A CATALOG OF EXOPLANETS POTENTIALLY BEARING HABITABLE EXOMOONS

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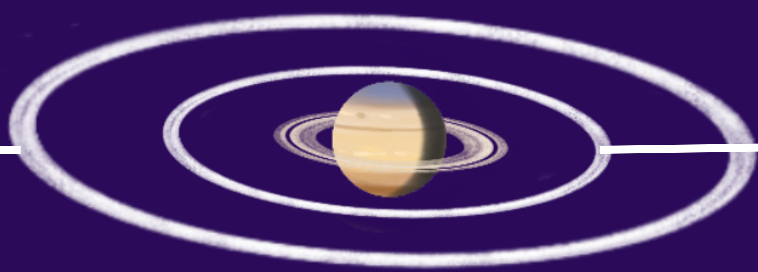
When looking for places beyond Earth that could potentially support life, some of the moons of Jupiter and Saturn are often considered as candidates given their presence of liquid water. When looking outside the Solar System, astronomers search Earth-like planets with liquid water on their surface, but at the same time, moons with liquid water are also a viable candidate.

DEFINITIONS

- **Exoplanet** - A planet that does not orbit our Sun, often found orbiting another star
- **Exomoon** - A moon that orbits an exoplanet
- **Habitable Zone** (HZ) - A region around a star where liquid water could potentially exist given sufficient atmospheric pressure.
- **Conservative Habitable Zone** - A variation of the HZ bounded by the melting and boiling temperatures of water
- **Optimistic Habitable Zone** - A variation of the HZ bounded by research suggesting Venus and Mars had liquid water before
- **Hill radius** - The maximum radius where a planet's gravitational influence is dominant



- **Roche Limit** - A radius wherein within it, a planet's gravity exceeds another object's own gravity

AIM & CONSIDERATIONS

Currently, there are no known exomoons, so their parent exoplanets must be considered. The goal of this research is to create a catalog of exoplanets that may harbor potentially habitable exomoons for future investigations by telescopes like the JWST. The primary factors considered were:

- **The spectral type of the star**

Only F-type stars and lower (Sato et al, 2014).

- **The radius of the parent planet**

Greater than or equal to 3 Earths (Hill, 2018).

- **The distance of the parent planet from the Sun**

Must be located in the HZ. The habitable zone can be computed with these equation.

$$\left(\frac{L_{sun}}{S_{eff}}\right)^{0.5}$$

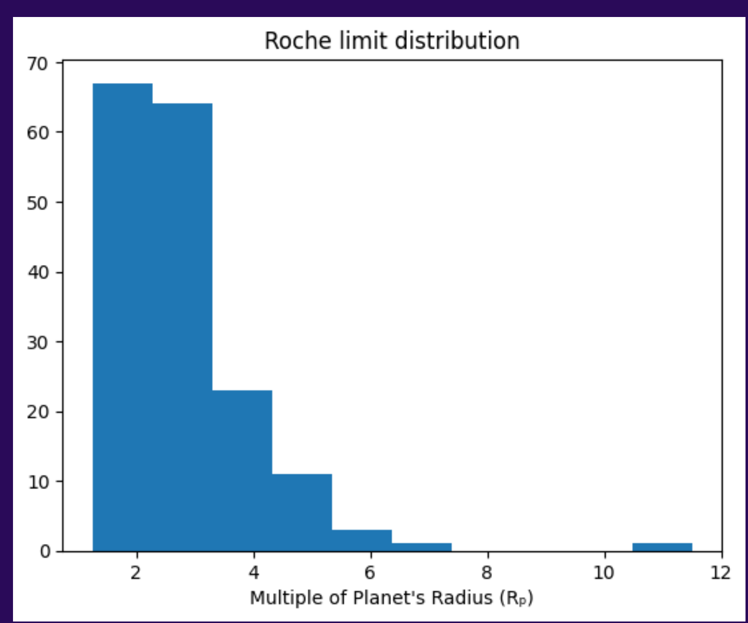


Figure 2. A histogram showcasing the distribution of the catalog's planets according to their Roche limit. The majority fall within 2.5 Earth radii.

The majority of the planets have Roche limits at least 3x their radii. The most frequent Roche limit was about 2.55 Earth radii.

