The search for a new Earth: Study of Exoplanets and The Current Exploration Projects

Fady Kiroles

Abstract

For thousands of years humanity has been consuming the resources of the Earth at an exponential rate. Scientists have found that the valuable resources humans depend on are nearing depletion. This motivated astronomers to start the search for a new earth outside of the solar system. Space exploration projects are now more focused on finding potentially habitable planets than anything else. While Mars has been a candidate for the first habilitation project for many years, it is not a certain solution to the problem. Therefore, projects aim towards exploring exoplanets and finding a suitable one for humanity.

Background

According to the global footprint network, as indicated in Figure 1, on August 1st of 2018 humans have consumed more than what the Earth could regenerate that year. With this rate of consumption, it would require 1.7-Earths-worth of resources to sustain human needs.

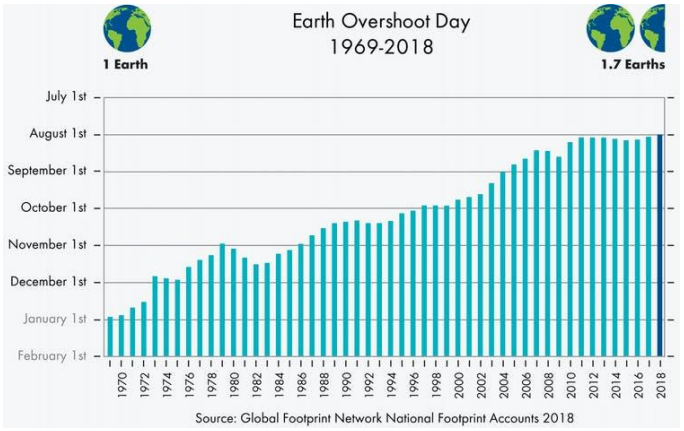

Figure 1: Resource consumption estimation on overshoot day [1]

A viable solution for this problem would be to find a new planet with fresh resources. While there are currently projects that aim to habilitate Mars, their chances of success are quite slim. This is due to Mars's consistently poor weather. The red planet suffers from frequent and unpredictable sandstorms that may affect the habilitation process. This started the search for exoplanets, which are planets that lie outside our solar system. However, none of the currently discovered exoplanets satisfy the conditions for human survival.

Exoplanet habitable zone

The habitable zone is the region around a star where planets can have liquid water and a stable temperature. This region varies with the size of the star, as shown in Figure 2, where the habitable region of smaller stars is

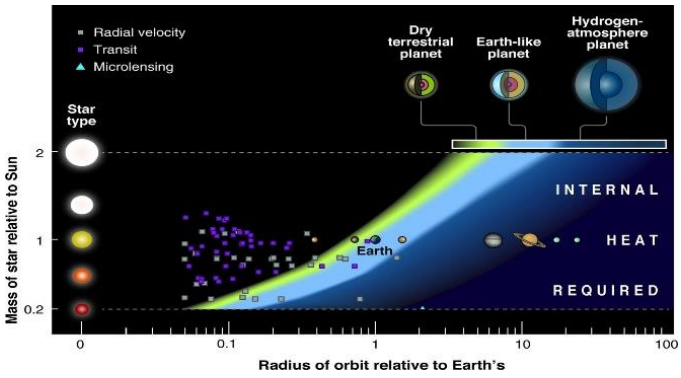

Figure 2: an estimation of the habitable zone [2].

