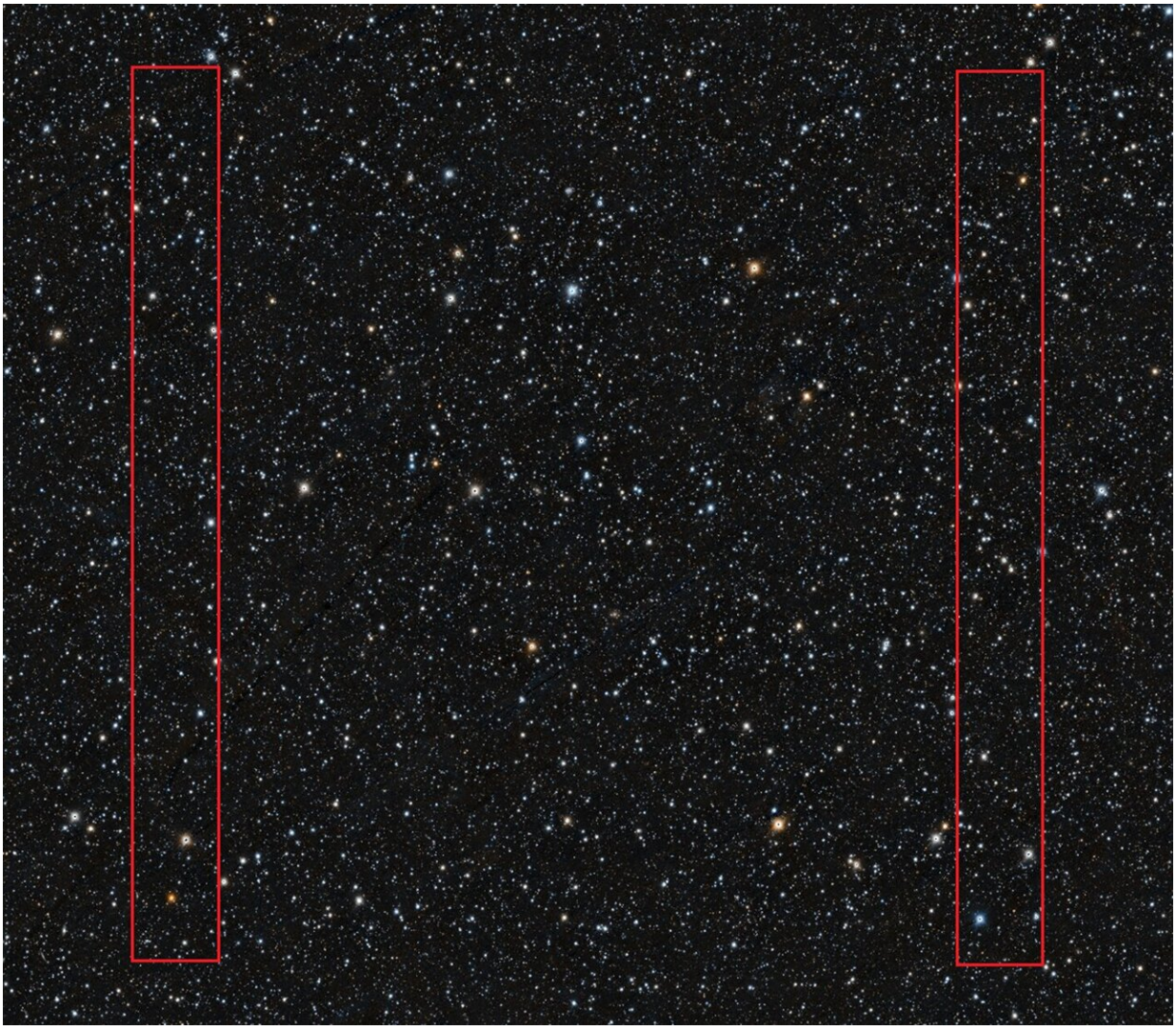

In red, the two regions where the WOW! Signal could have originatedSource: Pan-STARRS/DR1. Credit: *International Journal of Astrobiology* (2022). DOI: 10.1017/S1473550422000015

In 1977, the Big Ear Radio Telescope at Ohio State University picked up a strong narrowband signal from space. The signal was a continuous radio wave that was strong in intensity and frequency and had many expected characteristics of an extraterrestrial transmission. This event would come to be known as the "Wow!" signal, and it remains the strongest candidate for a message sent by an extraterrestrial civilization. Unfortunately, all attempts to pinpoint the source of the signal (or detect it again) have failed.