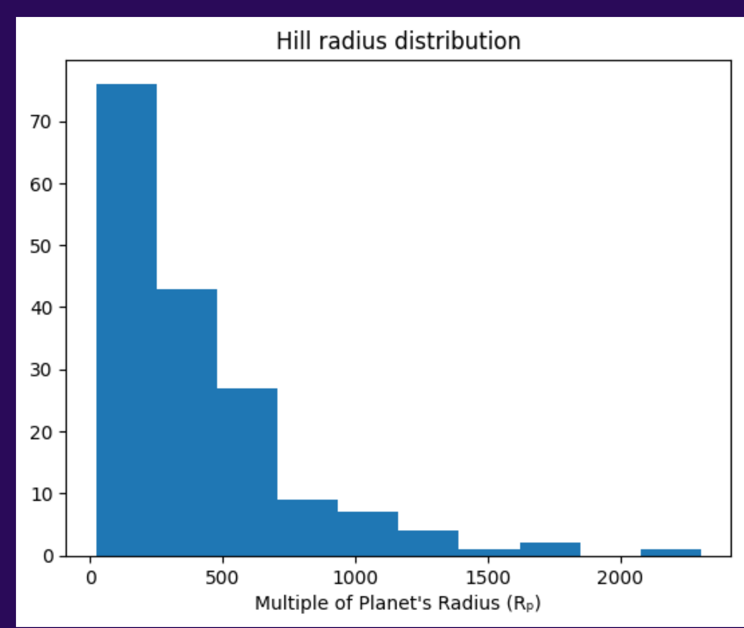
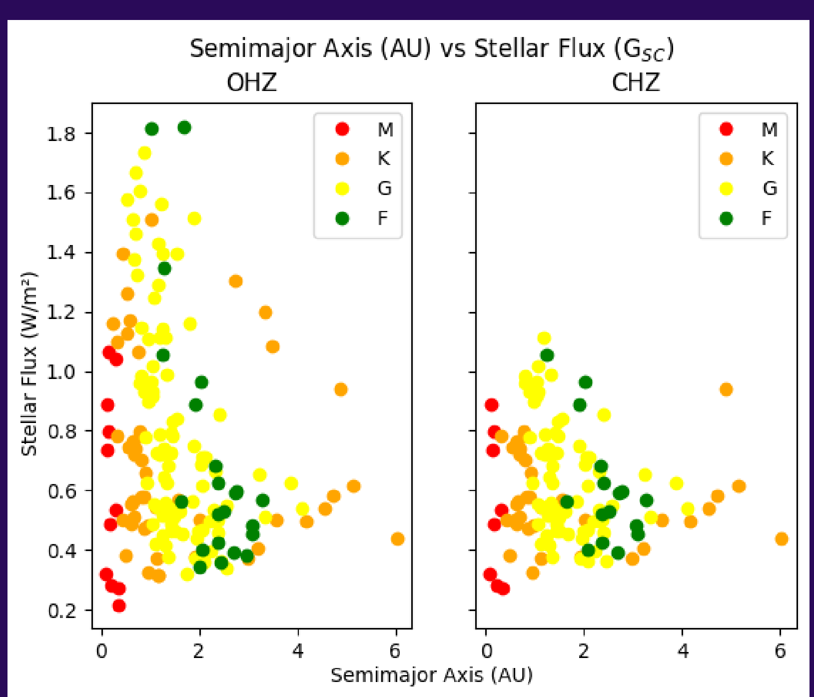


Figure 2. A histogram showcasing the distribution of the catalog's planets according to their Hill radius. The majority fall within 250 Earth radii.

The majority of the planets have Hill radii at least 300x their radii. The most frequent Hill radius was about 22.99 Earth radii.

In total, 171 candidates were found, with 126 of them being located within the CHZ, and 46 only in the OHZ. Majority of them orbit G and K type stars, with 90 orbiting the former type and 48 for the latter.

RESULTS AND DISCUSSION



Majority of the planets are within 2.5 AU from their star and receive up to 1.8x the solar constant. Those in the CHZ received fluxes closer to the solar constant than those in just the OHZ.

Figure 1. The stellar flux are multiples of the amount of flux Earth receives from the Sun. The color of the dots correspond to their star's spectral class.

CONCLUSION

A catalog of exoplanets containing potentially habitable exomoons was created. The catalog may be used by space telescopes to select candidates for finding exomoons, which may be found from at least 1-2.5 to 300 planetary radii from their parent planet. Given the distance of the planet from Earth, the angle needed to resolve such an exomoon given an assumed radius could be computed.

It is recommended to update the catalog every few years due to additional exoplanet discoveries.

Hill, M. L., Kane, S. R., Duarte, E. S., Kopparapu, R. K., Gelino, D. M., & Wittenmyer, R. A. (2018). Exploring Kepler giant planets in the habitable zone. *The Astrophysical Journal, 860*(1), 67.

Kipping, D., Bryson, S., Burke, C., Christiansen, J., Hardegree-Ullman, K., Quarles, B., ... & Teachey, A. (2022). An exomoon survey of 70 cool giant exoplanets and the new candidate Kepler-1708 bi. *Nature Astronomy, 6*(3), 367-380.