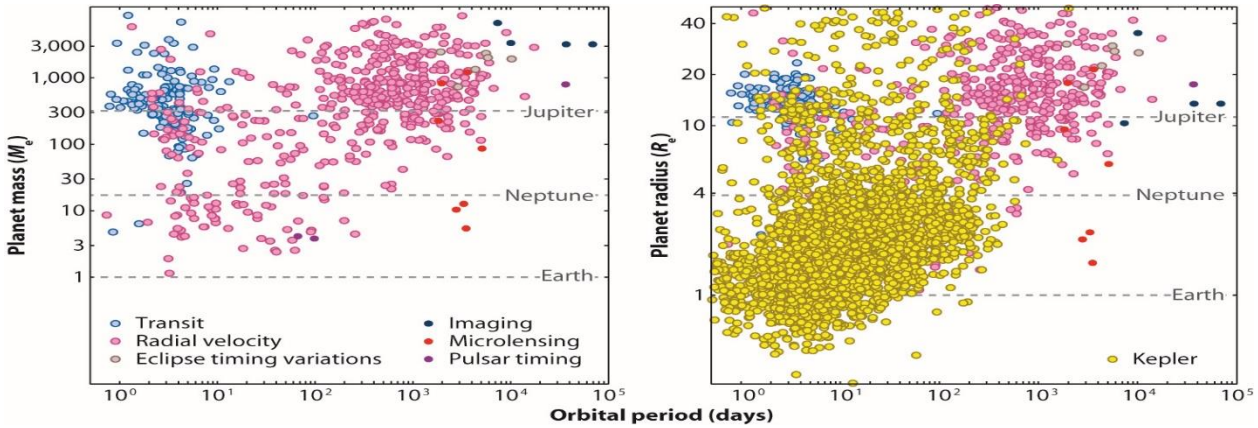

Figure 3: A graph of currently discovered exoplanets and their relative radii and masses.

closer to them than the Earth is to the sun. The reason why the habitable zone has stable temperature is because of the percentage of greenhouse gases in that region. There are currently no means of measuring the percentage of greenhouse gases present in exoplanets and thus, scientists rely on the distance between exoplanets and the star to estimate it.

Exoplanet interior composition

The main reason behind the habilitation projects of exoplanets is to find fresh resources. However, the exact amount and types of resources are quite difficult to estimate relying exclusively on distant pictures of said planets. After studying a variety of planets, scientists spotted a relationship between the interior composition of the planets and the ratio between their mass and radius [3]. This relationship can be utilized to understand the interior composition of exoplanets without sending probes and/or rovers on costly exploration missions.

Exoplanet biosignature gases

Biosignature gases are gases present in the atmosphere at detectable levels produced by living organisms (e.g., acetaldehyde, acetone, benzene, carbon disulfide). Although the presence of said gases could be correlated with that of lifeforms, this method has one major flaw: We only know of biosignature gases that are produced by carbon-based lifeforms here on earth, and those biosignatures wouldn't necessarily be the same ones on exoplanets (if we're to find any). All work of finding biosignature gases to date has been limited to speculating how exoplanetary products would act if they were transplanted onto planets of the same mass and atmosphere of Earth.

Current exoplanet studies

JUNO

Project JUNO launched from Cape Canaveral Air Force Station in Florida on August 5, 2011. It released a spacecraft in polar orbit around Jupiter. This project aims to determine the amount of global water and ammonia present in the atmosphere of ice-rock planets.

SHERLOC

The Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals is going to be used in the next Mars exploration mission. The SHERLOC uses spectrometers, a laser and a camera to search for organics and minerals that have been altered by watery environments and may be signs of past microbial life. This will enable scientists to discover more biosignature gases and consequently give them a better idea of what to look for on exoplanets.

TESS

The Transiting Exoplanet Survey Satellite is one of the largest projects to launch in 2017. It has the capability of surveying 200,000 stars and the planets orbiting them. This will allow for a huge scale scan of exoplanets, easing the search for an Earth-like planet.

Conclusion

Humanity's increasing consumption of Earth's resources will end in their inevitable demise. The only solution is to find a planet that can satisfy humankind's needs, and this would only be possible if space projects concentrated more on exploring exoplanets and ways of habilitating them.

References

[1] Richardson, R. B. (2018, August 1). Depleting Earth's resources. Retrieved from https://msutoday.msu.edu/news/2018/depleting-earths-resources/

[2] Seager, S. (2013). Exoplanet Habitability. Science, 340, 577-581. doi:10.1126/science.1232226

[3] Seager, S., Kuchner, M., Hier-Majumder, C. A., & Militzer, B. (2007). MASS-RADIUS RELATIONSHIPS FOR SOLID EXOPLANETS. The Astrophysical Journal, 669, 1279-1297.

[4] Science - Planetary And Exoplanetary Atmospheres: Projects. (n.d.). Retrieved September 25, 2020, from https://science.jpl.nasa.gov/PlanetaryScience/PlanetaryAtmospheres/projects.cfm

[5] Madhusudan, N., & Seager, S. (2009). A TEMPERATURE AND ABUNDANCE RETRIEVAL METHOD FOR EXOPLANET ATMOSPHERES. The Astrophysical Journal, 707, 24-39.

[6] Ricker, G., Winn, J., & Vanderspek, R. (2014). Transiting Exoplanet Survey Satellite. Journal of Astronomical Telescopes, Instruments, and Systems, 1(1), 1-10

[7] Seager, S. (n.d.). Exoplanets. Retrieved September 25, 2020, from http://seagerexoplanets.mit.edu/research.htm