This led many astronomers and theorists to speculate as to the origin of the signal and what type of civilization may have sent it. In a recent series of papers, amateur astronomer and science communicator Alberto Caballero offered some fresh insights into the "Wow!" signal and extraterrestrial intelligence in our cosmic neighborhood. In the first paper, he surveyed nearby sun-like stars to identify a possible source for the signal. In the second, he estimates the prevalence of hostile extraterrestrial civilizations in the Milky Way galaxy and the likelihood that they'll invade us.

Almost 50 years after it was detected, the "Wow!" signal continues to tantalize and defy explanation. In recent years, attempts have been made to attribute it to comets at the edge of our solar system, an explanation that the astronomical community has since rejected. In 2020, interest in this candidate ETI signal was revitalized when Cabellaro identified a sun-like star in the vicinity of the sky where the "Wow!" signal was detected. If the analysis is correct, this famous signal may have come from a sun-like star located 1,800 light-years away.

The recap, the "Wow!" signal was detected by the now-defunct Ohio State University Radio Observatory (nicknamed "Big Ear"), which was assigned to SETI surveys in 1973 after completing an extensive survey

of extragalactic radio sources. In the summer of 1977, astronomer Jerry R. Ehman was working as a volunteer with the project and was tasked with analyzing the massive amounts of data printed on paper. On August 15, he spotted a series of values indicating a massive intensity and frequency boost.

Ehman circled the alphanumeric designation for this signal (6EQUJ5) and wrote "Wow!" next to it. In recent years, coinciding with the 35th anniversary of the signal's detection, there has been renewed interest and research into this mysterious event. This should come as no surprise, considering that it remains the most likely candidate for an extraterrestrial message. Despite being (from all accounts) an unmodulated continuous wave, there were several indications at the time that the signal was not natural in origin.

For one, the signal was only heard on one frequency, with no noise detected on any of Big Ear's 50 other radio channels. This is inconsistent with natural emissions, which cause static at other frequencies, whereas the "Wow!" signal was narrow and focused—what we would expect from a transmitted radio signal. Second, the signal "rose and fell" during the 72 seconds it was detectable. This is consistent with signals from space, which increase in intensity as they move across the sky and approach the telescope's radio, then decrease as they move away from the telescope.

Third, the signal was observed near 1420 MHz, a "protected frequency" that Earth-based transmitters are forbidden to use since they are reserved for astronomical studies. All of this pointed toward an extraterrestrial origin, as satellites and terrestrial radio sources would have been repeating in nature, whereas the "Wow!" signal appeared to be a one-off event. Based on the timing and orientation of the Big Ear telescope, astronomers deduced that it must have come from somewhere in the direction of the Sagittarius constellation.

The "Wow!" signal has long been the subject of interest to Alberto Caballero Díez, a Spanish exoplanet hunter, SETI researcher, and science communicator. While Caballero studied Criminology at the University of Santiago de Compostela in Spain, he has since focused his efforts on researching habitable exoplanets and extraterrestrial intelligence. He has even come to rely on one of his hobbies (day trading) to finance his efforts in the search for extraterrestrial intelligence (SETI).

Caballero is perhaps best known as the host of The Exoplanets Channel, a Youtube channel about exoplanet studies, SETI, and interstellar travel. He is also known for coordinating the Habitable Exoplanet Hunting Project (HEHP), an international network of professional and amateur astronomers dedicated to studying exoplanets in nearby star systems. In particular, the project hopes to find potentially habitable exoplanets around non-flaring G (yellow dwarf), K (orange dwarf), or M-type (red dwarf) stars within 100 light-years of Earth.

"The project is a worldwide network of professional and amateur optical observatories searching for potentially habitable exoplanets around nearby stars, using the transit method," Caballero told Universe Today via email. "I founded the project in 2019. [S]ince then, more than 30 observatories in the five continents have joined."

In 2020, the HEHP announced the discovery of a Saturn-sized exoplanet orbiting within the habitable zone of its parent star. This constituted the first exoplanet discovery made entirely by amateur astronomers. It was also in 2020 that Caballero observed a sun-like star almost identical to our sun (a solar analog) while searching the sector of the sky where the "Wow!" signal was detected. Caballero described this discovery via The Exoplanets Channel and in a paper published in the *International Journal of Astrobiology* in early May.

In this paper, Caballero surveyed nearby sun-like stars using data obtained by the ESA's Gaia Observatory (compiled in the Gaia Archive), and determined the most likely source. The survey contained a sample of 66 G-type yellow dwarfs (similar in size and spectra to the sun) and K-type orange dwarfs (slightly smaller and dimmer than the sun). He narrowed it down to one candidate star located about 1,800 light-years from the solar system. This was 2MASS 19281982-2640123, a perfect solar analog comparable in size, mass and spectra to the sun.

