City Lights on Other Planets

By Avi Loeb on February 2, 2021

The *International Space Station* Commander Terry Virtz opened his interview with me by stating that he spent seven months in space. His most memorable moments involved staring at the nightside of Earth and noticing how city lights delineate the boundaries of continents and signal politics through the level of illumination that various populated regions exhibit.

Can astronomers follow Terry's insights and study city lights on other planets?

Our best chance for imaging city lights outside the solar system is around the nearest star to the Sun, Proxima Centauri, a red dwarf located 4.25 light years away. This star is nearly six hundred times fainter than the Sun, and so a planet needs to be twenty times closer to Proxima's furnace than the Earth is from the Sun, in order for it to support life based on liquid water. In August 2016, astronomers discovered a planet weighing 1.3 Earth masses in this habitable zone. Because of its proximity to the star, this planet - Proxima b - is thought to be tidally locked, showing the same side to the star at all times - just like the Moon does relative to Earth. Proxima b has a permanent dayside and a permanent nightside. My daughters say that if we ever move there, they want a house on the strip that separates the two sides, where they can watch the sunset forever.

If Proxima b is already inhabited by a technological civilization, its dayside may be coated with photovoltaic cells to generate electricity that would illuminate and warm the nightside, which is otherwise too cold and dark for comfortable life.

In a scientific paper with the Stanford undergraduate, Elisa Tabor, we showed that the recently launched James Webb Space Telescope could potentially detect city lights on the permanent nightside of Proxima b. Even if the artificial illumination is as faint as our civilization currently utilizes on the nightside of Earth, Webb could detect it as long as it was limited to a frequency band that is a thousand times narrower than the starlight. Future space telescopes, like the proposed Large Ultraviolet Optical Infrared Surveyor, will be sensitive to even fainter levels of artificial illumination on the nightside of Proxima b. In another paper with my former postdoc, Manasvi Lingam, we showed that a substantial coverage of Proxima b's dayside with solar panels is detectable on its own, based on its characteristic spectral edge in reflecting starlight.

Proxima b orbits its star every 11.2 days, making birthday celebrations thirty times more frequent than on Earth. The high demand for bright lights during birthday parties on the nightside of Proxima b would be a reason for us to celebrate as well, if the signal would be noticed by our future telescopes.

Obviously, we could also search for bright artificial lights on spaceships moving through space. A decade ago, I attended a conference inaugurating the campus of New York University in Abu Dhabi along with my colleague from Princeton University, Ed Turner. The conference included a tour through the neighborhood, during which the local tour guide bragged that their city lights can be seen all the way from the Moon. Ed and I looked at each other with awe and wondered: how far away could our deepest image of the Universe detect a single city? During the following day, we calculated that the Hubble Ultra Deep Field could notice a city like Tokyo on a spaceship that is 30-50 times farther than the Earth-Sun separation.

But most importantly, if Webb discovers city lights on Proxima b, NASA should consider building a bigger telescope that will trace these faint lights to learn about the continents and politics on this distant planet.

ABOUT THE AUTHOR

Avi Loeb is the head of the Galileo Project, founding director of Harvard University's - Black Hole Initiative, director of the Institute for Theory and Computation at the Harvard-Smithsonian Center for Astrophysics, and the former chair of the astronomy department at Harvard University (2011-2020). He chairs the advisory board for the Breakthrough Starshot project, and is a former member of the President's Council of Advisors on Science and Technology and a former chair of the Board on Physics and Astronomy of the National Academies. He is the bestselling author of "*Extraterrestrial: The First Sign of Intelligent Life Beyond Earth*" and a co-author of the textbook "*Life in the Cosmos*", both published in 2021.

Image taken from the International Space Station shows artificial lights from Spain and Portugal. (Image credit: NASA)