Caballero said, "I dismissed red dwarfs because a large percentage of them emit flares that destroy exoplanetary atmospheres, and we don't know which of them from the data are flare stars."

The similarities between this star and our sun make it the most likely place to find life and a possible civilization as we know it. At the same time, the distance is consistent with previous research by Italian astronomer Claudio Maccone. In 2010, Maccone conducted a statistical analysis, concluding (with 75% confidence) that the closest ETI would be located between 1,000 to 4,000 light-years away. Caballero explained that this makes 2MASS 19281982-2640123 an ideal candidate for follow-up searches for possible technosignatures.

These conclusions raise another interesting point, which goes directly to the heart of the whole "to listen or to message" (SETI vs. METI) debate. While SETI efforts consist of listening to the cosmos for signs of possible extraterrestrial transmissions ("passive SETI"), messaging extraterrestrial intelligence (METI, or "active SETI") consists of composing messages that are transmitted to space. In this respect, the "Wow!" signal is a perfect example of passive SETI efforts, whereas the Arecibo message is a perfect example of active SETI or METI.

In his second paper, Caballero addresses this issue by conducting a statistical analysis of possible hostile civilizations in our galaxy and the

possibility that one or more of these would detect signals coming from Earth (and possibly choose to invade). Because radio antennas and radar constantly leak signals into space, Cabellero felt a risk evaluation was necessary. As he explained, this consisted of using the past century of Earth's history as a template, a century steeped in conflict:

"I based the estimation on the frequency of invasions on Earth in the last 100 years. Only 51 countries out of the 195 invaded another country. I found that as time goes by and humanity develops, the frequency of invasions decreases. Extrapolating the results to humanity once it becomes a Type-1 civilization capable of interstellar travel, the frequency and therefore probability of invasion goes down. The estimations are based on life as we know it."

In addition, Caballero turned this same analysis toward humanity and the possibility that we might become a "malicious civilization" once we've become a Type-1 civilization on the Kardashev Scale. A civilization at this level of development would be capable of harnessing all of its planet's energy and limited a measure of interstellar travel to nearby star systems. His analysis showed that a maximum of four malicious civilizations would be within earshot of our transmissions. Caballero said this indicates that an alien invasion is not the greatest existential threat facing humanity:

"The low risk estimated, lower than the impact probability of a planet-killer asteroid, could support METI efforts. SETI is necessary, but it's like looking for a needle in a haystack. If we really want to have chances of ET contact, we need to start broadcasting laser messages to thousands of exoplanets. Whether we should do it or not depends on what the international community says."

Statistically speaking, METI may not constitute the existential risk that some say it could. It is likely not more dangerous than threats that are

much closer to home. This, according to Caballero, also raises the important question of whether intelligent civilizations are more likely to destroy themselves than others. This is a time-honored question among scientists and is even considered a possible reason we haven't found conclusive evidence that an intelligent civilization exists beyond Earth—a la the "Great Filter" or the "Brief Window" hypothesis.

The debate over messaging and whether it poses a risk has been revitalized in recent years, partly in response to efforts like Breakthrough Message, the Galileo Project, and The Beacon in the Galaxy (BITG) message—an updated version of the Arecibo Message. Despite the division of opinion, both sides agree that a discussion must take place on an international level and that it must happen now. Both sides are also actively working to make that discussion happen and to get as many government entities, scientific institutes, nonprofits, entrepreneurs and members of the general public to participate.

These efforts parallel the growing interest in astrobiology, exoplanet studies and SETI efforts that has accompanied the revolutionary developments that have taken place since the turn of the century. In the past 20 years, the number of known exoplanets has increased by several orders of magnitude, and multiple missions have been dispatched to Mars to search for evidence of past life. In the coming years, next-generation telescopes will discover and characterize tens of thousands more, and robotic missions will expand the scope of astrobiological research to places like Europa, Enceladus and Titan.

With so many missions dedicated to searching for life on distant worlds and planets and moons here at home, key discussions need to happen. Should we be content to sit back and listen or broadcast ourselves to the wider universe? What opportunities and inherent dangers are there in making our presence known? Are we prepared for what we might find? And, if we receive a message (or detect a probe), what should we do

with it? The possibilities are endless, but so are the risks.

More information: Alberto Caballero, Estimating the prevalence of malicious extraterrestrial civilizations. arXiv:2205.11618v1 [physics.soc-ph], arxiv.org/abs/2205.11618

Alberto Caballero, An approximation to determine the source of the WOW! Signal, *International Journal of Astrobiology* (2022). DOI: 10.1017/S1473550422000015

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